BERTRAND COMPETITION, EMPLOYMENT RATIONING AND COLLUSION
THROUGH CENTRALIZED NEGOTIATIONS

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Abstract
This paper studies the role of employment rationing in a unionized oligopolistic industry. Firms bargain collectively with an industry-wide union, and then compete in prices. Negotiations may be conducted over a bonus scheme which specifies the bonus that each employee receives if firm/industry profits exceed a certain target (or if industry employment does not exceed a certain level). After firms have chosen prices, they request workers from the union to realize their production plans. The number that each firm actually receives depends on the union's rationing scheme. Firms, by a suitable choice of a bonus scheme, can ensure a collusive outcome in equilibrium. Indeed, firms have no incentive to deviate from the monopoly price knowing that they would be optimally rationed by the union (JEL Classification: L42, J33, J51).

Key words
Centralized Negotiations, Bertrand Competition, Collusion, Employment Rationing.

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1 Introduction

Recent empirical work suggests that profit-sharing in one form or another is a widespread practice. Smith[17] reports that for the U.K., 21% of companies had at least one all-employee scheme. Blanchflower and Oswald[5] found that in 1984, 40% of the workers in the private manufacturing and non-manufacturing sector (U.K.) were eligible to participate in a profit-sharing scheme, and regarding actual participation they found that 25% of workers were involved in a share-ownership scheme, 20% in a profit-sharing scheme and 15% in value-added bonus schemes. Freeman and Weitzman[11] observe that the Japanese bonus system has the essential features of profit sharing, and is often cited as one main reason why Japanese firms face a less adversary relationship with their employees as compared to American firms.

Given the prevalence of such schemes one is naturally led to ask: why are profit-sharing schemes adopted by industries? Indeed, recent evidence on profit sharing (see e.g. Cable and Wilson[6]), suggests that the introduction of profit sharing will not necessarily have productivity enhancing effects unless there are accompanying changes in other dimensions of organisational design. Wadhwani and Bell[21] also support this conclusion for a sample of manufacturing firms in the UK. In the absence of such productivity enhancing effects of profit sharing would firms adopt such schemes?

There have been some recent attempts to answer this question: some of the theoretical literature on profit-sharing includes e.g. Weitzmann[22, 23, 24], who in a series of macro-theoretic papers advocated profit-sharing schemes to help increase aggregate employment. The strategic interdependence of firms is neglected in these models, the market being monopolistically competitive. Fung[12], Stewart[19] and Bensaid and Gary-Bobo[1], on the other hand, use strategic considerations in profit-sharing at the firm level, as the driving force of their models. In Bensaid and Gary-Bobo, for example, profit-sharing contracts are viewed as a means of strategic commitment. It is shown that with Cournot competition in the product market, profit-sharing by a firm is a best response to both the wage system and profit sharing by other firms, but all firms are worse off when they adopt such schemes. Employment increases and output prices decrease.

Our paper suggests an alternative explanation of why firms may adopt profit-sharing schemes. Our setting is a homogeneous Bertrand oligopolistic industry where firms negotiate with an industry-wide union in the labour
market. Contrary to the previous literature, we show that profit-sharing schemes have in fact negative effects on employment and that these negative effects are exacerbated in the presence of a minimum wage in the industry.

Profit-sharing traditionally refers to a two-tier payment scheme for workers, where one part of the scheme consists of a flat wage rate and the other consists of a “share” of the firm profits. Thus profit-sharing could refer to a continuous scheme where total remuneration to labor rises with firm (industry) profits, or it could refer to a bonus scheme where workers receive a higher total remuneration when the firm (industry) profits rise above a target level.

In particular, this paper investigates the possible use of bonus schemes by firms as a collusion facilitating device in homogeneous oligopolistic industries where firm-union negotiations are conducted at the industry level. We consider a multi-stage oligopoly game. In the first stage, the representatives of the firms jointly offers a contract (bonus scheme) to an industry-wide union. Then the union accepts or rejects; if it rejects the scheme, the usual wage system is implemented. In the third stage firms set their prices and also announce their requisitions for labor from the union. The union then decides to satisfy the firms demands for workers, or ration those demands. Thereafter, firms produce to satisfy their demands at the prices set, subject to the labor supply constraint (if any) that the union has imposed on them. The wage rate at which workers can be hired if their union refuses the contract are assumed to be exogenously given.

We show that firms in a homogeneous Bertrand oligopoly, by effectively delegating their employment decision to the union through a properly selected bonus scheme, can make strictly positive profits in equilibrium. Indeed, the firms are able to achieve the “monopoly” outcome, albeit at the expense of an increase in their marginal costs equal to the bonus offered. The industry-wide union in effect being used as a “common agent” (Bernheim and Whinston [4, 3]) in our model. However, this paper exploits the institution of centralized negotiations to allow joint contracts between the firms and the union, while the usual common agency models assume independent actions by the firms.

The idea that unions can be used strategically by firms is not new. It has been introduced, however, only in the literature on barriers to entry. Dewatripont ([9]) considers a model where an incumbent firm prevents potential entry by signing a labor contract with its union, and thus committing to an
excessive post-entry output. Similarly, in a case described by Williamson ([25]), *United Mine Workers v Pennington*, the main issue was a contract between the union and a multi-employer bargaining unit to charge a uniform wage rate to all firms, regardless of ability to pay. Of course, once union-firm negotiations have been considered as a barrier to entry mechanism, their use as a collusive device cannot be ruled out either.

The rest of the paper is organised as follows: Section 2 introduces a benchmark model of a symmetric homogeneous Bertrand duopoly and the main result is demonstrated for this model. It also generalizes the result to a symmetric homogeneous oligopoly. Section 3 discusses conditions under which a bonus scheme that satisfies the participation constraint of the union exists and provides necessary condition for some specific family of demands. In Section 4 possible extensions are briefly discussed. Finally, Section 5 concludes with some references to related literature and policy implications.

## 2 The benchmark model: Bertrand duopoly

We consider two identical firms producing a homogeneous good in a unionized industry. The inverse demand function for the good is denoted by $P(Q)$ where $Q$ is its quantity, and $D(p)$ denotes its demand for a price $p$, with $D'(p) < 0$. Firms are endowed with one factor technologies given by: $x_i = x_i(L_i)$ where $L_i$ is the labour supplied to firm $i$, $i = 1, 2$. For simplicity, we assume constant returns to scale, i.e. $x_i = aL_i$, with $a > 0$ a constant, representing the productivity of labour. All workers belong to an industry-wide union whose objective is to maximize:

$$U(w - w_0, L)$$

where $w_0$ represents the workers best alternative wage (e.g. the competitive wage or the unemployment benefits). $U(.)$ is increasing in both the wage rate, $w$, and the aggregate employment, $L$, and in general there is some substitutability between wages and aggregate employment. In what follows, we assume that the wage rate has been negotiated between firms and the union in a previous stage, hence it will be taken as exogenously given$^1$.

$^1$It is a common practice that wages are negotiated first, and once the wage rate has been agreed upon, firms and unions negotiate over a profit-related payment (PRP). See e.g. the British Trade Union Congress guidelines (Wadhwani and Wall [21]).
The firms and the union are involved in a 4-stage game: In stage 1, they bargain over a bonus scheme to be paid to the employees under some specified conditions. For simplicity, we model this bargaining as a take-it-or-leave-it offer: firms have all the bargaining power to set the bonus scheme and workers can only respond with a “yes” or “no”. This simply determines whether the participation constraint of the union is satisfied. Thus, in stage 1, a representative of the firms confers with a representative of the union, and offers a bonus scheme, BS, for the workers of the form:

\[ r = w + b \quad \text{if} \quad \pi \geq \bar{\pi} \]
\[ = w \quad \text{if} \quad \pi < \bar{\pi} \]  \hspace{1cm} (1)

where \( r \) represents the total remuneration per worker, \( b \) the bonus, and \( \pi \) the total industry profits. The firms (jointly) choose \( b \) and \( \pi \) and the union accepts or rejects the scheme. Alternatively, the firms’ representative may offer a bonus scheme, \( BS' \), of the form:

\[ r = w + b \quad \text{if} \quad L \leq \bar{L} \]
\[ = w \quad \text{if} \quad L > \bar{L} \]  \hspace{1cm} (2)

where \( \bar{L} \) is the maximum number of workers that the union assigns to all the firms in the industry. The firms then select \( b \) and \( \bar{L} \) and the union accepts or rejects. This alternative bonus scheme is more appropriate when unions have incomplete information about the profits of firms, and may not be willing to condition wages on something they do not directly observe. On the other hand, an industry-wide union has often control over the aggregate employment in the industry. In what follows, we will concentrate on the bonus scheme \( BS \). However, the results do not depend on whether the target level is aggregate employment or industry profits. With a simple modification of the union’s rationing rule (see the asymmetric duopoly case below), we get exactly the same results. As we will see, the essential point is the delegation of the labour supply decision to the union and the conversion of the infinitely elastic labour supply curve to a step labour supply function – a quantity premium rather than a discount.

\[ ^2 \text{It is also more convenient when there are asymmetries in productivity between firms.} \]
In stage 2, the firms simultaneously and independently set prices. In this stage, the requisition for labour \((L_1, L_2)\) is also made\(^3\).

In stage 3, the union chooses the allocation of labour to the two firms; \((\hat{L}_1, \hat{L}_2)\), with the sum denoted by \(\hat{L}\). Firms are not obliged to pay all the workers allocated to them; they will only pay those workers they use to satisfy their demands for a given vector of prices \((p_1, p_2)\). Let \(\bar{L}\) denote the workers actually used by the firms. Then the union gets:

\[
U(w - w_0 + b, \bar{L}) \quad \text{if} \quad \pi \geq \bar{\pi}
\]

and

\[
U(w - w_0, \bar{L}) \quad \text{if} \quad \pi < \bar{\pi}
\]

In the last stage, each firm carries out its production plans according to \(\min(x_i(p_i), x_i(\hat{L}_i))\) and sells its product at the announced price \(p_i\), where \(x_i(p_i) = D(p_i)\) if \(p_i < p_j\), \(x_i = 0\) if \(p_i > p_j\) and \(x_i(p_i) = \frac{D(p_i)}{2}\) if \(p_i = p_j\). Wages and bonus are paid in accordance with the initial agreement. Each firm pays only the workers it uses.

We now demonstrate a subgame perfect equilibrium of this game which has the characteristic that if the participation constraint of the union is satisfied, then Bertrand firms can make strictly positive profits. Let \(L_m\) denote the aggregate employment corresponding to the monopoly output \(x_m\) at the marginal cost \(\frac{w + b}{a}\), \(p_m\) the corresponding monopoly price, while \(L_b\) represents aggregate employment at the Bertrand level of output, with marginal cost \(\frac{w}{a}\).

**Proposition 1:** The following is a subgame perfect equilibrium of the 4-stage game described above: in stage 1, firms choose as target the "monopoly" level of profits \(\pi_m\) and a bonus \(b\) such that the union's participation constraint is satisfied as an equality, i.e.

\[
U(w + b - w_0, L_m) = U(w - w_0, L_b)
\]  

\[(4)\]

In stage 2, both firms choose the monopoly price \(p_m\). In stage 3, the union supplies labour according to \((\frac{L_m}{2}, \frac{L_m}{2})\) and in stage 4, each firm produces output \(\frac{x_m}{2}\) and sells it at \(p_m\).

\(^3\)We do not insist that requisition of labour be made simultaneously and it would not change the results to have it sequential to the announcement of prices.
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\(^3\)We do not insist that requisition of labour be made simultaneously and it would not change the results to have it sequential to the announcement of prices.
We present some preliminary results before the main proof. Let $\bar{L}$ represent the labour demand corresponding to the profit level $\bar{\pi}$, i.e. with marginal cost given by $\frac{u+b}{a}$, if $\bar{L}$ is supplied to the industry the profit level is $\bar{\pi}$. Note first that, whenever firms announce $(p_1, p_2)$, then labour is requisitioned according to $(\frac{D(p_1)}{a}, \frac{D(p_2)}{a})$. Since a firm pays only the labour it uses, it will requisition $L_i \geq \bar{L}_i$ if $\bar{L}_i$ denotes the amount it will actually use. Then the maximum firm $i$ can use is $\frac{D(p_i)}{a}$, and therefore this strategy weakly dominates everything else. Note further that, if the contract is offered and accepted, at a level $b > 0$ of the bonus, the labour used $\bar{L} = \bar{L}_1 + \bar{L}_2$ will always be smaller than $\bar{L}_b$. This is obvious since the marginal cost of firms increases by $b$, and the demand is strictly decreasing. Hence, if the contract has been accepted, the union cannot do better than supplying $\bar{L}$ and ensuring that it is fully used. This is because if the firms ask for more than $\bar{L}$, the union can gain only if $\bar{L} > \bar{L}_b$, which is not feasible. The following lemma describes the union's optimal rationing rule.

**Lemma 1:** Given that the union's participation constraint is satisfied in stage 1, and given that in stage 4, firms are obliged to sell at the prices announced, the union has the following optimal response function: if $\bar{L} = \bar{L}_m$, (or $\bar{\pi} = \pi_m$) and for any requisition of labour $(L_i, L_j)$ such that at least one of the firms chooses the monopoly price $p_m$,

\[
\bar{L}_i, \bar{L}_j = \left( \frac{L_m}{2}, \frac{L_m}{2} \right) \quad \text{whenever} \quad p_i = p_m, i = 1, 2. \tag{5}
\]

\[
\bar{L}_i, \bar{L}_j = \left( 0, L_m \right) \quad \text{whenever} \quad p_i \neq p_m = p_j \tag{6}
\]

If none of the firms has chosen $p_m$, then it is a weakly dominant strategy for the union to supply all the workers requisitioned, i.e. $(\bar{L}_i, \bar{L}_j) = (L_i, L_j)$.

**Proof:** If its participation constraint is satisfied, then the union simply wants to ensure, by a suitable choice of its allocation of labour scheme, that monopoly profits are reached somehow: this is only possible if at least one of the firms announces a price $p_m$. The allocation scheme in this event ensures that the union gets the bonus and employment of $L_m$. On the other hand, if both firms announce some other price then the union can never ensure that monopoly profits are reached, and thus the bonus is never paid to the employees. Then the best for the union is to supply all the workers.
requisitioned by firms. If, for instance, one firm set a price of \( w \) (and asked for \( \frac{D(w)}{a} \) workers), then this strategy guarantee for the union the same level of welfare as if the bonus scheme were implemented. Note that the two firms together will never absorb more labour than \( L_b \), hence the union can never actually achieve an employment level more than \( L_b \).

Now we are ready to prove Proposition 1. To prove that this is a SPE, we need to show that the strategies in each subgame constitute a Nash equilibrium given the optimal continuation of the game. First, consider stage 4: at this point the firms and the union have observed the acceptance of the contract, the prices announced by each of the firms and the labour supplied by the union to each firm. Given that firms are committed to the announced prices, \((p_m, p_m)\), and are supplied with labour by the union \((\frac{L_m}{2}, \frac{L_m}{2})\), the best that each firm can do is to produce the maximum output (subject to this induced capacity constraint), \( \frac{L_m}{2} \), and sell it at \( p_m \). Next, we check that at stage 3, given the history, and given firms output choices in stage 4, the union has no incentive to deviate from the supply \( \frac{L_m}{2} \) to each firm. This follows from Lemma 1. Finally, in stage 2, given that the contract has been accepted, and that the union will supply according to its optimal response function, a firm has no incentive to deviate from the monopoly price. If a firm deviates by reducing or increasing the price, he gets no workers at all and hence its profits are zero. In stage 2, the union accepts the contract since its participation constraint is satisfied. At stage 1, therefore, the best that firms can do is to choose the monopoly level of output, since no firm has an incentive to deviate given the optimal response of labour, hence \( \bar{\pi} = \pi_m(w + b) \).

The same analysis is easily generalised to the case of \( n \) symmetric firms, with a suitable modification of the union's allocation rule.

**Proposition 2:** If the participation constraints are satisfied, there exists a subgame perfect equilibrium where the \( n \) firms and the union sign the contract, and firms choose the monopoly level of profit \( \pi_m \). The equilibrium strategies are as above except that in stage 3, the union supplies labour according to \((\frac{L_m}{n})\), for each firm. Correspondingly in stage 4, the firms produce and sell \( \frac{\bar{\pi}_m}{n} \) and charge the monopoly price corresponding to this marginal cost \( \frac{w+b}{a} \).

**Proof:** The proof of this is just as in Proposition 1, except for the union's allocation rule which now changes such that the firms are supplied with \( \frac{L_m}{k} \) where \( k \) is the number of firms which announce a price \( p_m \). If no firm
announces $p_m$, then the union again supplies all the workers requisitioned by the firms and thus guarantees the maximum employment level (but no bonus).

3 Existence and Illustrations

In this section, we discuss the existence of such a bonus scheme for a symmetric duopoly, with two specific demand functions. This gives a flavour of the kind of conditions needed in the general case. Assume that the union's objective is given by:

$$U(w - w_0, L) = (w - w_0)^k L^{1-k}$$

where $k, 0 \leq k \leq 1$, represents the relative weight that the union assigns to wages. Then $k = 0.5$ corresponds to a "risk-neutral" union. The case $k = 1$ can be thought to be the objective of an insider dominated union with a sufficiently small number of insiders. Note that in this case there always exist a bonus scheme as the insiders care only about their remuneration (which is higher than the wage under any bonus scheme). As $k$ decreases, aggregate employment becomes more important for the union, and as we shall see the conditions under which the bonus scheme exists are more and more restrictive. In fact, when $k$ equals zero, there does not exist any bonus scheme, since the union cares exclusively about employment and the bonus scheme necessarily decreases employment.

3.1 Linear Demand Function

The demand function is:

$$P(Q) = A - dQ$$

where $Q = x_1 + x_2$. As before, technology is $x_i = aL_i$ for both firms. If $w_0$ represents the best alternative wage then:

**Proposition 3:** (i) If $w_0 = 0$ and $k = 0.5$, a bonus scheme exists that satisfies the participation constraint of the union if and only if the market is sufficiently large, i.e. $A > (4 + \sqrt{8})w$. (ii) If the market is not large enough, then there exists a $w_0 > 0$, or a $k > 0.5$, such that there is a bonus scheme satisfying the participation constraint of the union.
Proof: A bonus scheme exists if the participation constraint of the union is satisfied. Of course, as firms have all the bargaining power, they will choose the bonus scheme such that it is satisfied as equality. Therefore, for a $b$ to exist we need:

$$(w + b - w_0)^k L_m^{1-k} \geq (w - w_0)^k L_b^{1-k}$$

(7)

where $L_m = \frac{x_m}{a} = \frac{A-(w+b)}{2ad}$ and $L_b = \frac{x_b}{a} = \frac{A-w}{ad}$. This inequality can be rewritten as:

$$g(w_0, \varphi) = (1 + \frac{b}{w - w_0})^\varphi(1 - \frac{b}{A - w}) \geq 2$$

(8)

where $\varphi = k/(1 - k)$. Then for $w_0 = 0$ and $\varphi = 1$, (8) reduces to:

$$b^2 - (A - 2w)b + w(A - w) \leq 0$$

(9)

This expression reaches its minimum at $b = \frac{A - 2w}{2}$, and this minimum is $-(A^2 - 8Aw + 8w^2)$. Therefore, a bonus scheme exists if $A > (4 + \sqrt{8})w$, i.e. if the market is sufficiently large. Note further that $g$ is increasing in $w_0$ and $\varphi$ (and thus in $k$), and becomes (typically) larger than 2 for sufficiently large $w_0$, or $\varphi$. Therefore, if the market is not too large, (8) is satisfied whenever the alternative wage is large enough, or the wages are important enough for the union.

3.2 Constant Elasticity Demand Function

We now analyse the same conditions for a Constant Elasticity demand function:

$$P(Q) = \left(\frac{A}{Q}\right)^\ell$$

where $\ell$ represents the elasticity of demand (assumed to be greater than one). With this specification we find the conditions under which a positive level of bonus exists that satisfies the participation constraint of the union.

Proposition 4: If the demand is of constant elasticity, there is a positive level of bonus which satisfies the participation constraint of the union if the alternative wage $w_0$ is sufficiently high.
Proof: Since \( x_m = A^{\frac{1-\epsilon}{w+b}} \) and \( x_b = A^{-\frac{1}{\epsilon}} \), the participation constraint of the union is satisfied if:

\[
(w - w_0)^k \left( \frac{1}{w} \right)^{1-k} \leq \left( w - w_0 + b \right)^k \left( \frac{1 - \epsilon}{w + b} \right)^{1-k}
\]

This inequality is equivalent to:

\[
(1 + \frac{b}{w - w_0})^k \left( \frac{w(1 - \epsilon)}{w + b} \right)^{1-k} \geq 1
\]

and it is satisfied for some positive level of bonus if \( w_0 \) sufficiently close to \( w \). (To see this set \( (w - w_0) = tb \). Then the first term of LHS becomes arbitrarily large for a \( t \) sufficiently small). Moreover, as \( \varphi \) increases, this difference between \( (w - w_0) \) can be larger.

4 Extensions and Discussion

4.1 Asymmetric Duopoly

In this section we allow the two firms to have different technologies and demonstrate that even in this case there may exist a scheme such that both firms are better off. Let \( x_1(L) = a_1L \) and \( x_2(L) = a_2L \), where \( a_1 > a_2 \), i.e. firm 1 is more efficient. We assume that the difference in productivity is not too large, otherwise there will be no bonus scheme such that the efficient firm is better off. In the standard Bertrand game, only the efficient firm remains in the market, and makes a profit of (in the limiting equilibrium):

\[
x_1^B = \left( \frac{w}{a_2} - \frac{w}{a_1} \right) D\left( \frac{w}{a_2} \right)
\]

Since the marginal costs differ for the two firms, there is no unique monopoly outcome to which firms could be driven. While the particular level adopted would depend on the process (e.g. bargaining) by which the two firms decide, one possible choice of \( \hat{L}^* \) is the following. Let the monopoly price when only the (in)efficient firm is in the market (and the bonus is paid)

\footnote{When there are asymmetries between firms, a bonus scheme of the form \( BS' \) results more convenient, i.e. the union receives the bonus only if the aggregate employment is lower than a certain level.}
be given by $p_{m1}(p_{m2})$; the corresponding monopoly output being $x_{m1}(x_{m2})$. One possibility is that this output is divided equally between the two firms; then the corresponding sum of labor needed to produce this output is $L_{mi} = \frac{\varepsilon_{mi}}{2} (\frac{1}{a_1} + \frac{1}{a_2})$, $i = 1, 2$. If the bonus scheme is of the form $BS'$, then as Proposition 4 shows firms can collude to this specific monopoly outcome by delegating employment decisions to the union$^5$.

**Proposition 5:** If the participation constraints for the efficient firm and the union are satisfied for $L = L_{mi}$, there is a subgame perfect equilibrium where firms choose $b$ to satisfy the participation constraint of the union and the union accepts the contract. In stage two, firms choose $p_j = p_{mi}$, $i, j = 1, 2$. In stage three, the union supplies labor $(\frac{D(p_{mi})}{2a_1}, \frac{D(p_{mi})}{2a_2})$ to the firms. In stage four, the firms produce $\frac{x_{mi}}{2}$ each, sell the good at $p_{mi}$ and pay the labor used (the total employment is thus $L_{mi}$).

The proof of this proposition is along the lines of the proof of Proposition 1, and is not repeated here. The main difference is the union's optimal allocation rule: for $L = L_{mi}$, the union has to assign to the firms different amounts of labor, because they have different technologies. Firm 1 gets $\frac{x_{mi}}{2a_1}$ and firm 2 $\frac{x_{mi}}{2a_2}$, if both prices are below or equal to $p_{mi}$, otherwise the firm that charges a higher price gets no labor. Given this rationing rule, both firms do best by charging the price $p_{mi}$.

The efficient firm has incentive to participate and offer jointly with the inefficient firm the scheme only if its profits $\frac{x_{mi}}{2}(p_{mi} - (w + b))$ are larger than $\pi^B$, i.e. the profits that he would make by staying alone in the market. Therefore, the conditions under which such a bonus scheme exists are more demanding. The following example demonstrates the result of Proposition 5.

**Example 1:** Let $P(Q) = 10 - Q$, $w = 1, a_1 = 1, a_2 = 0.5, w_0 = 0$. Let the union's objective be $U = (w - w_0)L$, i.e. risk-neutral union. Then in the standard Bertrand game, only firm 1 stays in the market and makes profits of $(10 - 2)(2 - 1) = 8$; aggregate employment equals 8 and the union's welfare is 8. Suppose first that firms choose to coordinate on the monopoly

$^5$Note that this SPE assumes that the level of output $x(L)$ chosen in the first stage is an outcome of some bargaining process between the two firms. We do not explicitly model this process and therefore the choice of $L$ is restricted to be exactly this. A paper where the bargaining between firms is modelled explicitly is e.g. Cave and Salant[7].
outcome with the marginal cost of the inefficient firm. It can be checked that \( p_{m2} = \frac{12 + b}{2} \) and \( Q_{m2} = \frac{8 - b}{2} \) (whenever the bonus is paid). Then \( L_{m2} = \frac{Q_{m2}^2 + \frac{Q_{m2}}{2(0.5)}}{2} = \frac{3(8 - b)}{4}(1 + b) = 8 \)

hence the optimal bonus is 0.4043. As a result, \( p_{m2} = 6.202, Q_{m2} = 3.798, L_{m2} = 5.697, \pi_1 = 9.111 > 8 \), and \( \pi_2 = 7.212 > 0 \). Both firms are better off, but the bulk of the additional profits go to the inefficient firm.

Suppose next that firms coordinate on the monopoly outcome with the marginal cost of the efficient firm. It can be checked that in this case \( b = 0.2141, p_{m1} = 6.107, Q_{m1} = 4.393, L_{m1} = 6.590, \pi_1 = 10.747 > 8 \), and \( \pi_2 = 8.551 > 0 \). Again, the inefficient firm gains relatively more if the bonus scheme is implemented, but the increase in the efficient firm's profits is greater now than in the previous case. This example demonstrates that firms bargaining about the type of the joint offer to the union is not a trivial task, and thus further research on this is necessary.

### 4.2 Further Extensions and Remarks

1. **Differentiated goods:** The scheme above could easily be extended to the case of a symmetric differentiated industry with Bertrand competition. The target profits are then the maximum joint profits of the firms when their marginal cost is \( \frac{w + b}{a} \). Thus the allocation rule must be set according to prices announced by each firm. In a symmetric differentiated goods model, the monopoly price is common for all firms and the allocation rule thus remains essentially the same as in Proposition 1. The participation constraints are more difficult to satisfy however as firms make initially positive profits.

2. **Uncertainty:** An objection to this mechanism might be that it does not take account of the fact that demand (hence profits) are subject to uncertainty. Thus wages are normally conditioned on both profits and demand shocks. We allow for demand shocks to occur, but we can deal with this letting renegotiation between union and firms remain a possibility. Thus our game begins once the demand shock has already occurred, i.e. with the renegotiated levels of target profits.

3. **Multiplicity of equilibria:** In this paper we only prove that there is an equilibrium (when participation constraints are satisfied) where firms make
positive profits. There may be many equilibria of this game—because there
may be more than one optimal rationing scheme of the union; however we
interpret the rationing scheme that we use as a “focal point” among the
multiple such schemes.

(4) Partially collusive outcomes: When the participation constraint of
the union is not satisfied in case that the target is the monopoly profits, it
may be possible for firms to shift their profits down a bit from the monopoly
level to a partially collusive level, till the union’s participation constraint is
satisfied. Firms still do better as they make positive profits, even though
these are not the monopoly profits.

(5) Transfer Mechanism within the union: Since our result relies on the
union voluntarily restricting employment, an obvious question is under what
conditions would this make sense? One answer is e.g. insider dominated
unions, who would be willing to sacrifice employment for higher wages. An-
other answer is that there do exist transfer mechanisms whereby compensa-
tion to unemployed workers is made and one could imagine such mechanisms
being a way to achieve Pareto improvements.

(6) Agenda: It would be more realistic to ask for an institution where em-
ployers and union bargain together over the bonus scheme. We have modelled
the bargaining in a particularly simplistic fashion: all we are interested in is
the outcome of such bargaining: i.e. a common bonus for all firms and one
moreover that is linked to industry profits or aggregate employment. While
in the context of symmetric firms it does not matter if the bonus is linked
to individual profits ($\hat{\pi}$) or to industry profits ($\bar{\pi}$) and we could well inter-
pret this as being linked to firm profits, the fact that the bonus is the same
is essential to the model. In fact once an institution exists e.g. employers
federations, and bargaining is centralised, the agenda is endogenous. We do
not know exactly how and over what the bargaining takes place but it seems
a reasonable conjecture that bargaining could be over a uniform profit-share
or bonus scheme.

(7) Continuous Profit-sharing Schemes: The bonus scheme we present is
a special case of a more general point i.e. that profit-sharing schemes can be
used by firms as a collusion device. This can be done through a continuous
profit-sharing scheme as well, and we propose to extend the result in this
direction.
5 Conclusion

There is evidence that profit-sharing and centralized negotiations are institutions that co-exist in many countries. Indeed, in Japan, although the formal institutions of bargaining are at the company level, there are effective mechanisms, namely highly co-ordinated employers' organizations, that ensure a high degree of centralisation in wage setting ([18]). Bonus payments in Japan constitute an average of greater than twenty percent of annual earnings of Japanese workers ([14]). Moreover, the documented higher productivity of American workers compared to Japanese raises a question as to why firms would go in for such bonus schemes, if higher productivity does not result. Among other reasons why this may happen, our paper is an attempt to answer exactly this type of question. It might be argued that if firms collude through the union, why not do it directly? The first answer to this is Antitrust law. Secondly, even without this, cheating is difficult to prevent. The question is: is monitoring essential? This is important because most analyses of oligopolistic pricing (see e.g. the survey of Williamson, [25]) suggest that joint profit maximization in any but the most concentrated industries with substantial barriers to entry and at a mature stage of development, will be rarely seen. Clearly in our model, the union acts as a commitment mechanism which, by optimally rationing employment in a later stage, guarantees the collusion of firms in the market.

Our conclusion that oligopolistic firms may reach monopoly profits may seem extreme and should be interpreted with caution. The bounds of collusion depend on the objectives of the union: the more it values employment the higher will the bonus necessary to induce union's participation, and hence the higher the marginal cost to the firms. It should be clear, therefore, that we do not refer to monopoly profits in the usual sense, since the bonus offered will increase the firms' marginal costs.

A broader theoretical theme related to this paper is the use of third party contracts (Green [13], Dewatripont [9], and Bensaid and Gary-Bobo [2]) to

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6 We refer here to the fact that "labor is expressly exempted from the antitrust laws on the grounds that the 'labor of a human being is not a commodity or article of commerce'" (quotation taken from Williamson, [25]), while in contrast an explicit cartel would come under the purview of Anti-trust law.

7 It would require profit pooling (Fellner, [10]) with all its attendant informational and monitoring effectiveness problems.
enable firms to precommit to some action. The third party in our model is the union, and a contract between all parties is assumed to be legally binding. In the definition of Dewatripont our contract is renegotiation proof, i.e. it is not possible for all parties to improve their position if any one of them reneges on the contract.

While unions play the major co-ordinating role in this paper, one could imagine in general that any intermediate input could fulfill this function. In this sense, our approach parallels the literature on vertical restraints. Empirical evidence in the telecoms industry e.g. suggests that various schemes are used to encourage suppliers of intermediate goods to carry out practices that result in increased concentration in downstream firms (access pricing literature). Most of this literature is however concerned with issues of entry rather than collusion of existing firms.

Finally, our paper might have relevance as an alternative solution of the Bertrand paradox. Kreps and Schienkman ([15]), suggested the addition of a game in capacities prior to the price competition stage. Our model is obviously quite different: we allow firms to have joint actions in the first stage, but it is the use of induced capacity constraints (through the union's optimal employment rationing rule) that is finally responsible for the firms being able to achieve higher profits.

We next explore some of the policy implications from the paper. Historically, centralization of wage bargaining in countries which have this institution, e.g. Germany, was prompted by the strategic interests of established firms in an industry. Indeed, it could be interpreted as an artifact of the cross-class coalition of insider dominated unions and established firms. Though these strategic interests were more in terms of creating barriers to entry, our paper puts forward another reason why centralized negotiations should be discouraged.

We also demonstrated some conditions under which profit-sharing leads to lower employment, in contrast to the results of Weitzman.

Finally since such coalitions between union and firms are more difficult to achieve if asymmetries exist, and/or there is competition from firms not covered by the agreement (e.g. across the border), the implications for Antitrust law are that it should be geared to industries with very similar cost functions and those where the upper bound on prices due to transnational

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8See e.g. [20],
competition is quite high.
References


