UNION STRUCTURE AND THE INCENTIVES FOR INNOVATION IN OLIGOPOLY

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A B S T R A C T

In this paper we consider the effect of union structure on the adoption of innovation in the context of Cournot duopoly. With a market size large enough we show that the incentive to innovate is higher under a decentralized union structure (with each firm facing its own independent union) than under an industry-wide union. However, for a small market size (or, equivalently, for sufficiently drastic potential innovation) the new technology is more likely to be adopted in the presence of a centralized union. This result goes against the conventional view that unionization harms the incentive to innovate.

Keywords: Oligopoly, Unions, Innovation.

JEL: J51, L13

1. Introduction.

The interaction between oligopolistic product markets and unionized labor markets has been studied in the recent literature from different perspectives (e.g., Davidson, 1988; Dobson, 1994; Dowrick, 1989, 1993). Those contributions emphasize the role of the wage bargaining structure on labor and product market outcomes.

This paper deals with the interactions between different union-firm bargaining structures and innovation under oligopoly. Different aspects of this issue have been recently addressed by some authors.[1] We focus on the effect of the degree of union centralization on the firms incentives to adopt innovation. Specifically we consider a Cournot duopoly where innovation and wages are determined endogenously. We compare the outcomes of two alternative settings. In the first case, it is assumed a model with an independent union in each firm. In this model, every firm decides, simultaneously, to adopt or not an innovation, then each union and its firm bargain the wage of their workers and, finally, firms compete in quantities à la Cournot. In the second case, we assume a model where, instead of independent unions, there is a single industry-wide union which bargains the wages with both firms.

Our model is similar in spirit to Tauman and Weiss (1987), who consider the incentives for innovation by a unionized duopolistic firm when its competitor is not unionized. However they assume that only one firm is unionized, while in our case both firms are unionized. In another similar approach, Ulph and Ulph (1994) analyze

[1] See Ulph and Ulph (1998) for a general discussion on the role of R&D as a strategic tool in oligopolistic unionized markets. Also Dowrick and Spencer (1994) have investigated the unions attitude towards innovation under oligopoly.

a duopolistic model where both …rms are unionized and compete in the product market and in a patent race to obtain a new technology. In their work only one …rm can innovate (the winner of the patent race), while in our setting both …rms have the choice of adopting the new technology. Another important di¤erence with Ulph and Ulph (1994) is that those authors only consider the case of a decentralized union structure (that is, each …rm faces a single union), while we compare both possibilities.

Freeman and Medo¤ (1984, pp. 170-71) have pointed out the ambiguity of unionization on the incentive to invest in a new technology. On the one hand, a higher wage associated with a greater union power increases the …rms incentives for adopting a new technique using less labor (the "labor-saving" e¤ect). On the other hand, the potential returns of investing in innovation are reduced due to the higher rents captured by the union in the bargaining process, which decreases the incentives to innovate (the "rent-seeking" e¤ect). We characterize which of these two e¤ects is dominant, depending on the degree of potential innovation. For this purpose, we will interpret the move from a decentralized to a centralized union structure as an increase in the level of unionization.

Our main …ndings are the following:

1) For a small market size (or, equivalently, a very drastic potential innovation) a centralized union structure favors the adoption of innovation, relative to the decentralized setup.

2) For high levels of market size, a centralized union makes innovation more di¢ cult than a decentralized union structure.

Intuitively, for any given market size the innovation is …rstly adopted by just one firm as the innovation cost decreases sufficiently, but in the case of a small market size only the innovator will be active. However, the incentive to become an innovator monopolist is greater in the centralized model than in the decentralized model since duopolist profits are smaller in the centralized model than in the decentralized setting. In other words: the "labor-saving" effect of increased unionization prevails in this case. Nevertheless, if market size is large then both firms are still active when the innovation is firstly introduced and, consequently, the previous argument does not hold. In this case our result agrees with the usual (and conventional) view that increased unionization harms the incentive to innovate due to the prevailing "rent-seeking" effect.

The rest of the paper is organized as follows. In Section 2, we analyze the model with a centralized or industry-wide union, in Section 3 we develope the model with two independent or decentralized unions. In Section 4 we undertake the comparative analysis of the outcomes in the previous models. Finally, Section 5 gathers our conclusions.

2. The model with a decentralized union structure.

Let us consider a duopoly where firms produce a homogeneous product with a linear demand function. We will consider two different cases. Firstly, in this section, we analyze a situation where there is a union per firm, each one maximizing the utility of its firm's workers and, secondly, a situation in which there is only an industry-wide union which maximizes the total utility of the workers in the industry.

We will refer to the first situation as the "decentralized" union model and the second one as the "centralized" union model.

We will establish the following specific assumptions:

The inverse demand function in the product market is $p = a - (x_1 + x_2)$ $(a > 0)$; where p is the price and x_i $(i = 1; 2)$ is the output of the ith firm.

Each firm i has the cost function:

$$C_i = w_i \cdot k_i \cdot x_i + \eta_i;$$

where w_i is the wage paid for firm i; k_i is the labor requirement per unit of output for firm i and η_i is a fixed cost: Then the employment by firm i is given by $L_i = k_i \cdot x_i$: In our model, k_i and η_i are constant parameters which will be determined by a technological decision of firm i.

In our model, if firm i decides not to innovate, then $k_i = 1$ and $\eta_i = 0$: On the other hand, the possibility for innovation is modelized in the following way: if firm i chooses a new technology, then $k_i = e < 1$ and $\eta_i = \varepsilon > 0$; where ε is assumed to be a sunk cost, which can be interpreted as the fixed investment necessary to obtain the new technology (e.g. R&D investment), and $(1 - e)$ is the reduction in the labor requirement per unit of output, as a result of choosing the new technology. In other words: we consider only labor-saving innovations.

We will define the utility function of the union in firm i as $V_i = (w_i - r) \cdot L_i$; where r is the reservation wage, which can be interpreted as the wage earned in the competitive sector. That is, each union aim is to maximize the total amount of rent, namely the remuneration in excess of the reservation wage in each firm. This assumption is standard in the literature of unionized oligopolistic industries, see for example De

Fraja (1993). For a more general specification of the unions utility functions, see Dowrick and Spencer (1994) in their analysis of the relationship between innovation and unions.

Each firm, say i, is assumed to maximize its profits, given by $\Pi_i = p \cdot x_i - C_i$.

We assume a wage-setting mechanism known in the literature as the "right-to-manage" model, in which the firm and the union bargain over the wage while the employment is set unilaterally by the firm. The solution concept in this model is the Nash bargaining solution, obtained by maximizing the following function with respect to w_i:

$$Z_i(w_i) = (V_i(w_i) - \overline{V})^{\beta} (\Pi_i(w_i) - \overline{\Pi})^{1-\beta}.$$

Where $\overline{V}$ and $\overline{\Pi}$ are the fall-back positions of the union and the firm, respectively, and β is the union's bargaining power. A particular example arises when all the bargaining power corresponds to the union, that is $\beta = 1$, which is known as the "monopoly union" model, following the terminology by Oswald (1985). We will assume symmetric bargaining powers, that is $\beta = \frac{1}{2}$, and that the fall-back positions of both bargainers are zero.

The time structure of the game is as follows:

Stage 1. Each firm decides simultaneously its technology, the new one or the old one.

Stage 2. Each union bargains simultaneously with its firm on the wage corresponding to its workers.

Stage 3. Each firm decides simultaneously its output and employment.

In the analysis of the model we will use backwards induction in order to find out the Subgame Perfect Equilibrium (SPE) of the above game.

Let us first consider the case where both firms are active at the third stage. As we will show below this will happen if the degree of innovation $(1 - e)$ is small enough, relative to market size, measured by a.

Standard computations show that the Cournot-Nash equilibrium output, employment and profits levels in stage 3 are:

$$x_i = \frac{a - 2k_i w_i + k_j w_j}{3} \quad i; j = 1; 2 \ i \neq j \tag{2.1}$$

$$L_i = k_i \cdot \left(\frac{a - 2k_i w_i + k_j w_j}{3} \right) \tag{2.2}$$

$$\pi_i = \frac{(a - 2k_i w_i + k_j w_j)^2}{9}. \tag{2.3}$$

Thus, the objective function of union i at stage 2 can be written as

$$V_i = (w_i - r) \cdot \left(\frac{a - 2k_i w_i + k_j w_j}{3} \right) \cdot k_i.$$

The first order conditions of stage 2 give the following solution:

$$w_i = \frac{1}{21} \frac{3a + 16rk_i + 2k_j r}{k_i}; \quad i; j = 1; 2; \ i \neq j.$$

Depending on the previous technological choices by the firms, in Stage 1, the above results yield the following profits:

Case i) Both firms choose not to innovate (i.e: $k_i = k_j = 1$ and $\eta_i = 0$):

$$\pi_i = \pi_j = \frac{4(a - r)^2}{49}$$

Case ii) Both firms choose to innovate (i.e: $k_i = k_j = e < 1$; and $\eta_i = \varepsilon$) :

$$\pi_i = \pi_j = \frac{4(a - re)^2}{49} - \varepsilon$$

Case iii) One firm (say i) decides to innovate and the other (say j) chooses not to innovate (i.e, $k_i = e < 1$; $\eta_i = \varepsilon$; $k_j = 1$ and $\eta_j = 0$) :

$$\pi_i = \frac{4(3a + 2r - 5re)^2}{441} - \varepsilon; \quad \pi_j = \frac{4(3a + 2re - 5r)^2}{441}$$

To solve for the SPE of the decentralized union game, let us consider the following payoff matrix for the firms, at the first stage, obtained from the previous analysis of stages 2 and 3. In this matrix, New stands for the decision of choosing the new technology and Old stands for the decision of not innovating. Without loss of generality let us assume $r = 1$ and define $\gamma = 1 - e$ and $\alpha = a - 1$: Recall that $(1 - e)$ is the reduction in the labor requirement per unit of output, as a result of choosing the new technology and α can be interpreted as a measure of the market size relative to the reservation wage.

		Firm 2	
		New	Old
Firm 1	New	$\frac{4(\alpha+\gamma)^2}{49} - \varepsilon; \frac{4(\alpha+\gamma)^2}{49} - \varepsilon$	$\frac{4(3\alpha+5\gamma)^2}{441} - \varepsilon; \frac{4(3\alpha-2\gamma)^2}{441}$
	Old	$\frac{4(3\alpha-2\gamma)^2}{441}; \frac{4(3\alpha+5\gamma)^2}{441} - \varepsilon$	$\frac{4\alpha^2}{49}; \frac{4\alpha^2}{49}$

From the above matrix, it follows that there might be three different types of SPE depending on the parameters of the model:

First, if $\frac{4}{49}\alpha^2 > \frac{4}{441}(3\alpha+5\gamma)^2 - \varepsilon$ then choosing the old technology is the dominant strategy and thus SPE implies both firms choosing Old. Let us denote this particular type of SPE by (Old,Old). This condition can be rewritten as

$$\varepsilon > \frac{40}{147}\alpha\gamma + \frac{100}{441}\gamma^2 = D_1(\alpha;\gamma):$$

Second, if $\frac{4}{49}(\alpha+\gamma)^2 - \varepsilon > \frac{4}{441}(3\alpha - 2\gamma)^2 - \varepsilon;$ then choosing the new technology is the dominant strategy and the SPE is (New, New). This condition can be rewritten as

$$\varepsilon < \frac{40}{147}\alpha\gamma + \frac{20}{441}\gamma^2 = D_2(\alpha;\gamma):$$

Finally, by a similar argument, if $D_1(\alpha;\gamma) < \varepsilon < D_2(\alpha;\gamma)$; then there are two SPE, where only one firm innovate: $(New; Old)$, and $(Old; New)$:

The previous results are valid if $\alpha \geq \frac{2}{3}\gamma$: In this case both firms are always active. However if the market size (measured by α) is small enough relative to the degree of innovation (measured by γ) then in the asymmetric choices $(New; Old)$ and $(Old; New)$ only the innovator is active. This happens in the case $\alpha < \frac{2}{3}\gamma$; where the production of the firm choosing the old technology is zero if the other firm innovates. Standard computations yield the following matrix of profits, taking into account that if choices are $(New; Old)$ or $(Old; New)$ we have only one union bargaining with a monopolist innovator:

		Firm 2	
		New	Old
Firm 1	New	$\frac{4(\alpha+\gamma)^2}{49} - \varepsilon; \frac{4(\alpha+\gamma)^2}{49} - \varepsilon$	$\frac{9(\alpha+\gamma)^2}{64} - \varepsilon; 0$
	Old	$0; \frac{9(\alpha+\gamma)^2}{64} - \varepsilon$	$\frac{4\alpha^2}{49}; \frac{4\alpha^2}{49}$

Now, $(Old; Old)$ is the SPE if $\frac{4}{49}\alpha^2 > \frac{9}{64}(\alpha+\gamma)^2 - \varepsilon$; or

$$\varepsilon \geq \frac{185}{3136}\alpha^2 + \frac{9}{32}\alpha\gamma + \frac{9}{64}\gamma^2 = D_1(\alpha;\gamma).$$

And $(New; New)$ is the SPE if $\frac{4}{49}(\alpha+\gamma)^2 - \varepsilon \geq 0$; or

$$\varepsilon \leq \frac{4}{49}\alpha^2 + \frac{8}{49}\alpha\gamma + \frac{4}{49}\gamma^2 = D_2(\alpha;\gamma).$$

A similar argument shows that if $D_2(\alpha;\gamma) < \varepsilon < D_1(\alpha;\gamma)$ there are two SPE: $(New; Old)$ and $(Old; New)$.

The Figure 1 illustrates the previous result in the $(\alpha;\varepsilon)$ space, considering γ as given. The region above $D_1(\alpha;\gamma)$ corresponds with set of values for α and ε such that the SPE is given by (Old, Old), that is, both firms decide not to innovate. In the region below $D_2(\alpha;\gamma)$ both firms innovate and in the region between $D_1(\alpha;\gamma)$ and $D_2(\alpha;\gamma)$ the SPE are (New, Old) and (Old, New) that is, only one firm innovates.

(Insert Figure 1)

The previous analysis, is summarized in the following

Proposition 1. In the decentralized union game, the following properties hold:

i) If $\varepsilon \geq D_1(\alpha;\gamma)$; then, at the SPE both firms decide not to innovate.

ii) If $D_1(\alpha;\gamma) < \varepsilon < D_2(\alpha;\gamma)$; then there are two SPE, with only one firm innovating. Moreover, if $\alpha \leq \frac{2}{3}\gamma$ only the innovator is active at each SPE.

iii) If $\varepsilon \leq D_2(\alpha;\gamma)$; then at SPE both firms innovate.

Where

$$D_1(\alpha;\gamma) = \begin{cases} \frac{40}{147}\alpha\gamma + \frac{100}{441}\gamma^2 & \text{if } \alpha \geq \frac{2}{3}\gamma \\ \frac{185}{3136}\alpha^2 + \frac{9}{32}\alpha\gamma + \frac{9}{64}\gamma^2 & \text{if } \alpha < \frac{2}{3}\gamma; \end{cases}$$

$$D_2(\alpha;\gamma) = \begin{cases} \frac{40}{147}\alpha\gamma + \frac{20}{441}\gamma^2 & \text{if } \alpha \geq \frac{2}{3}\gamma \\ \frac{4}{49}\alpha^2 + \frac{8}{49}\alpha\gamma + \frac{4}{49}\gamma^2 & \text{if } \alpha < \frac{2}{3}\gamma. \end{cases}$$

According to Proposition 1, for any market size α; the lower the cost of innovation ε the more likely is that the new technology is chosen. In terms of Figure 1, as we decrease ε (given α); the new technology is initially chosen by just one firm (that is when D_1 is reached). In the case of small market size ($\alpha < \frac{2}{3}\gamma$) the first innovator becomes, initially, a monopolist, while with large market sizes ($\alpha \geq \frac{2}{3}\gamma$) this firm is still a duopolist. Finally, if ε is small enough (that is when D_2 is reached) both firms will adopt the new technology.

3. The model with a centralized union structure.

In this section , we will analyze the case in which there is a unique industry-wide union which bargains the wages for both firms in order to maximize the following objective function:

$$V = V_1 + V_2 = (w_1 - r) \cdot L_1 + (w_2 - r) \cdot L_2.$$

The time structure of the game is as follows:

Stage 1. Each firm decides simultaneously its technology, the new one or the old one.

Stage 2. The single union bargains with both firms the wages corresponding to the workers of each firm.

Stage 3. Each firm decides simultaneously its output and employment.

Thus, in our model it is assumed that the industry-wide union bargains on wages simultaneously with both firms.[2]

When computing the Nash solution of the bargaining problem, we will assume that the status quo payoff of the union is given by the payoff that it would obtain in the bargaining with the other firm as a monopolist. Standard computations show that this status quo payoff is $V_i^m = \frac{3}{32}(a - k_j r)^2$.

By an argument analogous to the one used in the previous section, we compute the following solution levels of wages:

$$w_i = \frac{1}{4}\frac{a + 3k_j r}{k_j}; \; i = 1, 2; \; i \neq j.$$

Depending on the previous technological choices by the firms, in stage 1, the above results yield the following profits:

Case i) Both firms choose not to innovate (i.e: $k_i = k_j = 1$ and $\eta_i = 0$):

$$\Pi_i = \Pi_j = \frac{(a - r)^2}{16}.$$

Case ii) Both firms choose to innovate (i.e: $k_i = k_j = e < 1$; and $\eta_i = \varepsilon$) :

[2] See Dobson (1994) and De Fraja (1993) for union models in which sequential bargaining is also considered.

$$\Pi_i = \Pi_j = \frac{(a - re)^2}{16} - \epsilon.$$

Case iii) One firm (say i) decides to innovate and the other (say j) chooses not to innovate (i.e, $k_i = e < 1$; $\eta_i = \epsilon$; $k_j = 1$ and $\eta_j = 0$) :

$$\Pi_i = \frac{(a - 2er + r)^2}{16} - \epsilon; \quad \Pi_j = \frac{(a - 2r + er)^2}{16}.$$

To solve for the SPE of the decentralized union game, let us consider the following payoff matrix for the firms, at the first stage, obtained from the previous analysis of stages 2 and 3. Recall that $r = 1$; $\gamma = 1 - e$ and $\alpha = a - 1$.

		Firm 2	
		New	Old
Firm 1	New	$\frac{(\alpha+\gamma)^2}{16} - \epsilon; \frac{(\alpha+\gamma)^2}{16} - \epsilon$	$\frac{(\alpha+2\gamma)^2}{16} - \epsilon; \frac{(\alpha-\gamma)^2}{16}$
	Old	$\frac{(\alpha-\gamma)^2}{16}; \frac{(\alpha+2\gamma)^2}{16} - \epsilon$	$\frac{\alpha^2}{16}; \frac{\alpha^2}{16}$

From the above matrix, it follows that there might be three different types of SPE depending on the parameters of the model:

First, (Old; Old) is the SPE if $\frac{\alpha^2}{16} \geq \frac{(a+2\gamma)^2}{16} - \epsilon$ or

$$\epsilon \geq \frac{1}{4}\alpha\gamma + \frac{1}{4}\gamma^2 = C_1(\alpha; \gamma).$$

Second, (New; New) is the SPE if $\frac{(\alpha+\gamma)^2}{16} - \epsilon \geq \frac{(a-\gamma)^2}{16}$ or

$$\epsilon \leq \frac{1}{4}\alpha\gamma = C_2(\alpha; \gamma).$$

A similar argument shows that if $C_2(\alpha;\gamma) < \varepsilon < C_1(\alpha;\gamma)$ there are two SPE: (New, Old) and (Old, New):

In the case $\alpha < \gamma$; the production of the firm choosing the old technology is zero if the other firm innovates. Standard computations yield the following matrix of profits, taking into account that if choices are (New, Old) or (Old, New) the union bargains with a monopolist innovator:

Firm 2

Firm 1		New	Old
	New	$\frac{(\alpha+\gamma)^2}{16} - \varepsilon; \frac{(\alpha+\gamma)^2}{16} - \varepsilon$	$\frac{9(\alpha+\gamma)^2}{64} - \varepsilon; 0$
	Old	$0; \frac{9(\alpha+\gamma)^2}{64} - \varepsilon$	$\frac{\alpha^2}{16}; \frac{\alpha^2}{16}$

Now, (Old, Old) is the SPE if $\frac{1}{16}\alpha^2 \geq \frac{9}{64}(\alpha+\gamma)^2 - \varepsilon$; or

$$\varepsilon \geq \frac{5}{64}\alpha^2 + \frac{9}{32}\alpha\gamma + \frac{9}{64}\gamma^2 = C_1(\alpha;\gamma):$$

And (New, New) is the SPE if $\frac{1}{16}(\alpha+\gamma)^2 - \varepsilon \geq 0$; or

$$\varepsilon \leq \frac{1}{16}\alpha^2 + \frac{1}{8}\alpha\gamma + \frac{1}{16}\gamma^2 = C_2(\alpha;\gamma):$$

A similar argument shows that if $C_2(\alpha;\gamma) < \varepsilon < C_1(\alpha;\gamma)$ there are two SPE: (New, Old) and (Old, New).

The Figure 2 illustrates the previous result in the $(\alpha;\varepsilon)$ space, considering γ as given. The region above $C_1(\alpha;\gamma)$ corresponds with set of values for α and ε such that the SPE is given by (Old; Old); that is, both firms decide not to innovate. In the region below $C_2(\alpha;\gamma)$ both firms innovate and in the region between $C_1(\alpha;\gamma)$ and $C_2(\alpha;\gamma)$ the SPE are (New, Old) and (Old, New), that is, only one firm innovates.

(Insert Figure 2)

The previous analysis, is summarized in the following

Proposition 2. In the centralized union game, the following properties hold:

i) If $\varepsilon \geq C_1(\alpha;\gamma)$; then, at the SPE both firms decide not to innovate.

ii) If $C_1(\alpha;\gamma) < \varepsilon < C_2(\alpha;\gamma)$; then there are two SPE, with only one firm innovating. Moreover, if $\alpha \leq \gamma$ only the innovator is active at each SPE.

iii) If $\varepsilon \leq C_2(\alpha;\gamma)$; then at SPE both firms innovate.

Where

$$C_1(\alpha;\gamma) = \begin{cases} \frac{1}{4}\alpha\gamma + \frac{1}{4}\gamma^2 & \text{if } \alpha \geq \gamma \\ \frac{5}{64}\alpha^2 + \frac{9}{32}\alpha\gamma + \frac{9}{64}\gamma^2 & \text{if } \alpha < \gamma; \end{cases}$$

$$C_2(\alpha;\gamma) = \begin{cases} \frac{1}{4}\alpha\gamma & \text{if } \alpha \geq \gamma \\ \frac{1}{16}\alpha^2 + \frac{1}{8}\alpha\gamma + \frac{1}{16}\gamma^2 & \text{if } \alpha < \gamma: \end{cases}$$

The interpretation of Proposition 2 is analogous to Proposition 1, and is reflected in Figure 2. Note, however, that the upper-bound of the levels of α consistent with the presence of an innovator monopolist is now greater than in the decentralized model. The intuition behind this result relies on the fact that under a centralized union wages are higher than in the decentralized model, which involves that the required market size to allow competition between the innovator and the non-innovator is greater.

4. Comparing outcomes under different union structures.

In this section we will focus on the comparative effects of union structure on technological innovation.

From Propositions 1 and 2 we get the following result:

Corollary 1. Assume that ε (the cost of adopting the new technology) is decreasing in time. Then the following properties hold relative to the SPE in the centralized and decentralized union games:

i) If $\alpha \leq \frac{2}{3}\gamma$; the innovation is introduced in the centralized model before it is in the decentralized one. In both models the innovation is initially introduced by a firm that becomes a monopolist. (See figure 3.i)

ii) If $\frac{2}{3}\gamma < \alpha < \gamma$; the innovation is introduced in the decentralized (resp. centralized) model before it is in the centralized (resp. decentralized) model for small (resp. large) values of α: Only in the centralized case the innovator becomes a monopolist. (See figure 3.ii)

iii) If $\alpha \geq \gamma$; the innovation is introduced in the decentralized (resp. centralized) model before it is in the centralized (resp. decentralized) model for large (resp. small) values of α: Both firms are always active in each model. (See figure 3.iii)

The previous result is illustrated in Figures 3i, 3ii and 3iii in the $(\alpha; \varepsilon)$ space.

Insert Figures 3i, 3ii, 3iii

In the case of part i) of the Corollary, as ε decreases the innovation is adopted in the centralized model before than in the decentralized one (note that $C_1 > D_1$

in this case). Therefore, one interesting implication of the previous corollary is that the centralized union structure enhances the adoption of innovation relative to the decentralized union structure, in the presence of small market sizes (that is, when ® < $\frac{2}{3}$°). To explain this result, note, …rst, that with this market sizes both models involve that if only one …rm innovates then it becomes a monopolist. Therefore, the pro…ts of a monopolist innovator are the same in both models, while the pro…ts of each …rm in a duopoly with no innovation are smaller in the case of a centralized model, which implies that the incentives to innovate are greater in this latter model.

With high enough market sizes (part iii of the corollary) the innovation is …rst introduced in the decentralized model, while for intermediate market sizes there is a subinterval with the same property as in part i).

Comparing our model and results with those in the work by Ulph and Ulph (1994) where they develop a model of patent race, some interesting similarities and di¤erences are worth to be noted. First, in their model, if unions negotiate on both wages and employment there are cases in which bargaining with a stronger union will help a …rm to win the patent race. In our model the more centralized is the union structure, the more likely is that the innovation is adopted by at least one …rm, if market size is small enough. In other words, their model establishes that, in some cases, a stronger bargaining power by an independent union stimulates innovation at the …rm level, while in our model a stronger union structure in the industry as a whole yields higher incentives to innovate, but at the industry level. Moreover, in our framework the fact that, in some cases, only one …rm innovates is an endogenous outcome of the model, while in their model that is an assumption associated with their modelling of innovation as a patent race in which only one …rm can get the new technology. In fact, in our model the technology is adopted, in some cases by both …rms.

However, note …rst that from our previous results it is easy to check that workers utility in each …rm will always be higher with a single industry-wide union than with independent unions. This result is rather intuitive and is similar to those obtained by Dowrick (1993) in a model where this author compares the di¤erent outcomes associated with di¤erent levels of centralization in union structures. However in his model there is no innovation, thus a …rst consequence from our model is that it allows to extend some previous results by Dowrick (1993) for the case in which endogenous innovation is allowed.

5. Conclusions.

In this paper we have investigated the in‡uence of the organizational aspects of the unions on the …rms decisions about innovation, in the context of duopolistic Cournot competition. We identify the conditions under which the incentive to innovate increases in the presence of a centralized industry-wide union, relative to the case of decentralized or independent unions.

Our results have some connections with some previous literature. In particular, our model is related with the one developed by Tauman and Weiss (1987), who analyze the incentive to adopt a new technology by a unionized duopolistic …rm competing with a non-unionized …rm. They show that the unionized …rm might have a higher incentive to adopt the new technology than the non-unionized …rm. However, this result only holds if the unionized …rm has initially higher marginal production cost than its competitor. In contrast, we show that an increased unionization (reflected in a higher level of union centralization) can stimulate innovation even if both firms have the same initial technology.

Our paper is also related with the model by Ulph and Ulph (1994), which basic insight is that the innovation depends crucially on the form in which each firm bargains (on wages or/and employment) with its own union. In our model we focus, instead, on the form in which unions are organized. We show that if innovation is sufficiently drastic then an industry-wide or centralized union enhances the incentive to innovate relative to the case in which there are independent unions (See Corollary 1).

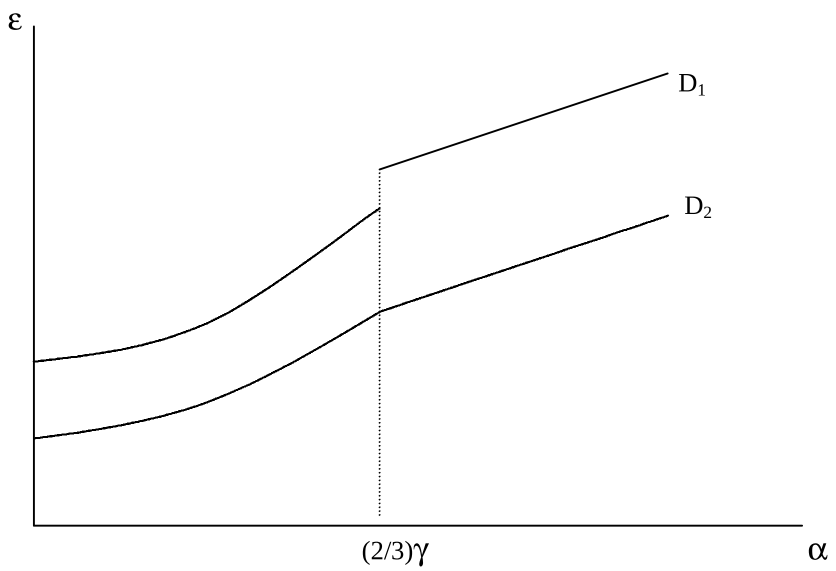

Figure 1

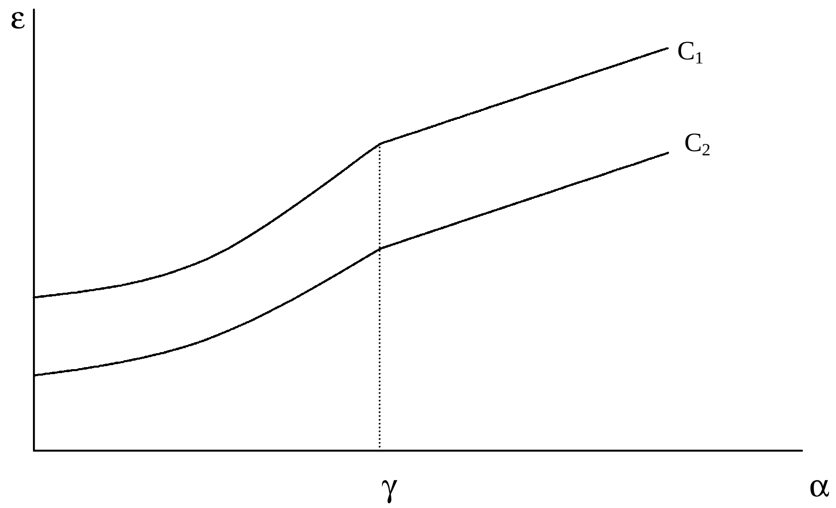

Figure 2

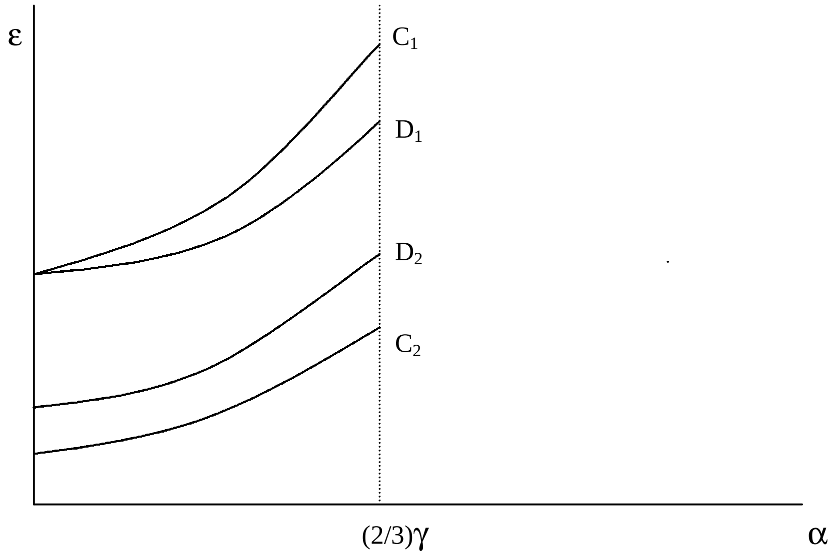

Figure 3i

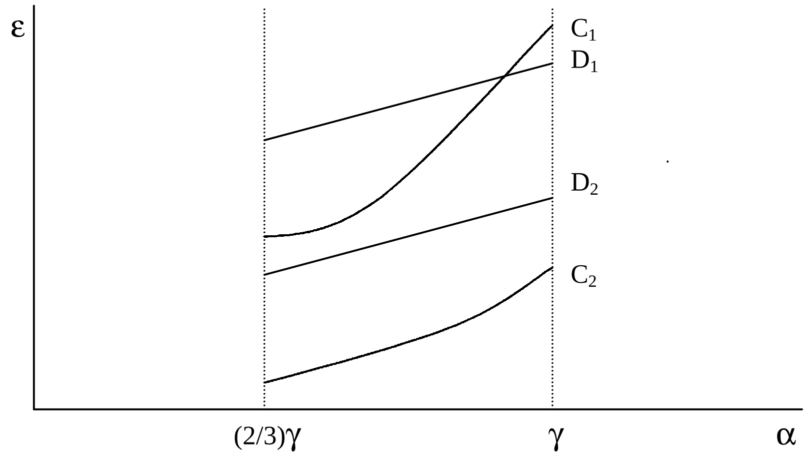

Figure 3ii

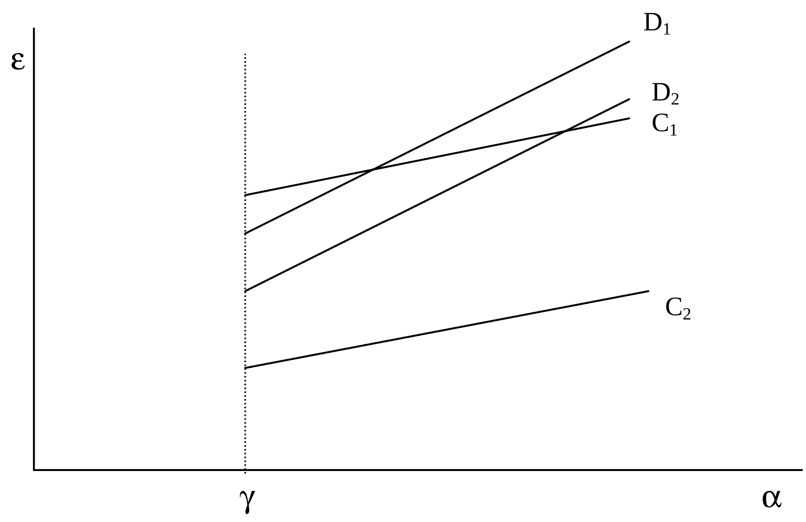

Figure 3iii

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