

The Strategic Choice of Contractual Policies

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This paper is devoted at analyzing the strategic choice of intra-firm contractual policies in an oligopoly framework. It derives conditions under which a cooperative bargaining process between firms' owners and employees characterizes a dominant strategy equilibrium of the game. It then extends the model to consider a different specification of the two parties' outside options and the implications of the equilibrium allocation on social welfare and collusion possibilities [JEL Code: L13, L20].

1. - Introduction

This paper deals with agency relations within the framework of an oligopolistic market. It focuses on employer-employee relations and analyzes the effects of different strategies firm owners can use to sign a labor contract with their workers. More specifically, it provides a comparison among the outcome of a bargaining strategy and other contractual policies based either on effort monitoring or on the formulation of one-sided offers to the employees. This analysis is developed within the framework of a multi-stage oligopoly game¹.

*[<alessandro.bonatti@yale.edu>](mailto:alessandro.bonatti@yale.edu) I wish to thank professor Riccardo Martina for the support and advice he has given me ever since I started writing my thesis, Rossella Argenziano, Luigi Balletta and Salvatore Piccolo for helping me with part of the models used here and three anonymous referees whose important comments and critiques have helped improve this paper.

¹ As a reference, see FUDENBERG D. - TIROLE J. (1991) or BAGWELL K. - WOLINSKY A. (2002).

The scope of this paper is to assess whether a bargaining process can represent a profitable strategy to achieve an agreement over the terms of a labor contract (wage level; required effort). In the literature, alternative specifications of the first-stage decision process have been shown to influence considerably the equilibrium of the oligopoly (market) stage game. Fershtman (1985) has explored case of two managers running a firm pursuing different objective functions, whereas Kraft (1998) has focused on code-termination of employment levels.

In this paper, we analyze the private incentive for the principal (the owner) to select alternative mechanisms of specifying labor contracts. In particular, we compare two different intra-firm contractual policies. The first one *a*) follows a cooperative bargaining approach and is based on negotiating the wage scheme with the employees' Unions; the second one *b*) is based on making take-it-or-leave-it contract proposals to the employees and on monitoring their effort. The problem is modeled as a three stage game where decisions are taken according to the following timeline: at stage 1, the firms' owners simultaneously choose between alternatives *a* and *b*; at stage 2, the terms of the contract (wage, effort) are determined, within each firm, according to the owners' initial choice; finally, at stage 3, firms simultaneously choose the levels of their market variables.

The adoption of a bargaining process by both firms turns out to be a dominant strategy equilibrium of this game. This equilibrium is efficient with respect to total welfare, though collusion between firms remains a likely event.

This paper is organized as follows: Section 2 describes two alternative contractual policies. Section 3 derives the equilibrium of the three-stage game and analyzes its implications on social welfare as well as its collusionrobustness. Section 4 presents the main results and conclusions. Most of the formal derivations are in Appendix.

2. - Two Contractual Policies

This Section aims at analyzing the problem of choosing of a

contractual policy in the framework of a duopolistic market under full information, Cournot competition and linear demand. It is assumed that each firm's employees can improve their firm's productive efficiency, that is, they can reduce average costs by exerting effort. Therefore, the cost function of each firm can be represented by:

$$(1) \quad c(\beta, e, q) = (\beta - e)q$$

where β is a measure of a firm's technology and of its employees' average skill level; e indicates employees' effort and q is the owners-chosen output level.

A contract between a firm and its employees is defined as a (w, e) vector, with w being the wage paid to each worker. Exertion of effort (e) is costly on the employees' part: therefore, their (quasi-linear) utility function is given by:

$$(2) \quad U(w, e) = w - \psi(e)$$

where $\psi(e)$ is a convex function representing the disutility of effort.

At this stage, it is assumed that workers' effort is not observable by the firm. Owners can deal with this problem in two alternative ways. They can implement a monitoring system to acquire additional information on their employees' activities or rather they can sign a contract with the workers' Union and delegate the monitoring activity to the latter's (more efficient) internal control system. The two following sections look at these alternatives in more detail.

2.1 *An Effort-Monitoring Strategy*

This Section examines the case where each firm selects the wage and effort to be offered to the employees through a "take-it-or-leave-it" procedure.

This contract has to verify employees' participation constraint, that is:

$$(3) \quad w \geq \psi(e)$$

However, firm owners also need to prevent workers from shirking: for this purpose, it is assumed that, if a firm monitors an employee's activity and finds that he is not exerting the required effort level, the firm acquires the right not to pay his wage. It is important to point out that, even if a firm is perfectly informed on its technological parameter, it cannot infer an employee's effort level by observing the realized average cost; in fact, this observation may only give information on the average effort level put forth by the employees but it does not allow to attribute specific (personal) responsibilities for shirking, as it happens in an owner-manager agency relation. We assume that this monitoring system is not perfectly efficient, but is only capable of detecting a shirking employee with a commonly-known probability λ . For the sake of simplicity, we assume that λ is exogenously determined whereas in the literature the "inspection games"² approach has been largely adopted.

Each firm must offer its employees a contract that induces them not to undertake an opportunistic action, namely, accepting a contract and not exerting the required effort. The expected utility of a shirking employee is thus $w(1 - \lambda)$. The contract the firm proposes the must therefore verify:

$$U(w, e) \geq w(1 - \lambda)$$

from which the following constraint (no-shirking condition) can be obtained:

$$(4) \quad w \geq \frac{\psi(e)}{\lambda}$$

² A good example of an inspection game is in FUDENBERG D. - TIROLE J. (1991, p. 17).

2.2 A Bargaining Strategy

We now turn our attention to the case of a bargaining strategy. Such a strategy consists in hiring unionized labor and agreeing to define the employees' compensation scheme through a cooperative bargaining process between the firm's owners and their Union.

Assuming that firms are symmetric, each of them maximizes the following profit function:

$$(5) \quad \Pi (\beta, q, e, w) = pq - c (\beta, e, q) - w$$

Moreover, if both the firms' and the workers' objective functions are commonly known, by applying Nash's asymmetric solution³, the following expected outcome of the bargaining process can be obtained:

$$(6) \quad w^B = \arg \max [pq - c (\beta, e, q) - w]^\alpha [w - \psi (e)]^{1-\alpha}$$

$$w^B (\alpha, e, q) = (1 - \alpha) [pq - c (\beta, e, q)] + \alpha \psi (e)$$

where α is a measure of the firm's bargaining power. The equilibrium wage expression shows that firms pay their (risk neutral) employees a weighted average of the disutility of effort and of the firm's revenue. This means that the firm gives back to its employees a part of the gains coming from their effort. In fact, the employees' utility function can be re-written as:

$$(7) \quad U^B (e, q) = (1 - \alpha) [(p - \beta + e) q - \psi (e)]$$

When firms choose this policy, *i.e.* hiring unionized labor through a collective agreement, they eliminate the risk of an opportunistic behavior on the employees' part. This can be motivated assuming that unions have perfectly efficient internal control systems⁴.

³ It is initially assumed that outside options give both parties zero profits (or perfectly offset one another).

⁴ More about this assumption will be discussed in the next Section.

However, the Nash solution to the bargaining process actually specifies the terms of a contract only if the workers agree to negotiate a collective agreement in the first place. This decision depends on the utility workers can obtain through the two different kinds of contracts. In fact, when workers receive a take-it-or-leave-it offer, they expect to obtain a positive utility level that depends on the effort level chosen by the firm and on the efficiency of the monitoring system. When offered to negotiate over the wage level, the Union's expected utility essentially depends on its bargaining power. In equilibrium, it is possible to derive a critical value α^* (λ) that defines the minimum bargaining power unions must hold in order to find it profitable to take part in the wage-negotiation process.

3. - SPNE of the 3-Stage Game

The aim of this Section is to prove that, under certain conditions, the choice of a bargaining policy can represent a dominant strategy for both firms. For this purpose, a three-stage oligopoly game is set up as follows: in the first stage, both firms choose simultaneously whether to bargain with the employees' Unions or to make them a take-it-or-leave-it offer. In the second stage, wage and effort levels for each firm's employees are chosen and made public. In the third stage, firms simultaneously choose the optimal production levels.

It is assumed that the distribution of bargaining power and the efficiency of the monitoring system are known and symmetric for each firm. As a consequence, each firm's owner will choose his strategy on the basis of the values of α , λ and of the other parameters of the model. The firms' first stage strategies are constrained by the need to make concessions to the employees⁵ if the latter do not hold sufficient bargaining power. In the third stage, firms solve the following problem:

⁵ That is, firms will have to refrain from exerting all the bargaining power they own if they intend to start a bargaining process.

$$(8) \quad \max_{q_i} [(p(q_i, q_j) - \beta + e_i) q_i - w_i] \quad i, j = 1, 2$$

Substituting the linear demand function⁶, the following reaction functions are obtained:

$$(9) \quad q_i^*(q_j, e_i) = \frac{1}{2}(A - q_j - \beta + e_i) \quad i, j = 1, 2$$

The equilibrium output levels are given by:

$$(10) \quad q_i^*(e_i, e_j) = \frac{1}{3}(A - \beta + 2e_i - e_j) \quad i, j = 1, 2$$

In the second stage, the effort and wage levels are chosen within each firm. Anticipating the Cournot equilibrium in stage 3, Each firm maximizes the following objective function:

$$(11) \quad \max_{e_i, w} [(p(q_i^*(e_i, e_j), q_j^*(e_i, e_j)) - \beta + e_i) q_i^*(e_i, e_j) - w_i]$$

s.t. $w_i = g(e_i, e_j)$

In this problem, the wage level is determined according to the mechanism chosen in stage 1. Therefore, the first-stage choice influences the constraints imposed on the firm's second-stage maximization problem. If a monitoring strategy is chosen, then the wage must satisfy the workers' no-shirk condition⁷; if the firm chooses to bargain over the wage level, then the wage is determined through the Nash solution. Assuming that $\psi(e) = e^2$, the constraint $g(e_i, e_j)$ is given by:

$$(12) \quad w_i^M(e_i) - \frac{e_i^2}{\lambda} = 0$$

⁶ $p(q_i, q_j) = A - q_i - q_j$

⁷ This is true since the employees' no-shirk condition is always more exigent than their participation constraint.

$$(13) \quad w_i^B(e_i, e_j) = (1 - \alpha) (p(q_i^*, q_j^*) - \beta + e_i) q_i^* + \alpha e_i^2$$

depending on the firm's policy choice. Here M stands for monitoring, B for bargaining and q^* is the optimal output level $q_i^*(e_i, e_j)$ set in stage 3.

These constraints allow to derive the reaction functions for effort as determined by the mechanism choice. When monitoring is adopted, we get:

$$(14) \quad e_i^M(e_j) = \frac{2\lambda (A - \beta - e_j)}{9 - 4\lambda}$$

whereas, if the bargaining strategy is chosen, we get:

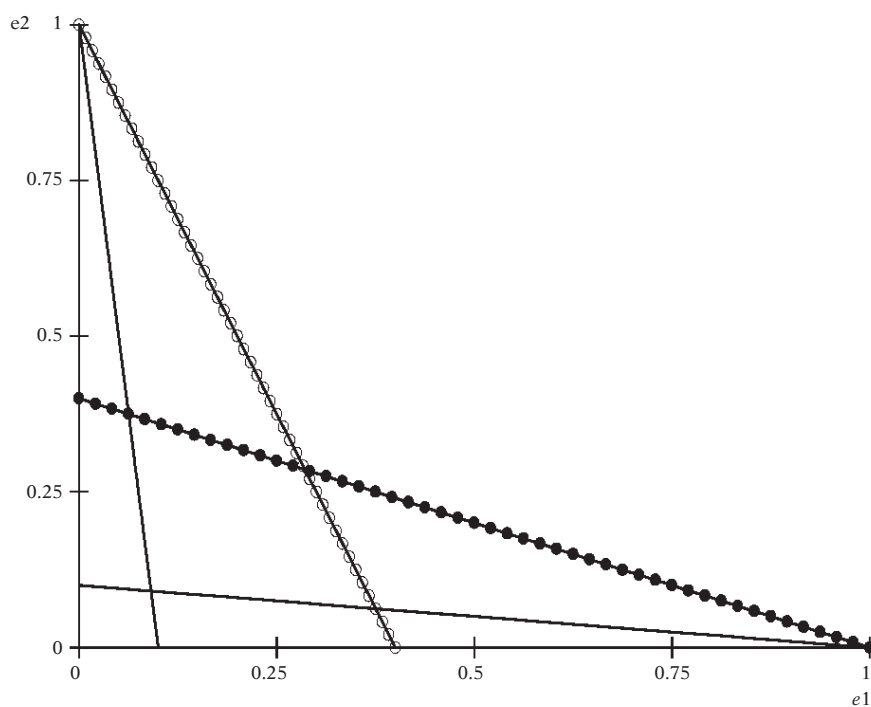
$$(15) \quad e_i^B(e_j) = \frac{2}{5} (A - \beta - e_j)$$

If a firm were a monopolist in the output market, it would simply compare the profits deriving from each of the alternative strategies, and would choose bargaining⁸ only if $\alpha \geq 3/4 - \lambda$. The main reason why firms in an oligopolistic market would choose the bargaining strategy is instead given by its effect on the firm's behavior in the subsequent stages. In fact, when a firm chooses a bargaining strategy, its reaction function for effort pivots around the horizontal intercept, leading to a more aggressive choice of effort. Since effort choices are strategic substitutes, this will have the twofold effect on the market-stage reaction function of lowering its own marginal costs and raising its rival's. Normalizing market size to one and taking $\lambda = 0.75$ as an example, the reaction functions are depicted in Graph 1.

The four possible combinations of the reaction functions for effort allow to solve for (e_1^*, e_2^*) and to represent all the four outcomes of game, as anticipated in the first-stage. The equi-

⁸ For a derivation, see *Appendix*.

GRAPH 1

REACTION FUNCTIONS $e_2(e_1)$ AND $e_1(e_2)$ 

librium effort levels ultimately determine the outcome of the oligopoly game: in fact, by the symmetry of the optimal output levels, the firm that is able to obtain a higher effort level will produce more than its rival, thus obtaining higher profits. The equilibrium effort levels, quantities and profits⁹ are summarized in Table 1.

The relative magnitudes of the firm's bargaining power and of the monitoring system's efficiency determine the first stage choices and thus the outcome of the whole game.

⁹ The computation of equilibrium profits fails to include monitoring costs. This simplified procedure aims at comparing the two contractual policies on the basis of one key element for each one. Namely, the comparison is built on monitoring efficiency and on bargaining power.

TABLE 1

EQUILIBRIUM EFFORT, OUTPUT AND PROFIT LEVELS'

$E(1; 2)$	M	B
M	$\left(\frac{2\lambda}{9-2\lambda}; \frac{2\lambda}{9-2\lambda}\right) \cdot (A-\beta)$	$\left(\frac{2\lambda}{15-8\lambda}; \frac{2(3-2\lambda)}{15-8\lambda}\right) \cdot (A-\beta)$
B	$\left(\frac{2(3-2\lambda)}{15-8\lambda}; \frac{2\lambda}{15-8\lambda}\right) \cdot (A-\beta)$	$\left(\frac{2}{7}; \frac{2}{7}\right) \cdot (A-\beta)$
$Q(1; 2)$	M	B
M	$\left(\frac{3}{9-2\lambda}; \frac{3}{9-2\lambda}\right) \cdot (A-\beta)$	$\left(\frac{2(4\lambda-3)}{15-8\lambda}; \frac{2(6-5\lambda)}{15-8\lambda}\right) \cdot (A-\beta)$
B	$\left(\frac{2(6-5\lambda)}{15-8\lambda}; \frac{2(4\lambda-3)}{15-8\lambda}\right) \cdot (A-\beta)$	$\left(\frac{3}{7}; \frac{3}{7}\right) \cdot (A-\beta)$
$\Pi(1; 2)$	M	B
M	$\left(\frac{5}{(9-2\lambda)^2}; \frac{5}{(9-2\lambda)^2}\right) \cdot (A-\beta)^2$	$\left(\frac{9-4\lambda}{(15-8\lambda)^2}; \frac{5\alpha(3-2\lambda)^2}{(15-8\lambda)^2}\right) \cdot (A-\beta)^2$
B	$\left(\frac{5\alpha(3-2\lambda)^2}{(15-8\lambda)^2}; \frac{9-4\lambda}{(15-8\lambda)^2}\right) \cdot (A-\beta)^2$	$\left(\frac{5\alpha}{49}; \frac{5\alpha}{49}\right) \cdot (A-\beta)^2$

PROPOSITION 1. If the firms' bargaining power is sufficiently high relatively to monitoring efficiency, then there's a unique, dominant-strategy, SPNE in which both firms bargain over the wage levels. Moreover, the critical level of bargaining power α^* (λ) is always lower in an oligopolistic market than in a monopoly.

PROOF. See *Appendix*.

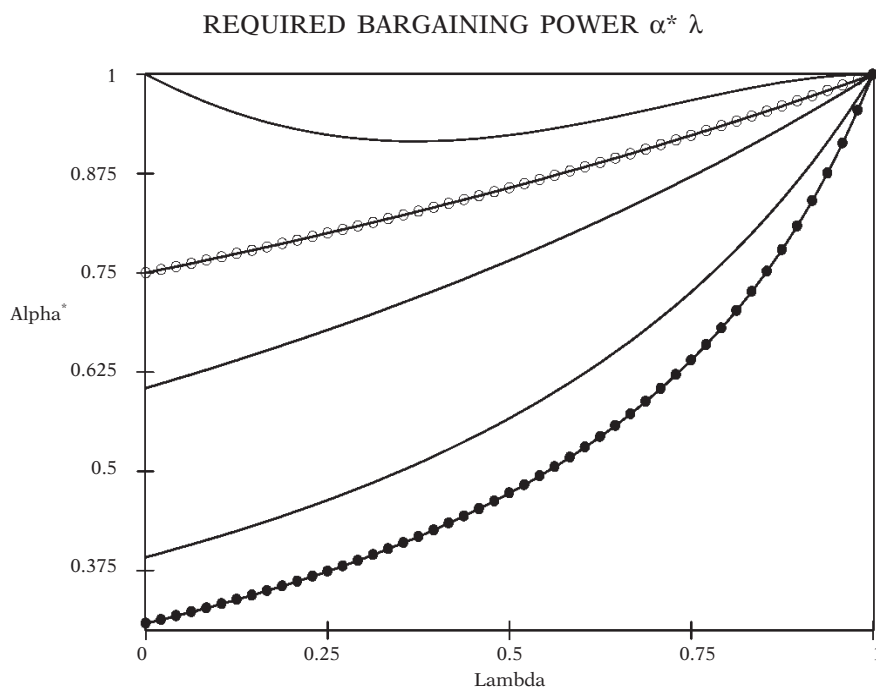
This results depends heavily on the assumption that hiring unionized labor guarantees the firm its employees' effort. This assumption can be justified considering that large companies and institutions (holding a large bargaining power) often negotiate expensive collective agreements with their workers' unions, although they

would be capable to effectively monitor their employees' activities. This happens even more so, in the presence of competition between institutions or, more in general, in any situation in which firms have an incentive to require high levels of effort to their employees.

The highest curve in Graph 2 represents the minimum levels of bargaining power for which the employees are willing to reach a collective agreement. The lower curves represent (respectively, from highest to lowest) the minimal distributions of bargaining power (as a function of monitoring efficiency) that allow: *a*) a monopolist to choose bargaining; *b*) the $(B; B)$ solution to be a Pareto dominant allocation; *c*) bargaining to be a dominant strategy and *d*) bargaining to be a profitable deviation from the $(M; M)$ equilibrium.

If the two firms' bargaining power is not extremely high, workers' are significantly better off under a bargaining regime, since higher salaries offset the higher required effort levels. If this is

GRAPH 2



the case, they will accept to negotiate their wages collectively. The minimum bargaining power function reflects two contrasting effects of an increase in λ on workers' utility: on one hand, a higher λ allows the firm to lower the wage without risking to face an opportunistic behavior from its workers; on the other hand, a higher λ yields a higher choice of effort, therefore raising the wage. For low levels of monitoring efficiency, the wage offered by the firms to their workers grows faster than the disutility of required effort; for higher levels, the effects are reversed: employees will therefore often agree to bargain even if they hold, in principle, a weak position.

3.1 *Outside Options*

In a more realistic setting, the bargaining process can be differently specified so to include the possibility of firms producing output without requiring effort from their employees. This specification would change the Nash product in the bargaining game by introducing a non-zero outside option for the firms.

The original specification's Nash product

$$N(e_i, e_j, w_i) = [(p(q_i^*, q_j^*) - \beta + e_i) q_i^* - w_i]^\alpha [w_i - e_i^2]^{1-\alpha}$$

would therefore become:

$$(16) \quad \{(p^* - \beta + e_i) q_i^* - w_i - [p(q_i^*(0, e_j), q_j^*(0, e_j)) - \beta] q_i^*(0, e_j)\}^\alpha [w_i - e_i^2]^{1-\alpha}$$

where q^* is the optimal output level $q_i^*(e_i, e_j)$ and $p^* = p(q_i^*, q_j^*)$. As a consequence of the increase in the firm's threat point, the bargained wage will be lower than under the previous setting; namely, it will be equal to:

$$(17) \quad w_{0i}^B(e_i, e_j) = w_i^B(e_i, e_j) + \\ - (1 - \alpha) (p(q_i^*(0, e_j), q_j^*(0, e_j)) - \beta) q_i^*(0, e_j)$$

The additional share of gross revenue that firms are able to obtain because of their higher threat point does not depend on the level of effort they require in this new setting. Quite remarkably, the firm’s objective function will not qualitatively change; thus, the firm will not modify its reaction function neither. Consequently, equilibrium choices of effort for both firms remain unchanged, whereas the split of the revenue pie shifts in their favor.

The conditions for Bargaining to be chosen by both firms in a SPNE are more easily verified after modifying the disagreement point. However, the workers’ unions will now require a higher minimum bargaining power, since they expect the negotiations to yield, *ceteris paribus*, a worse outcome than in the absence of profitable outside options.

After increasing all bargaining profits by:

$$(1 - \alpha) \left(\frac{A - \beta - e_j^*(0)}{3} \right)^2$$

to represent higher disagreement point, and normalizing market size $(A - \beta)$ to 1, the payoffs matrix is given by Table 2.

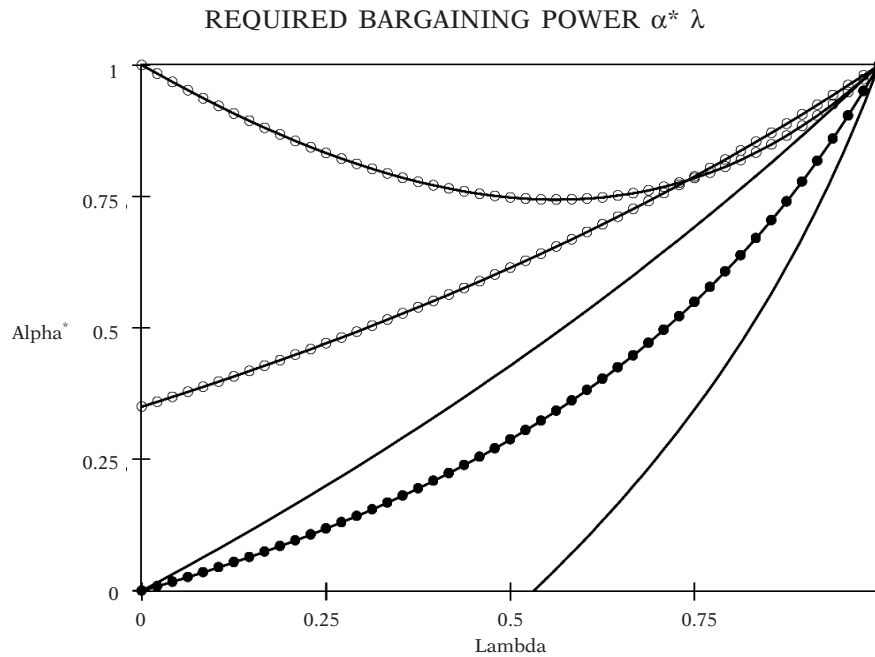
The resulting conditions for: *a)* Unions’ participation to negotiations; *b)* Pareto-optimality of $(B; B)$; *c)* monopolist’s choice of Bargaining; *d)* $(B; B)$ SPNE, *e)* profitable deviation from $(M; M)$ are represented in Graph 3 (respectively from highest curve to lowest):

TABLE 2

EQUILIBRIUM PROFITS

$\Pi(1; 2)$	<i>M</i>	<i>B</i>
<i>M</i>	$\left(\frac{5}{(9-2\lambda)^2}; \frac{5}{(9-2\lambda)^2} \right)$	$\left(\frac{9-4\lambda}{(15-8\lambda)^2}; \frac{5\alpha(3-2\lambda)^2}{(15-8\lambda)^2} + \frac{(3-2\lambda)^2(1-\alpha)}{(9-4\lambda)^2} \right)$
<i>B</i>	$\frac{5\alpha(3-2\lambda)^2}{(15-8\lambda)^2} + \frac{(3-2\lambda)^2(1-\alpha)}{(9-4\lambda)^2}; \frac{9-4\lambda}{(15-8\lambda)^2}$	$\frac{76}{1225}\alpha + \frac{1}{25}; \frac{76}{1225}\alpha + \frac{1}{25}$

GRAPH 3



3.2 Welfare Analysis

Since the bargaining outcome entails higher total output than in the monitoring case, consumers' surplus will be higher than under monitoring. If $(B; B)$ is also a Pareto-optimal SPNE and workers' bargaining power is sufficiently high, then the bargaining equilibrium certainly represents a Paretoimprovement from the social welfare point of view. This result holds in the region between the two highest solid curves in the previous Graph. In the region where $(B; B)$ is a dominant-strategy equilibrium but isn't Pareto optimal, this game represents a "prisoners' dilemma" similar to the one described in Fershtman (1985). In this article, each firm finds profitable to deviate unilaterally from a strategy (i.e. giving managers incentives only to maximize profits) that guarantees higher payoffs to both firms. In our model, both firms' owners choose a (more aggressive) bargaining strategy; as a re-

sults, both firms will choose higher output levels and obtain lower profits, than if they agreed upon adopting a monitoring strategy. Therefore, both in the Fershtman models and in the one presented here, a Pareto-inefficient, 11 dominant strategy Nash equilibrium is obtained when firms adopt strategies based on a cooperative bargaining process.

PROPOSITION 2. If both firms choose Bargaining, total social welfare increases, relatively to the one-sided offers case.

PROOF. For a formal proof, see *Appendix*. An intuitive reason for this result is that the higher effort levels determined through the bargaining process improves firms' productive efficiency and allows them to increase output.

In this analysis, the wage level does not influence total welfare, since it does not have any effect neither on effort nor on output. Wages would play a role in the welfare analysis only if equity considerations were taken into account. Formally, total social welfare is given by:

$$(18) \quad TS = \Pi + U + CS$$

Since firms are symmetric, it can be expressed as a function of only one firm's output level, therefore:

$$(19) \quad TS(e, q) = \int_0^q p(x) dx - c(e, q) - \psi(e)$$

Substituting the results obtained in the two symmetric cases (monitoring and bargaining) and comparing the two expressions for $TS(e, q)$, the following can be stated¹⁰:

$$(20) \quad TS(Q^M) \leq TS(Q^B) \quad \forall \lambda \in [0,1]$$

This means that, even if the two firms' owners' payoffs are not Pareto efficient, the game's equilibrium solution is preferable if total social welfare is considered¹¹. Moreover, it can be easily

¹⁰ See the *Appendix* for calculations.

¹¹ The two solutions are identical if $\lambda = 1$.

verified that, under linear demand and quadratic disutility of effort, the effort level chosen by the two firms on the oligopolistic market $[2/7 (A - \beta)]$ is lower than the socially optimal one¹². However, this level higher than the one the two firms would choose if effort and output choices were taken simultaneously¹³. This result is due to the strategic use the two firms make of the effort level choices. In the same way as managerial compensation does in Fershtman and Judd (1987), higher effort choices shift reaction functions upwards; since variables in the third (market) stage of the game are strategic substitutes, firms have an incentive to choose over-effort in second stage.

3.3 Collusion Analysis

Representing competition on an oligopolistic market through a one-shot game can be somewhat unrealistic, since it ignores the possibility of collusion between firms. In our model, an interesting collusion possibility arises.

PROPOSITION 3. If firms choose the collusion effort and output levels, then the $(B; B)$ solution is Pareto-dominated by $(M; M)$.

PROOF. For a formal proof, see *Appendix*. Intuitively, if both firms know they will coordinate on effort and output choices, the bargaining strategy loses its main advantage, i.e. inducing a more aggressive choice of market variables. Moreover, as total output is reduced, and price-cost markup increased, the cost of adopting a bargaining strategy (i.e. sharing the firm's revenue with the employees) increases considerably. Therefore, as long as workers' compensation (under the monitoring strategy) is not too high, the take-it-or-leave-it offers policy characterizes the collusion path.

To assess the robustness of this collusion possibility, an infinitely-repeated game is considered and it is assumed that firms adopt a trigger strategies¹⁴ punishment scheme. Therefore, on the

¹² The social optimum is $e^* = \arg_e \max TS(e, q(e)) = 5/13$.

¹³ When the equilibrium effort choices are e_i^* (e_p^* , q_p^* , q_i^*), they are set at $1/5 (a - c)$.

¹⁴ For the definition of a trigger strategy, see TIROLE J. (1991), Chapter 6

collusion path, firms play $(M; M)$ and choose effort and output levels so to maximize joint profits, until one firm decides to deviate and to adopt bargaining in the first stage. From the second stage of that period on, both firms play the SPNE $(B; B)$ strategy and choose effort and output competitively. The expected profits from deviation are given by¹⁵:

$$(21) \quad \Pi^{DEV} = \Pi^{(B;M)} + \frac{\delta}{1-\delta} \Pi^{(B;B)}$$

where δ is the common discount factor. For the $(M; M)$ collusion-path to be actually followed by both firms, the following condition must hold:

$$(22) \quad \Pi^{(B;M)} \leq \frac{1}{1-\delta} (\Pi_{COLL}^{(M;M)} - \delta \Pi^{(B;B)})$$

where $\Pi_{COLL}^{(M;M)}$ refers to the different payoff arising from a collusive choice of 2nd and 3rd stage variables. Substituting the expressions for equilibrium profits when the disagreement point is set at:

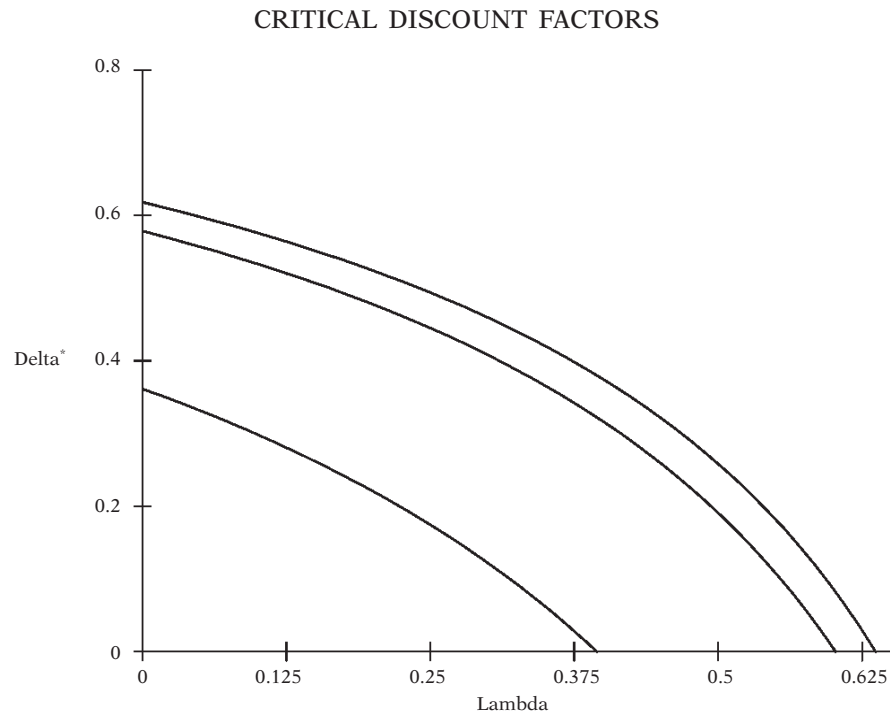
$$(\Pi_i^B(0, e_j^*); 0)$$

it can be concluded that collusion is sustainable if the discount factor of each firm exceeds a critical value $\delta^*(\alpha, \lambda)$.

The critical discount factor depends both on the distribution of Bargaining power and on the firms' ability to monitor their employees. The $\delta^*(\alpha, \lambda)$ function is negatively sloped since an increase in monitoring efficiency determines a higher profitability of the collusion strategy. On the contrary, an increase in the firms' bargaining power shifts the $\delta^*(\alpha, \lambda)$ locus upwards, as deviating becomes more profitable. However, for any distribution of bar-

¹⁵ B = bargaining; M = monitoring. First symbol next to Π indicates own choice of each player; next symbol indicates other player's strategy.

GRAPH 4



gaining power, if monitoring efficiency (λ) is sufficiently high, collusion is sustainable even if firms are very impatient. The critical discount factors obtained are on average lower than in the traditional Cournot oligopoly model (0.53). This result is due to the fact that firms can choose the efficient effort level before taking the production decision. This increases the payoffs along the collusion path and makes deviations less likely to take place.

Graph 4 shows the critical discount factor function $\delta^*(\alpha, \lambda)$ when $\alpha \in \{1/2, 3/4, 4/5\}$.

4. - Conclusions

The works of Fershtman and Judd (1987) and Sklivas (1987) have shown that, in equilibrium, owners are induced to modify

managerial incentives in a way that diverts their firm's market-stage decisions away from profit maximization. Within a similar framework, this paper has analyzed the strategic effects of committing to a collective wage-bargaining process as a contractual policy. It has shown that, under Cournot competition at the market stage, the choice of negotiating the wage structure with the employees' Unions can lead to an increase of the market share and to higher profits when compared to an effort monitoring strategy. This result holds if the distribution of bargaining power is balanced enough and if the monitoring system isn't perfectly efficient. If this is the case, then the negotiation strategy characterizes the unique Subgame Perfect Equilibrium of the oligopoly game. The results can be extended to a different specification of the bargaining process, i.e. when a different disagreement point is defined. Moreover, the equilibrium allocation is efficient with respect to total social welfare. However, firms have the possibility to collude on output and effort levels, as well as on the choice of the contractual policy. If this were the case, both firms would adopt a monitoring strategy. The consequent collusive equilibrium of the game would then be sustainable even for low values of the intertemporal discount factor.

Further research on this subject could focus on discussing the predictions of the model when firms' decisions are strategic complements (e.g. price competition): the basic results in the literature (Fershtman and Judd, 1987; Brander and Spencer, 1985; Eaton and Grossman, 1986) show that, in this setting, it is no longer an advantage to behave more aggressively than one's rival. It could also explore different specifications of the bargaining process and of the distribution of information within the firms.

APPENDIX**1. - The Monopolist's Choices**

Anticipating it will produce:

$$q(e) = \frac{A - \beta + e}{2}$$

a monopolist firm will choose:

$$e^M = \frac{A - \beta}{4 - \lambda} \text{ or } e^B = \frac{A - \beta}{3}$$

depending on its policy choice. Its profit level, depending on her policy choice, will be:

$$(23) \quad \Pi_m^M = \frac{(A - \beta)^2}{4 - k} \text{ under monitoring}$$

$$(24) \quad \Pi_m^B = \alpha \frac{(A - \beta)^2}{3} \text{ under bargaining}$$

Raising its threat point, the firm would obtain

$$\Pi_{m,0}^B = \frac{(A - \beta)^2}{12} (3 + \alpha)$$

Taking the differences between the two bargaining profits and the monitoring one, the following conditions are obtained:

$$(25) \quad \Pi_m^B \geq \Pi_m^M \Leftrightarrow \alpha \geq \frac{3}{4-\lambda}$$

$$(26) \quad \Pi_{m,0}^B \geq \Pi_m^M \Leftrightarrow \alpha \geq \frac{12}{4-\lambda} - 3$$

2. - Proof of Proposition 1

Start by considering the profitability of a “bargaining deviation”. Compare $\Pi^{(B; M)}$ with $\Pi^{(M; M)}$: if $\lambda = 1$, then deviating is not profitable (payoffs are equal only when $\alpha = 1$); as $\lambda \rightarrow 0$, the threshold $\alpha \rightarrow 25/81$; if $\alpha = 1$, then deviation is always profitable (with strict inequality if $\lambda < 1$). The generic threshold for which $(B; M) > (M; M)$ is given by:

$$(27) \quad \alpha^*(\lambda) = \frac{(15-8\lambda)^2}{(9-2\lambda)^2(3-2\lambda)^2}$$

Moreover, bargaining is a dominant strategy for both firms if:

$$(28) \quad \alpha \geq \frac{49}{5} \frac{9-4\lambda}{(15-8\lambda)^2}$$

Note that, if $(B; B) > (M; B)$, then the $(B; M) > (M; M)$ relation holds as well, which proves the first part of the statement. This condition is harder to verify than the

$$(\Pi_m^B \geq \Pi_m^M)$$

one, proving the second part of the statement. Moreover:

$$(B; B) > (M; M) \text{ if } \alpha > \left(\frac{7}{9-2\lambda} \right)^2$$

Since this last inequality is the hardest to verify, it can be concluded that if the bargaining equilibrium is Pareto optimal, then it is a dominant strategy equilibrium as well. Finally, comparing workers' equilibrium utility levels in the two symmetric cases ($B; B$) and ($M; M$), the minimum bargaining power relation is given by:

$$(29) \quad U^B \geq U^M \Leftrightarrow (1 - \alpha) \geq \frac{49}{5} \frac{4\lambda(1 - \lambda)^2}{(9 - 2\lambda)^2}$$

3. - Proof of Proposition 2

Total surpluses in the two symmetric cases ($B; B$) and ($M; M$) can be easily computed, and are equal to:

$$(30) \quad TS(q^B) = \int_0^{\frac{3}{7}} (1 - x) dx + \frac{2}{7} \frac{3}{7} - \frac{4}{49} = \frac{37}{98}$$

and:

$$(31) \quad TS(q^M) = \int_0^{\frac{3}{9-2\lambda}} (1 - x) dx + \frac{6\lambda}{(9-2\lambda)^2} - \left(\frac{2\lambda}{9-2\lambda} \right)^2 = \frac{45 - 8\lambda^2}{2(9-2\lambda)^2}$$

By inspection:

$$\frac{1}{2} \frac{45 - 8\lambda^2}{(9 - 2\lambda)^2} \leq \frac{37}{98} \quad \forall \lambda \leq 1$$

4. - Proof of Proposition 3

Determine first the collusion output and effort levels. In the third stage of the game, firms solve the optimization problem:

$$\max_{q_1, q_2} \left[(A - q_1 - q_2 - \beta + e_1)q_1 - \frac{e_1^2}{\lambda} + (A - q_1 - q_2 - \beta + e_2)q_2 - \frac{e_2^2}{\lambda} \right]$$

which yields the solution:

$$(33) \quad q_i^* = \left\{ \begin{array}{l} 0 \text{ if } e_i < e_j \\ \frac{A - \beta + e_i}{4} \text{ if } e_i = e_j \\ \frac{A - \beta + e_i}{2} \text{ if } e_i > e_j \end{array} \right\}$$

Assuming that both firms produce positive amounts, they will choose the same effort level. If both firms play Monitoring, the effort level is:

$$(34) \quad e^M = \arg \max_e \left[\frac{1}{8}(A - \beta + e)^2 - \frac{1}{\lambda}e^2 \right] = \frac{\lambda}{8 - \lambda}(A - \beta)$$

This choice yields profits of $(8 - \lambda)^{-1} (A - \beta)^2$ for each firm. If firms had chosen the bargaining strategy instead, they would have set

$$(35) \quad e^B = \arg \max_e \alpha \left[\frac{1}{8}(A - \beta + e)^2 - e^2 \right] = \frac{1}{7}(A - \beta)$$

and obtained profits level of $1/7 \alpha (A - \beta)^2$ each. The critical bargaining power that would ensure the profitability of the bargaining strategy is

$$\alpha^*(\lambda) = \frac{7}{(8 - \lambda)}$$

which lies above the minimum bargaining power required by the unions (unless λ is very low, in which case the monitoring strategy is never profitable), thus making it impossible for the firms to choose bargaining.

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