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IZA DP No. 9691

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Sabien Dobbelaere
Roland Iwan Luttens

January 2016

Forschungsinstitut
zur Zukunft der Arbeit
Institute for the Study
of Labor

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Sabien Dobbelaere
Vrije Universiteit Amsterdam, Tinbergen Institute and IZA

Roland Iwan Luttens
Amsterdam University College and Vrije Universiteit Amsterdam

Discussion Paper No. 9691
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IZA

P.O. Box 7240
53072 Bonn
Germany

Phone: +49-228-3894-0
Fax: +49-228-3894-180
E-mail: iza@iza.org

IZA Discussion Paper No. 9691
January 2016

ABSTRACT

Gradual Collective Wage Bargaining*

This paper presents an alternative implementation of firm-level collective wage bargaining, where bargaining proceeds as a finite sequence of sessions between a firm and a union of variable size. We investigate the impact of such a 'gradual' union on the wage-employment contract in an economy with concave production. In a static framework, the resulting equilibrium is equivalent to the efficient bargaining outcome. In a dynamic framework with search frictions, we demonstrate that gradual collective wage bargaining coincides with all-or-nothing bargaining when bargaining takes place in fictitious time before production.

JEL Classification: J30, J41, J51

Keywords: collective bargaining, gradual union, firm, search frictions, employment-at-will

Corresponding author:

Sabien Dobbelaere
Department of Economics
Vrije Universiteit Amsterdam
De Boelelaan 1105
1081 HV Amsterdam
The Netherlands
E-mail: sabien.dobbelaere@vu.nl

* We are grateful to Pieter Gautier and Aico van Vuuren for insightful comments. We especially thank Björn Brügemann for his thoughtful discussions and suggestions on an earlier version of the paper.

1 Introduction

The general assumption in canonical collective bargaining models is that all employed union members return to the external labor market permanently when negotiations fail.[1] In many real-world labor markets characterized by search frictions, such immediate termination may not be an accurate assumption because it entails, e.g., search costs of finding a new job, search costs of replacing the workforce and opportunity costs of forgone production. Therefore, it is unlikely that neither the union seriously contemplates leaving the firm permanently, nor the firm credibly considers dismissing its entire workforce.[2]

This paper presents an alternative implementation of decentralized collective wage bargaining, replacing the usual 'all-or-nothing' union by our proposed 'gradual' union. Essentially, in a discrete labor setting, the latter implies that the union bargains on behalf of N workers and if negotiations break down, the marginal worker leaves the firm and the union rebargains on behalf of the remaining $N-1$ workers, and so forth. In terms of interpretation, any time before production, the firm may fire an employee, or alternatively, an employee might grow frustrated and exit the firm after which bargaining resumes. Such a collective bargaining environment is particularly relevant in an 'at-will firm' where wage offers are unenforceable and renegotiations are frequent. We refer to Hogan (2001) for a rationalization of the presence of a union in an incomplete contracting environment.

We investigate the impact of a gradual union on the equilibrium wage-employment contract in both a static and dynamic framework of firm-level collective wage bargaining in an economy with concave production. In a static framework, the resulting equilibrium is equivalent to the equilibrium under efficient bargaining (EB), which assumes an all-or-nothing union (McDonald and Solow, 1981). In a dynamic framework where the firm cannot instantaneously replace workers after a breakdown of the wage bargaining, firm-level employment is no longer efficient. We demonstrate that gradual collective wage bargaining still coincides with all-or-nothing bargaining when bargaining takes place in fictitious time before production.

Our article relates to two strands of literature. First, our static analysis reexamines the work of Stole and Zwiebel (SZ) (1996a, 1996b) on intra-firm individual bargaining under non-binding contracts, based on the notion that contracts cannot commit the firm and its employees to wages and employment. The employment-at-will assumption, together with

[1] For the ungoing relevance of union wage bargaining, especially for European countries, we refer to Booth (2014).

[2] Bauer and Lingens (2013) provide a rare example of Ronald Reagan's dismissal of air trafic controllers in 1981, arguably a political rather than an economic act.

employee hold-up power, yields inefficiencies in hiring decisions. In equilibrium, the SZ firm overhires relative to the neoclassical (NC) firm to such an extent that bargained wages are driven down to the reservation wage. Our implementation of gradual collective wage bargaining allows to investigate how equilibrium wages and profits of SZ's at-will firm alter when bargaining takes place collectively rather than individually. Similar to all-or-nothing collective wage bargaining, gradual collective wage bargaining removes the wage externality by hindering firms from instantaneous renegotiations with individual workers. Table 1 summarizes various characteristics of the different bargaining arrangements that are compared in our static analysis.

Table 1: Characteristics of different bargaining arrangements

	Efficient bargaining (EB)	Intra-firm individual bargaining (SZ)	Gradual collective bargaining
Solution concept	generalized Nash	generalized Nash	generalized Nash
Bargaining parties	union-firm	worker-firm	union-firm
Bargaining scope	wages and employment	wages	wages
Disagreement action	all workers leave the firm	one worker leaves the firm	one worker leaves the firm
Nature of contract	binding	non-binding	non-binding

Second, we introduce a gradual union into the rent-sharing literature analyzing the interaction of search frictions and distortions caused by collective wage bargaining in a dynamic setting. We build on the work of Bauer and Lingens (BL) (2013) who investigate this interaction under the assumption of an all-or-nothing union in a large-firm random search model. In case the firm cannot immediately replace its workforce, two competing effects emerge: a strategic overhiring effect as in the SZ environment and a countervailing wage rise effect typical of unionized bargaining. BL demonstrate that the latter effect is more important and firm-level and aggregate employment are inefficiently low when the number of firms is held constant. We complement the analysis of BL by showing the equivalence between gradual and all-or-nothing bargaining when bargaining takes place in fictitious time before production starts. The fact that also under gradual bargaining all employees may exit off the equilibrium path in the current period explains this equivalence result. We conclude that inefficiencies in hiring decisions that arise in an economy characterized by search frictions and collective wage bargaining are not driven by the particular implementation of firm-level all-or-nothing collective bargaining.

The plan of the article is as follows. In Section 2, we introduce the gradual union in a static SZ framework. Section 3 extends the analysis to a dynamic large-firm search and bargaining environment. Section 4 concludes.

2 Gradual collective wage bargaining without search frictions

In Section 2.1, we present our gradual collective wage bargaining model in a static SZ framework with discrete labor and without externalities arising from job search. In Section 2.2, we derive the equilibrium wage-employment contract and demonstrate its equivalence with the equilibrium wage-employment contract under efficient bargaining.

2.1 Bargaining environment

Consider a fixed-size union of $\mathcal{N} \in \mathbb{N}$ members. A subset of N union members (the employees) work in the firm. We assume that the union is sufficiently large to cover labor demand ($N \leq \mathcal{N}$). We endogenize the choice of N later on. We denote $w(N)$ the employee's wage in a firm with N employees. The reservation wage is $\underline{w}$. The firm utilizes a single-asset, strictly increasing and strictly concave production function $F(N) : \mathbb{N} \to \mathbb{R}_+$. We assume that $F(j) \geq j\underline{w}$ for $j \in \{1, \ldots, N\}$. Furthermore, $F(0) = 0$. Denote Δ the first-difference operator, e.g. $\Delta F(N) = F(N) - F(N-1)$. The firm's profit function equals $\Pi(N) = F(N) - Nw(N)$. The neoclassical firm's profit function is denoted by $\Pi^{NC}(N) = F(N) - N\underline{w}$. Both the firm and workers are risk-neutral.

In the at-will firm, wage offers are unenforceable. Any time before production starts, the firm may fire an employee, or alternatively, an employee may quit the firm. Employees are irreplaceable. An employee who returns to the external labor market can never re-enter the firm and stays a union member earning the reservation wage.

Union preferences are represented by a utilitarian objective function. The union's payoff when there are N employees equals:

$$Nw(N) + (\mathcal{N} - N)\underline{w} \tag{1}$$

The union's payoff when there are $N-1$ employees equals:

$$Nw(N) + (\mathcal{N} - N)\underline{w}(N-1)w(N-1) + (\mathcal{N} - N + 1)\underline{w} \tag{2}$$

Hence, the gradual union's net gain from reaching a bargaining agreement equals:

$$Nw(N) - (N-1)w(N-1) - \underline{w} \tag{3}$$

The firm's net gain from reaching a bargaining agreement equals:

$$\Pi(N) - \Pi(N-1) \tag{4}$$

Following the collective bargaining literature, we assume that conventional generalized Nash bargaining is the appropriate solution concept. The bargaining scope is negotiation over wages alone. The firm chooses the employment level that maximizes profits. The bargained wage follows from maximizing the Nash product Ω:

$$\Omega = [Nw(N) - (N-1)w(N-1) - \underline{w}]^{\phi}[\Pi(N) - \Pi(N-1)]^{1-\phi} \tag{5}$$

where $\phi \in [0,1]$ denotes the workers' bargaining power.

For the sake of expositional clarity, we present an extensive-form bargaining game which unique subgame perfect equilibrium corresponds with the equilibrium wage-employment contract that follows from our static model.

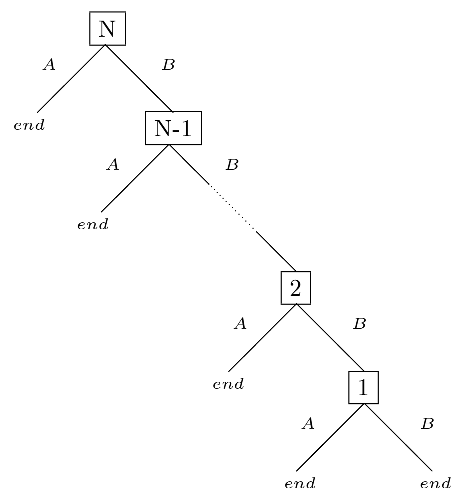

Figure 1: The gradual union bargaining game.

Bargaining proceeds as a finite sequence of pairwise bargaining sessions over wages between the union and the firm. In Figure 1, each bargaining session is depicted by a box, representing the number of employees on which behalf the union is negotiating with the firm. In the first bargaining session, the union represents N employees. In each bargaining session, either the union and the firm reach an agreement (A), or negotiations break down (B). Whenever an agreement is reached, the game ends. Whenever a bargaining session ends in a breakdown, one randomly chosen employee exits the game forever, after which bargaining instantaneously starts again between the firm and the union representing the remaining employees. At most N bargaining sessions can occur before the game terminates in which case all employees have dropped out following failed bargaining sessions.

Within each bargaining session, the union and the firm play a variant of the Rubinstein (1982) alternating-offers game where the firm and the union alternate wage offers. If an offer is accepted, production occurs and the wage is paid. If an offer is rejected by the firm (union), the bargain is either terminated by a specific separation shock that hits at a rate ϕ_f (ϕ_u) or proceeds to the next round, allowing the firm (union) to make a counteroffer. The game continues until the bargaining parties are separated or reach an agreement, which will occur instantaneously in equilibrium. Binmore *et al.* (1986) show that the generalized Nash bargaining solution emerges for the limit outcome where the time between offer and counteroffer approaches zero.[3]

2.2 Equivalence with efficient bargaining

Using the sharing rule that follows from maximizing Eq. (5), it holds that:

$$\Pi(j) - \Pi(j-1) = \frac{1-\phi}{\phi}(jw(j) - (j-1)w(j-1) - \underline{w}) \quad \text{for all } j = 1, \ldots, N \tag{6}$$

Since $\Pi(j) = F(j) - jw(j)$ and $\Pi(j-1) = F(j-1) - (j-1)w(j-1)$, it follows that:

$$jw(j) - (j-1)w(j-1) = \phi\Delta F(j) + (1-\phi)\underline{w} \tag{7}$$

Summing up Eq. (7) for $j = 1, \ldots, N$, we obtain:

$$Nw(N) = \phi \sum_{j=1}^{N} \Delta F(j) + (1-\phi)N\underline{w} = \phi F(N) + (1-\phi)N\underline{w} \tag{8}$$

Using Eq. (8), the firm's profit equals:

$$\Pi(N) = (1-\phi)\left[F(N) - N\underline{w}\right] = (1-\phi)\Pi^{NC}(N) \tag{9}$$

Hence, the profit-maximizing firm chooses the employment level that coincides with the optimal employment level of the NC firm that writes binding contracts with its workers at the reservation wage. It is well known that the optimal level of employment under efficient

[3] The bargaining power of the union ϕ equals $\frac{\phi_f}{\phi_u + \phi_f}$.

bargaining with risk-neutral agents also coincides with the latter. As such, we obtain a powerful efficiency argument for gradual collective bargaining.

Table 2 compares the equilibrium wage-employment contract in our setting with those of the NC firm, the EB firm and the SZ firm.[4]

Table 2: Comparison of equilibrium wage-employment contracts

Employment	$N^{EB} = N = N^{NC} < N^{SZ}$
Wage	$w^{SZ} = w^{NC} < w^{EB} = w$
Profits	$\Pi^{EB} = \Pi < \Pi^{SZ} < \Pi^{NC}$

Our equivalence result with EB confirms that in a static SZ environment, collective wage bargaining removes the wage externality by hindering firms from instantaneous renegotiations with its individual workers. As Stole and Zwiebel (1996b, Sec. III.B.) demonstrate, a union has the effect of linearizing the production function since the firm is now dealing with a single entity whose marginal product is identical to its total product. As a result, the bargained wage is no longer a function of employment and thus, the firm has no strategic overhiring incentive anymore. It is important that the efficiency argument for collective bargaining holds irrespective of whether one considers a gradual union (as we do) or an all-or-nothing union (as in Stole and Zwiebel, 1996b).

In the next section we extend the analysis to a dynamic environment with search frictions.

3 Gradual collective wage bargaining with search frictions

In Section 3.1, we introduce the dynamic large-firm search and bargaining environment of BL, following the work of Smith (1999) and Cahuc and Wasmer (2001). In Section 3.2, we derive the wage setting curve under gradual collective wage bargaining and show that the equilibrium under gradual collective wage bargaining coincides with the equilibrium under all-or-nothing collective bargaining. In Section 3.3, we discuss the inefficient equilibrium allocation that emerges in our economy.

[4] The rankings in Table 2 assume that $\phi \in (0, 1)$ in our setting, the EB setting and the SZ setting.

3.1 Environment

Time proceeds as a infinite sequence of discrete periods, where the length of a time interval is denoted by δ. Consider a continuum of workers and a large, countable number of firms m. The population of workers, who each supply one unit of labor inelastically, is fixed and normalized to one. Each firm i opens a continuum of vacancies V_i which involve flow costs $c\delta$ per vacancy and employs a continuum of workers N_i. All agents are risk-neutral, infinitely lived and discount future income at rate r. All firms use an identical production technology $F(N_i)$ with the same properties as in our static model.

The aggregate number of matches between workers and firms is given by $M(U,V) = \kappa U^{\gamma} V^{1-\gamma}$, where $\kappa > 0$, $\gamma \in (0,1)$, V is the economy-wide number of vacancies and U is the pool of unemployed workers. Let labor market tightness be denoted by $\theta = V/U$, the vacancy filling rate by $\lambda_m(\theta) = M/V = \kappa\theta^{-\gamma}$ and the job finding rate by $p(\theta) = \theta\lambda_m(\theta)$. At the end of each period, an exogenous proportion λ_s of filled jobs are destroyed.

3.2 Equilibrium wage-employment contract

The timing of events is as follows. First, wages are bargained. Then, firms choose the number of vacancies, given the bargained wage. As the firm's problem is stationary, it can be solved recursively. In what follows, we do not explicitly consider the vacancy choice of the firm but refer to BL for the derivation of the job creation curve, which we here repeat for further reference:

$$\frac{\partial F(N_i)}{\partial N_i} - \frac{\partial w(N_i)}{\partial N_i} N_i = w(N_i) + (r + \lambda_s) \frac{c}{\lambda_m(\theta)} \tag{10}$$

We now turn to the derivation of the wage-setting curve for our gradual collective wage bargaining setting.

Wage determination

We assume that we are in a steady state in which the firm always returns to the target employment level $\mathcal{N}_i$ in the next period, irrespective of what happens in the current period. This implies that the size of the union is constant at $\mathcal{N}_i$.

The utility of an employed worker in a firm with employment N_i is:

$$W^e(N_i) = w(N_i)\delta + \frac{1}{1+r\delta}\left[(1-\lambda_s\delta)W^e(\mathcal{N}_i) + \lambda_s\delta W^b\right] \tag{11}$$

where W^b denotes the outside option of the worker.

The utility of an employed worker in a firm with employment $N_i - \varepsilon$ is:

$$W^e(N_i - \varepsilon) = w(N_i - \varepsilon)\delta + \frac{1}{1 + r\delta}[(1 - \lambda_s\delta)W^e(\mathcal{N}_i) + \lambda_s\delta W^b] \tag{12}$$

Next, we specify the union objective. With N_i workers, the payoff of the union is:

$$\Psi(N_i) = N_i W^e(N_i) + (\mathcal{N}_i - N_i)W^b \tag{13}$$

If ε workers leave the firm, the payoff of the union is:

$$\Psi(N_i - \varepsilon) = (N_i - \varepsilon)W^e(N_i - \varepsilon) + (\mathcal{N}_i - N_i + \varepsilon)W^b \tag{14}$$

Thus:

$$\begin{aligned}\Psi(N_i) - \Psi(N_i - \varepsilon) &= N_i\left[W^e(N_i) - W^e(N_i - \varepsilon)\right] + \varepsilon\left[W^e(N_i - \varepsilon) - W^b\right] \\ &= N_i\left[w(N_i) - w(N_i - \varepsilon)\right]\delta + \varepsilon\left[w(N_i - \varepsilon) - \frac{r}{1 + r\delta}W^b\right]\delta \\ &+ \varepsilon\frac{1}{1 + r\delta}(1 - \lambda_s\delta)\left[W^e(\mathcal{N}_i) - W^b\right]\end{aligned} \tag{15}$$

Turning to the firm side, the payoff (profit) of the firm with N_i workers is:

$$\Pi\left(N_i\right) = \left[F\left(N_i\right) - w(N_i)N_i - cV_i\right]\delta + \frac{1}{1 + r\delta}\Pi\left(\mathcal{N}_i\right) \tag{16}$$

Since the difference equation for firm-level employment equals:

$$\mathcal{N}_i = N_i + \lambda_m\left(\theta\right)\delta V_i - \lambda_s\delta N_i \tag{17}$$

it holds that:

$$V_i = \frac{\mathcal{N}_i - \left(1 - \lambda_s\delta\right)N_i}{\lambda_m\left(\theta\right)\delta} \tag{18}$$

Substituting Eq. (18) in Eq. (16) yields:

$$\Pi\left(N_i\right) = \left[F\left(N_i\right) - w(N_i)N_i - \left[\mathcal{N}_i - (1 - \lambda_s\delta)N_i\right]\frac{c}{\lambda_m\left(\theta\right)\delta}\right]\delta + \frac{1}{1 + r\delta}\Pi\left(\mathcal{N}_i\right) \tag{19}$$

If ε workers leave the firm, the payoff of the firm is:

$$\begin{aligned}\Pi\left(N_i - \varepsilon\right) = &\left[F\left(N_i - \varepsilon\right) - w(N_i - \varepsilon)\left(N_i - \varepsilon\right) - \left[\mathcal{N}_i - \left(1 - \lambda_s\delta\right)\left(N_i - \varepsilon\right)\right]\frac{c}{\lambda_m\left(\theta\right)\delta}\right]\delta \\ &+ \frac{1}{1 + r\delta}\Pi\left(\mathcal{N}_i\right)\end{aligned} \tag{20}$$

Thus:

$$\begin{aligned}\Pi\left(N_i\right)-\Pi\left(N_i-\varepsilon\right)=&\left[F\left(N_i\right)-F\left(N_i-\varepsilon\right)-N_i\left[w(N_i)-w(N_i-\varepsilon)\right]\right.\\&\left.-\varepsilon w(N_i-\varepsilon)+\varepsilon\frac{(1-\lambda_s\delta)}{\delta}\frac{c}{\lambda_m\left(\theta\right)}\right]\delta\end{aligned}\tag{21}$$

The surplus sharing rule following Nash bargaining in our gradual union setting implies:

$$\phi\left[\Pi\left(N_i\right)-\Pi\left(N_i-\varepsilon\right)\right]=(1-\phi)\left[\Psi(N_i)-\Psi(N_i-\varepsilon)\right]\tag{22}$$

Substituting Eqs. (15) and (21) in Eq. (22), dividing both sides by ε and taking the limit as $\varepsilon\rightarrow 0$ yields:

$$\begin{aligned}&\phi\left[\frac{\partial F\left(N_i\right)}{\partial N_i}-N_i\frac{\partial w(N_i)}{\partial N_i}-w(N_i)+\frac{(1-\lambda_s\delta)}{\delta}\frac{c}{\lambda_m\left(\theta\right)}\right]\delta\\&=(1-\phi)\left[\left(N_i\frac{\partial w(N_i)}{\partial N_i}+w(N_i)-\frac{r}{1+r\delta}W^b\right)\delta+\frac{r}{1+r\delta}(1-\lambda_s\delta)\left(W^e(\mathcal{N}_i)-W^b\right)\right]\end{aligned}\tag{23}$$

Notice that on both sides, the wage schedule $w(N_i)$ enters only via the derivative of the total wage bill. Isolating this derivative on the left-hand side yields:

$$\begin{aligned}N_i\frac{\partial w(N_i)}{\partial N_i}+w(N_i)=&\;\phi\left[\frac{\partial F\left(N_i\right)}{\partial N_i}+\frac{(1-\lambda_s\delta)}{\delta}\frac{c}{\lambda_m\left(\theta\right)}\right]\\&+(1-\phi)\frac{1}{\delta}\left[\frac{r\delta}{1+r\delta}W^b-\frac{1}{1+r\delta}\left(1-\lambda_s\delta\right)\left(W^e(\mathcal{N}_i)-W^b\right)\right]\end{aligned}\tag{24}$$

Integrating Eq. (24) and dividing both sides by N_i yields the wage-setting curve in our gradual collective wage bargaining setting:

$$\begin{aligned}w(N_i)=\phi\frac{F\left(N_i\right)}{N_i}+&\left[\phi\frac{(1-\lambda_s\delta)}{\delta}\frac{c}{\lambda_m\left(\theta\right)}+(1-\phi)\frac{r}{1+r\delta}W^b\right.\\&\left.-(1-\phi)\frac{1}{\delta}\frac{1}{1+r\delta}\left(1-\lambda_s\delta\right)\left(W^e(\mathcal{N}_i)-W^b\right)\right]\end{aligned}\tag{25}$$

Equivalence with wage setting under all-or-nothing collective wage bargaining

In order to show the equivalence with wage setting under all-or-nothing collective wage bargaining of BL, we derive the steady-state wage. In steady state $N_i=\mathcal{N}_i$. Using Eq. (11) to solve for $W^e(\mathcal{N}_i)-W^b$ yields:

$$W^e(\mathcal{N}_i)-W^b=\frac{1}{r+\lambda_s}\left[\left(1+r\delta\right)w(\mathcal{N}_i)-rW^b\right]\tag{26}$$

Substituting Eq. (26) in Eq. (25), multiplying both sides by $(1 + r\delta)$ and subtracting rW^b from both sides gives:

$$(1 + r\delta)\, w(\mathcal{N}_i) - rW^b = (1 + r\delta)\, \phi \left[\frac{F(\mathcal{N}_i)}{\mathcal{N}_i} + \frac{(1 - \lambda_s \delta)}{\delta} \frac{c}{\lambda_m(\theta)} - \frac{r}{1 + r\delta} W^b \right] - (1 - \phi) \frac{1}{\delta} (1 - \lambda_s \delta) \frac{1}{r + \lambda_s} \left[(1 + r\delta)\, w(\mathcal{N}_i) - rW^b \right] \tag{27}$$

Solving Eq. (27) for $(1 + r\delta)\, w(\mathcal{N}_i) - rW^b$, using that $1 + (1 - \phi) \frac{1}{\delta} (1 - \lambda_s \delta) \frac{1}{r+\lambda_s} = \phi + (1 - \phi) \frac{1}{\delta} \frac{1+r\delta}{r+\lambda_s}$, we obtain:

$$(1 + r\delta)\, w(\mathcal{N}_i) - rW^b = \frac{(1 + r\delta)\, \phi}{\phi + (1 - \phi) \frac{1}{\delta} \frac{1+r\delta}{r+\lambda_s}} \left[\frac{F(\mathcal{N}_i)}{\mathcal{N}_i} + \frac{(1 - \lambda_s \delta)}{\delta} \frac{c}{\lambda_m(\theta)} - \frac{r}{1 + r\delta} W^b \right] \tag{28}$$

Dividing both sides of Eq. (28) by $(1 + r\delta)$ and defining

$$\widehat{\beta} = \frac{1}{1 + \frac{1-\phi}{\phi} \frac{1}{\delta} \frac{1+r\delta}{r+\lambda_s}} = \frac{\delta}{\delta + \frac{1-\phi}{\phi} \frac{1+r\delta}{r+\lambda_s}}$$

yields:

$$w(\mathcal{N}_i) = \widehat{\beta} \left[\frac{F(\mathcal{N}_i)}{\mathcal{N}_i} + \frac{(1 - \lambda_s \delta)}{\delta} \frac{c}{\lambda_m(\theta)} \right] + \left(1 - \widehat{\beta} \right) \frac{1}{1 + r\delta} rW^b \tag{29}$$

Eq. (29) coincides with the wage-setting curve (WS) in BL (p. 1075). In the latter, $\frac{1-\phi}{\phi}$ is replaced by the ratio of separation rates $\frac{\phi_u}{\phi_f}$.

This equivalence between wage setting under gradual collective bargaining and all-or-nothing collective bargaining arises because also under gradual bargaining all employees may exit off the equilibrium path in the current period. Hence, breaking the bargaining process down in gradual steps does not affect the wage outcome. It is important to note that our equivalence result is obtained when bargaining occurs in fictitious time before production starts.

As BL show, Eqs. (10) and (29) determine employment and wages at the firm level. Employment satisfies:

$$\frac{\partial F(\mathcal{N}_i)}{\partial \mathcal{N}_i} = \frac{1}{1 - \widehat{\beta}} \left[\widehat{\beta} \frac{1 - \lambda_s \delta}{\delta} + r + \lambda_s \right] \frac{c}{\lambda_m(\theta)} + \frac{1}{1 + r\delta} rW^b \tag{30}$$

Note that in the absence of search frictions ($c = 0$), employment is efficient as the marginal production value of a worker equals the worker's outside option, as long as the environment implies $\delta \longrightarrow 0$. This observation confirms our static equivalence result of gradual collective wage bargaining and efficient bargaining of McDonald and Solow (1981) (see Section 2.2).

3.3 Inefficient equilibrium allocation

We discuss the inefficient equilibrium allocation that arises in our search and collective wage bargaining economy in the case of an exogenous number of firms. Given the equivalent wage setting under all-or-nothing or gradual collective bargaining, this allocation coincides with the equilibrium allocation of BL who derive that firm-level employment and labor market tightness are inefficiently low. We highlight the role of the curvature of the production function and the union's bargaining power in affecting the firm's optimal employment decision.

When workers cannot be replaced instantaneously, the firm has an incentive to hire strategically, which can be seen from differentiating Eq. (29):

$$\frac{\partial w(\mathcal{N}_i)}{\partial \mathcal{N}_i} = \frac{\widehat{\beta}}{\mathcal{N}_i}\left[\frac{\partial F(\mathcal{N}_i)}{\partial \mathcal{N}_i} - \frac{F(\mathcal{N}_i)}{\mathcal{N}_i}\right] \leq 0 \tag{31}$$

This wage externality allows the firm to lower the wage by hiring additional workers. In isolation, overemployment would result. However, not only the incentive for overhiring emerges but bargained wages also increase. This countervailing wage rise effect arises for two reasons. First, workers' ability to hold up production increases firms' costs of rejecting a wage offer. Second, overhiring increases workers' job finding probability and thereby decreases the workers' costs of rejecting a wage offer.

BL demonstrate that the countervailing wage rise effect dominates the strategic vacancy posting effect by comparing the policy function, which implicitly relates firm-level employment $\mathcal{N}_i$ to labor market tightness θ, in their all-or-or-nothing collective bargaining setting to the policy function of a utilitarian planner. In a symmetric stationary equilibrium where firm-level and aggregate employment are constant, these policy functions take the following form (see Eqs. (23) and (22) in BL):

$$\frac{\partial F(\mathcal{N}_i)}{\partial \mathcal{N}_i} = \frac{r+\lambda_s+\gamma p(\theta)}{1-\gamma}\frac{c}{\lambda_m(\theta)} + \frac{a_1}{1-a_1}\left(-\frac{\partial w(\mathcal{N}_i)}{\partial \mathcal{N}_i}\mathcal{N}_i\right) \tag{32}$$

$$\frac{\partial F(\mathcal{N}_i)}{\partial \mathcal{N}_i} = \frac{r+\lambda_s+\gamma p(\theta)}{1-\gamma}\frac{c}{\lambda_m(\theta)} \tag{33}$$

with $a_1 = \frac{p(\theta)}{r+\lambda_s+p(\theta)}$. In Eq. (32), the Hosios condition is imposed to ensure that the crowding externality of firms' vacancy choice is internalized.

An increase in the curvature of the production function (via $\frac{\partial F(\mathcal{N}_i)}{\partial \mathcal{N}_i} - \frac{F(\mathcal{N}_i)}{\mathcal{N}_i}$) or a larger bargaining power of the union (via $\widehat{\beta}$) increases $\frac{\partial w(\mathcal{N}_i)}{\partial \mathcal{N}_i}$ in Eq. (31). Hence, inefficiently low equilibrium firm-level employment negatively depends on both the curvature and the union bargaining power parameters (see Eq (32)).

4 Conclusion

To acknowledge the prevalence of collective bargaining in contemporary labor markets characterized by search frictions, this paper presents an alternative implementation of firm-level collective wage bargaining. In a sequence of bargaining sessions, the gradual union bargains on behalf of its workers and if negotiations break down, a marginal employee leaves the firm and the union rebargains on behalf of the remaining workers. We investigate the impact of gradual collective bargaining on the equilibrium wage-employment contract in an economy with concave production.

In the static framework of Stole and Zwiebel (1996a, 1996b), the resulting equilibrium is equivalent to the static efficient bargaining outcome of McDonald and Solow (1981). The driving force behind this equivalence result is that collective wage bargaining removes the wage externality by preventing firms from renegotiating instantaneously with its individual workers. A union has the effect of linearizing the production function. The bargained wage is no longer a function of employment and the firm has no strategic overhiring incentive anymore. The efficiency argument for collective bargaining holds irrespective of whether one considers a gradual union or an all-or-nothing union.

In the dynamic framework with search frictions of Bauer and Lingens (2013), we demonstrate that wage setting under gradual collective bargaining and all-or-nothing collective bargaining again coincide when bargaining takes place in fictitious time before production starts. In case the firm cannot immediately replace its workforce and abstracting from firm entry, it has been shown that the wage rise effect typical of unionized bargaining dominates the strategic overhiring effect. We conclude that the resulting inefficient equilibrium allocation in a search and collective wage bargaining economy is not driven by the particular implementation of firm-level all-or-nothing collective bargaining.

References

[1] **Bauer, Christian, and Jörg Lingens.** 2013. "Does collective wage bargaining restore efficiency in a search model with large firms?" *Economic Journal*, 124(579): 1066-1085.

[2] **Binmore, Kenneth, Ariel Rubinstein, and Asher Wolinsky.** 1986. "The Nash bargaining solution in economic modeling." *Rand Journal of Economics*, 17(2): 176-188.

[3] **Booth, Alison.** 2014. "Wage determination and imperfect competition". *Labour Economics*, 30: 53-58.

[4] **Cahuc, Pierre, and Etienne Wasmer.** 2001. "Does intrafirm bargaining matter in the large firm's matching model?" *Macroeconomic Dynamics*, 5(5): 742-747.

[5] **Hogan, Chad.** 2001. "Enforcement of implicit employment contracts through unionization." *Journal of Labor Economics*, 19(1): 171-195.

[6] **McDonald, Ian M., and Robert M. Solow.** 1981. "Wage bargaining and employment." *American Economic Review*, 71(5): 896-908.

[7] **Rubinstein, Ariel.** 1982. "Perfect equilibrium in a bargaining model". *Econometrica*, 50(1): 97-109.

[8] **Smith, Eric.** 1999. "Search, concave production and optimal firm size." *Review of Economic Dynamics*, 2(2): 456-471.

[9] **Stole, Lars A., and Jeffrey Zwiebel.** 1996a. "Intrafirm bargaining under non-binding contracts." *Review of Economic Studies*, 63(3): 375-410.

[10] **Stole, Lars A., and Jeffrey Zwiebel.** 1996b. "Organizational design and technology choice under intrafirm bargaining." *American Economic Review*, 86(1): 195-222.