

Market competition and strike activity[☆]

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Abstract

We develop a model of wage bargaining with private information in a duopoly. We investigate how product differentiation and market competition (Bertrand vs. Cournot competition) affect wages and strikes. If bargaining takes place at the industry-level, then both the wage outcome and the strike activity do not depend on the degree of product differentiation whatever the type of market competition. However, if bargaining takes place at the firm-level, then wages and strikes are increasing with the degree of product differentiation, and the strike activity is smaller under Bertrand than under Cournot competition.

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1. Introduction

The empirical literature on collective bargaining disputes has established a number of regularities that a successful theory must accommodate. One of these

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regularities is that industry-specific factors are key determinants of strike activity. Indeed, Tracy (1986), Abowd and Tracy (1989), and Cramton and Tracy (1994) have shown that, beside sectorial growth and union density, factors such as the type of industry, industry size, concentration, and the size of the bargaining unit play an important role in explaining strike activity. Despite this evidence, there has not been to date a study of the relationship between the type of market competition, the level of bargaining and strike activity in the theoretical literature on wage bargaining in industries with market power.

To describe the market competition among firms in oligopolistic industries, two models dominate the literature: the Cournot model and the Bertrand model. In a Cournot market structure firms are assumed to choose their output levels, and the market price adjusts to clear the market. In contrast, in a Bertrand market structure firms set prices rather than output levels. In reality, firms make decisions about prices and quantities and the Cournot and Bertrand models perhaps are better viewed as reduced forms of some dynamic process where decisions are made about both type of variables. The variable that is more difficult to adjust would be the dominant strategic variable. That is, if capacity and output can be easily adjusted, then the Bertrand model is a better approximation of market competition. If, by contrast, output and capacity are difficult to adjust, then the Cournot model is a good approximation of market competition. Most real-world industries seem closer to the case when capacity is difficult to adjust. In other words, capacity or output decisions are normally the long-run variable, prices being set in the short run. Examples might include wheat, cement, steel, cars, and computers. The Cournot model would then seem a better approximation for these industries. There are, however, situations where capacities or at least output levels are adjusted more rapidly than prices. Examples perhaps include software, insurance, and banking.

In Table 1 we give for seven countries and four economic sectors the average number of days not worked each year per thousand workers. This measure of strike activity does not depend on the industry size and so allows us to make cross-industry comparisons. The countries we consider are the US, Canada, Japan, UK, Spain, Finland and Sweden. Wage-setting arrangements differ among these countries. Central wage agreements between powerful national employer associations and union confederations characterise the Nordic countries (Finland and Sweden). In Canada, the US, Japan, UK and Spain, wage bargaining is instead

Table 1

Average number of days not worked each year by economic activity (per thousand workers), period 1990–1999. Source: ILO Yearbook 2000

Economic activity	USA	Canada	Japan	UK	Spain	Finland	Sweden
Manufacturing	110.3	418.6	1.7	53.3	431.5	196.8	5.0
Finance, insurance	7.5	22.8	0.1	6.0	156.2	66.3	183.1
Elec., gas and water	24.6	98.6	0.1	11.5	63.0	6.6	27.9
Transport	187.9	278.1	16.8	126.2	384.5	33.5	66.8

mainly at the firm level, although there are certain elements of industry bargaining in the latter two countries (see e.g. Calmfors and Driffill, 1988; Layard et al., 1991). The four economic sectors we consider are manufacturing, finance and insurance, electricity, gas and water supply, and transport. From the discussion above, the Cournot model seems a better approximation of the manufacturing and transport industries. On the contrary, the Bertrand model arguably provides a better approximation of the insurance and banking sector as well as of electricity, gas and water supply.

Some stylised facts can be drawn from Table 1. First, the efficiency losses due to strikes and lockouts are not negligible. Indeed, the average number of days not worked each year (per thousand workers) for the manufacturing sector in the US is 110.3 which means that more than one in ten of the workers have lost each year one day of work due to work stoppages. One should keep in mind that the manufacturing industry counts more than 20 million workers. Second, in countries with decentralised negotiations, industries such as finance and insurance as well as electricity, gas and water supply have experienced fewer average days not worked compared to the manufacturing and transport industries. Third, in countries with centralised negotiations (Finland and Sweden) there is no obvious relationship between the number of days not worked each year and the economic activity. Fourth, for the finance and insurance industry the average number of days not worked each year is larger in countries with national or industry-level negotiations than in countries with firm-level negotiations. But, one should be cautious when making cross-countries comparisons about strikes and lockouts since the legislation with respect to strikes as well as the economic growth differ from country to country. For example, in Finland and Sweden peace agreements are often obtained in the national bargain between trade union federation and employers' federation, which rule out the use of strikes at the firm-level (see Layard et al., 1991).¹

The conclusions that we draw from Table 1 should be taken cautiously without having controlled for some other variables that might be important. Tracy (1986), Harrison and Stewart (1986), and Vroman (1989) have shown using US or Canadian data that labour market tightness (as measured by the inverse of the unemployment rate) has a positive and significant effect on strike incidence, but that strike duration is shorter in periods with tight labour markets. These empirical studies also support the view that both strike incidence and strike duration are negatively related to real wage growth over the previous contract, and that strikes are increasing with union density and union coverage. In Table 2 we give union density by economic activity for the US, Canada, Japan and UK. We observe that

¹ Moreover, the data does not distinguish the motives for strikes or lockouts. Some strikes could have as motive a wage dispute, others the number of working hours or even the plant working conditions. The latter motive is mainly a motive for striking at the firm-level. Hence, when peace agreements forbid strikes at the firm-level, the total number of strikes is biased and cross-countries comparisons are difficult.

Table 2

Union density by economic activity (2000) and average unemployment rate by economic activity (1990–1999). Sources: ILO, StatCan, AFL-CIO, JIN (Japan), DTI (UK)

Economic activity	Union density				Unemployment rate			
	USA	Canada	Japan	UK	USA	Canada	UK	Spain
Manufacturing	14.8	32.5	28.0	27.0	5.4	8.2	7.6	11.2
Finance, insurance	1.6	8.8	41.1	30.0	5.2	5.6	4.8	10.3
Elec., gas, water	22.8	64.6	56.1	53.0	2.4	4.1	5.0	5.2
Transport	24.8	42.4	37.3	42.0	4.2	6.0	6.3	7.4

sectors we have suggested compete à la Bertrand do not have a lower union density than these competing à la Cournot. Table 2 also shows the average unemployment rate for the US, Canada, UK and Spain. It appears that in the US and Spain unemployment rates in ‘Bertrand’ sectors can be higher or lower than unemployment rates in ‘Cournot’ sectors. Finally, the wage increases in collective agreements in Canada for the period 95–99 were similar in the electricity, gas and water supply and the transport sectors.² To summarise, all these observations support the view that the type of market competition may play a role in explaining strike activity, and that it is likely that in countries with decentralised wage negotiations the strike activity will tend to be smaller in industries competing à la Bertrand than in industries competing à la Cournot. Nevertheless, future econometric research needs to confirm the stylised facts through empirical test of the relationships between strikes, market competition and bargaining structures.

The purpose of this paper is to provide a theoretical study of how institutional features such as the bargaining structure and of how industry factors such as the product market competition will affect the outcome of wage negotiations in unionised duopolistic industries. Within an incomplete information framework, we develop a model of wage determination in a product differentiated duopoly. First, unions and firms negotiate over the wage level according to institutional features (industry-level vs. firm-level bargaining). Second, firms compete either in quantities (Cournot competition) or in prices (Bertrand competition) on the product market. To describe the wage bargaining process, we adopt Rubinstein’s (1982) alternating-offer bargaining model with two-sided incomplete information, which allows the occurrence of strikes at equilibrium.

Related contributions are Davidson (1988), Horn and Wolinsky (1988), and Dowrick (1989). When firms produce in related product markets, wage settlements create spillover effects (by altering the firms’ relative competitive positions in the product market) that have implications for the outcome of negotiations. Davidson

²The average wage increases in collective agreements in Canada (for the period 95–99) were 2.1, 1.2, 1.6 and 1.7 in the manufacturing, finance and insurance, electricity, gas and water supply, and transport sectors, respectively.

(1988) and Horn and Wolinsky (1988) have studied the impact of wage spillover effects on the interaction of union-firm bargaining and duopolistic quantity-setting. Around the same time, Dowrick (1989) has used a conjectural variation oligopoly model to study how product market power and profitability are related to wages. More recently, Dhillon and Petrakis (2002) have investigated, mainly for the case of centralised bargaining in oligopolistic industries, the effects of the degree of product differentiation and the type of market competition (Bertrand vs. Cournot competition) on the negotiated wage. But, all these previous studies have considered complete information frameworks so that strikes, which waste industry resources, cannot occur at equilibrium.³

So, we go beyond the analysis offered in Davidson (1988), Horn and Wolinsky (1988), Dowrick (1989) and Dhillon and Petrakis (2002), by developing a model that enables us to investigate for different bargaining structures and types of market competition how private information as well as spillover effects across payoff functions created by contract settlements affect the wages and the strike activity. We show that, if the wage bargaining takes place at the industry-level, then both the wage outcome and the strike activity do not depend on the degree of product differentiation whatever the type of market competition. Indeed, since wage spillover effects are internalised at the industry-level, wage bargaining affects employment and profits only through the overall level of industry demand. As a consequence, the strike activity is the same under both Bertrand and Cournot competition and is independent of product differentiation.

However, if the wage bargaining takes place at the firm-level, we show that wages and strikes are increasing with the degree of product differentiation. Since firm-level bargaining does not internalise the wage spillover effects and these spillover effects are decreasing with the degree of product differentiation, the strike activity at the firm-level is increasing with product differentiation. Indeed, wage spillover effects create incentives to lower wages in order to gain a larger share of the product market and to induce more concessions and less conflicts or strikes in wage bargains. These incentives are reinforced the less differentiated the products or brands are. In addition, the strike activity under Bertrand competition is smaller than under Cournot competition. This is due to the fact that wage spillover effects are greater under Bertrand competition.

Contrary to the complete information framework, the firm-level wage under Bertrand competition will not necessarily be lower than the firm-level wage under Cournot competition, in presence of private information. Furthermore, the firm-level wage under Cournot competition will not necessarily be lower than the industry-level wage under Cournot (or Bertrand) competition. However, it is commonly known that the local union is much stronger than the local firm and the

³ Strikes data seem to have a significant impact on the wage–employment relationship for collective negotiations (see e.g. Kennan and Wilson, 1989; Vannetelbosch, 1996).

degree of product differentiation is small, then Bertrand competition will decrease the firm-level wage at equilibrium and industry-level bargaining will increase the wage at equilibrium.

Finally, the strike activity is smaller under Bertrand than under Cournot competition when bargaining is decentralised. So, Bertrand competition increases the disparity, in terms of strike activity, of both bargaining structures.

The paper is organised as follows. In Section 2, the model is presented. The Bertrand and Cournot games in the duopolistic market are solved assuming that wages have already been determined. Section 3 describes the wage bargaining game and solves this game for the industry-level bargaining system. It also analyses the relationship between the industry-level bargaining structure, the degree of product differentiation, and the strike activity. Section 4 is devoted to the wage bargaining game for the firm-level bargaining system and analyses again the relationship between the firm-level bargaining structure, the degree of product differentiation, and the strike activity. Finally, Section 5 offers some predictions regarding the actual strike duration and the efficiency loss incurred during wage negotiations on the basis of observable industry characteristics. It also sheds some light on an equilibrium institution.

2. Description of the duopolistic market

We consider a duopolistic industry. Each firm is producing one brand of a differentiated product. Let firm i produce brand i in quantity q_i . There is no entry or threat of entry, and both firms are either price setters (Bertrand competition) or quantity setters (Cournot competition). The inverse demand function for the brand i of the differentiated product is given by

$$p_i(q_i, q_j) = a - q_i - b \cdot q_j, \quad i, j = 1, 2 \quad \text{and} \quad i \neq j. \quad (1)$$

The parameter $b \in (0, 1)$ represents the degree of substitutability between both brands. The higher the b , the higher is the degree of substitutability between i and j . When b tends to zero, each firm becomes almost a monopolist; when b tends to one, both brands are almost perfect substitutes.

Production technology exhibits constant returns to scale with labour as the sole input and is normalised in such a way that $q_i = l_i$, where l_i is labour input. The total cost to firm i of producing quantity q_i is $q_i \cdot w_i$, where w_i is the wage in firm i . Associated with each firm there is a risk-neutral union. The workforce for each firm is drawn from separate pools of labour, and the union objective is to maximise the economic rent, i.e.

$$U_i(w_i, \bar{w}, l_i, (q_1, q_2)) = l_i \cdot (w_i - \bar{w}) \quad i = 1, 2, \quad (2)$$

where \bar{w} is the reservation wage. The profit of firm i is given by

$$\Pi_i(w_i, l_i, (q_1, q_2)) = (a - q_i - bq_j) \cdot q_i - w_i \cdot q_i. \quad (3)$$

Interactions between the product market, the degree of product differentiation and the bargaining level are analysed according to the following game structure. In stage one, wages are negotiated at the firm-level or at the industry-level. In stage two, Bertrand or Cournot competition occurs. The two-stage structure makes the model an appropriate description of a situation in which wages are determined for a relatively long period while production decisions are made for a relatively shorter period. The model is solved backwards.

In the last stage of the game, the wage levels have already been determined. Under Cournot competition both firms compete by choosing simultaneously their outputs (and hence, employment) to maximise profits with price adjusting to clear the market. The unique Nash equilibrium of this stage game yields:

$$q_i^*(w_1, w_2) = \frac{a(2-b) - 2w_i + bw_j}{4-b^2} \quad i, j = 1, 2, i \neq j. \quad (4)$$

The Nash equilibrium output of a firm (and hence, equilibrium level of employment) is decreasing with its own wage, while it is increasing with the other firm's wage and total industry demand.

Under Bertrand competition both firms compete by choosing simultaneously their prices to maximise profits. The unique Nash equilibrium of this stage game yields:

$$p_i^*(w_1, w_2) = \frac{a(1-b)(2+b) + 2w_i + bw_j}{4-b^2} \quad i, j = 1, 2, i \neq j. \quad (5)$$

and

$$q_i^*(w_1, w_2) = \frac{a(1-b)(2+b) - (2-b^2)w_i + bw_j}{(1-b^2)(4-b^2)} \quad i, j = 1, 2, i \neq j. \quad (6)$$

In the first stage of the game, firms and unions negotiate the wage level foreseeing perfectly the effect of wages on firms' decisions concerning employment. To investigate the effects of the degree of product differentiation and the type of market competition (Bertrand vs. Cournot competition) on the negotiated wage and the strike activity, we consider two bargaining structures: industry-level and firm-level wage settlements.

3. Industry-level wage bargaining

At the industry-level, workers are represented by a central union (CU) whose objective function is to maximise the sum of local unions' payoffs. This central union negotiates the industry wage level with the firms representative (CF), whose

objective function is to maximise the sum of local firms' profits. Before considering the industry-level wage bargaining with private information we first analyse the complete information setting as a benchmark.

3.1. Industry-level agreements under complete information

The negotiation proceeds as in Rubinstein's (1982) alternating-offer bargaining model. The CF and the CU make alternatively wage offers, with CF making offers in odd-numbered periods and CU making offers in even-numbered periods. The length of each period is Δ . The negotiation starts in period 0 and ends when one of the negotiators accepts an offer. No limit is placed on the time that may be expended in bargaining and perpetual disagreement is a possible outcome. All local unions are assumed to be on strike in every period until an agreement is reached. Both CF and CU are assumed to be impatient: the CF and the CU have time preferences with constant discount rates $r_f > 0$ and $r_u > 0$, respectively. We assume that all unions have the same discount rate r_u and all firms have also the same discount rate r_f .⁴

To capture the notion that the time it takes to come to terms is small relative to the length of the contract, we assume that the time between periods is very small. This allows a study of the limiting situations in which the bargaining procedure is essentially symmetric and the potential costs of delaying agreement by one period can be regarded as negligible. As the interval between offers and counteroffers is short and shrinks to zero, the alternating-offer model has a unique limiting subgame perfect equilibrium, which approximates the Nash bargaining solution to the bargaining problem (see Binmore et al., 1986). Let $U = U_1 + U_2$ and $\Pi = \Pi_1 + \Pi_2$. Thus the predicted wage is given by

$$w_c^{\text{SPE}} = \arg \max [U - U^0]^\alpha \cdot [\Pi - \Pi^0]^{1-\alpha} \quad (7)$$

where the lowerscript 'c' means that wage bargaining is centralised (or industry-level), and where $U^0 = 0$ and $\Pi^0 = 0$ are, respectively, the disagreement payoffs of the CU and the CF. The parameter $\alpha \in (0, 1)$ is the CU bargaining power which is equal to $r_f / (r_u + r_f)$. In case of Cournot competition, simple computation gives us

⁴Two versions of Rubinstein alternating-offer bargaining model capture different motives that induce parties to reach an agreement rather than to insist indefinitely on incompatible demands. In a first version the parties' incentive to agree lies in the fact that they are impatient: player i is indifferent between receiving $x \cdot \exp(-r_i \cdot \Delta)$ today and x tomorrow, where $r_i > 0$ is player i 's discount rate. In a second version the parties are not impatient but they face a risk that if agreement is delayed then the opportunity they hope to exploit jointly may be lost: player i believes that at the end of each bargaining period there is a positive probability $1 - \exp(-r_i \Delta)$ that the process will break down, $r_i > 0$. So, r_i can be interpreted either as player i 's discount rate or as his estimate about the probability of a breakdown of the negotiations.

$$w_{c,c}^{\text{SPE}} = \bar{w} + \frac{\alpha}{2} \cdot (a - \bar{w}) = \bar{w} + \frac{r_f(a - \bar{w})}{2(r_u + r_f)}. \quad (8)$$

Expression (8) tells us that, in complete information, the wage is increasing with the reservation wage \bar{w} and with the CU bargaining power α , but it does not depend on the degree of product differentiation, $1 - b$. Then, one can easily obtain the equilibrium employment level as well as the CU and CF equilibrium payoffs, which are denoted $U_{c,c}^*(\alpha)$ and $\Pi_{c,c}^*(\alpha)$, and are given by

$$U_{c,c}^*(\alpha) = \frac{\alpha(2 - \alpha)}{2(2 + b)} \cdot (a - \bar{w})^2, \quad \Pi_{c,c}^*(\alpha) = \frac{(2 - \alpha)^2}{2(2 + b)^2} \cdot (a - \bar{w})^2.$$

Both the CU and the CF equilibrium payoffs are increasing with the degree of product differentiation. That is, both are decreasing with b . The equilibrium employment in firm i is $(2 - \alpha)(a - \bar{w})[2(2 + b)]^{-1}$ and is also increasing with the differentiation.⁵

In case of Bertrand competition, simple computation gives us

$$w_{c,b}^{\text{SPE}} = \bar{w} + \frac{\alpha}{2} \cdot (a - \bar{w}) = \bar{w} + \frac{r_f(a - \bar{w})}{2(r_u + r_f)}. \quad (9)$$

Expression (9) is the same as Expression (8). When wage bargaining takes place at the firm-level, each union–firm pair expects to be able to alter its relative wage position in the industry. Therefore, wage spillover effects are created: each union–firm pair has an incentive to lower wages in order to increase its market share (or employment level) and the firm's profits, incentive which decreases with the degree of product differentiation. But, when wage bargaining takes place at the industry-level, these wage spillover effects are internalised and vanish. As a consequence, wage bargaining affects employment and profits only through the overall level of industry demand, and the wage outcome is the same under both Bertrand and Cournot competition. In case of complete information and centralised wage negotiations, a general discussion on when and why wages are identical under both Bertrand and Cournot competition can be found in Dhillon and Petrakis (2002).

So, the wage in case of Bertrand competition is increasing with the reservation wage \bar{w} and with the CU bargaining power α , but does not depend on the degree of product differentiation, $1 - b$. Then, one can easily obtain the equilibrium employment level as well as the CU and CF equilibrium payoffs, which are denoted $U_{c,b}^*(\alpha)$ and $\Pi_{c,b}^*(\alpha)$, and are given by

⁵ An increase in the degree of product differentiation (a decrease in b) increases the market's firm size and reduces the intensity of competition. Since the market size effect dominates the competition effect, a firm's output increases with the differentiation in a Cournot industry.

$$U_{c.B}^*(\alpha) = \frac{\alpha(2-\alpha)}{2(1+b)(2-b)} \cdot (a-\bar{w})^2, \quad \Pi_{c.B}^*(\alpha) = \frac{(1-b)(2-\alpha)^2}{2(1+b)(2-b)^2} \cdot (a-\bar{w})^2.$$

Notice that now, the CU equilibrium payoff and the equilibrium employment in firm i , which is equal to $(2-\alpha)(a-\bar{w})[2(2-b)(1+b)]^{-1}$, are decreasing with the degree of product differentiation if $b > 1/2$, but are increasing otherwise.⁶ However, the CF equilibrium payoff is still increasing with the differentiation whatever the parameter b .

Although the wage is the same under both Bertrand and Cournot competition, we observe that the employment level is smaller under Cournot competition. Indeed, under Cournot competition each firm expects the other firm to hold its output level constant. Hence, each firm would maintain a low output level since it is aware that a unilateral output expansion would result in a drop in the market price. In contrast, under Bertrand competition each firm assumes that the rival firm holds its price constant. Hence, output expansion will not result in a price reduction because the rival firm will adjust its output in a compensatory way to leave its market price unchanged. Therefore, more output is produced and a higher level of employment is obtained under the Bertrand market structure than under the Cournot one.⁷

However, both the asymmetric Nash bargaining solution and the Rubinstein's model predict efficient outcomes of the bargaining process (in particular agreement is reached immediately). This is not the case once we introduce incomplete information into the wage bargaining, in which the first rounds of negotiation are used for information transmission between the two negotiators.

3.2. Industry-level agreements under incomplete information

The main feature of the negotiation is that both negotiators have private information. Each negotiator does not know the impatience (or discount rate) of the other party. It is common knowledge that the CF's discount rate is included in the set $[r_f^p, r_f^i]$, where $0 < r_f^p \leq r_f^i$, and that the CU's discount rate is included in the set $[r_u^p, r_u^i]$, where $0 < r_u^p \leq r_u^i$. The superscripts 'I' and 'P' identify the most impatient and most patient types, respectively. The types are independently drawn

⁶Contrary to the Cournot case, under Bertrand competition an increase in the degree of product differentiation increases a firm's output only if $b < 1/2$. Indeed, when $b > 1/2$, the competition effect dominates the market size effect because a Bertrand industry is more competitive than a Cournot industry.

⁷Throughout the paper it is assumed that the impatience of the players does not depend on product differentiation. But one could argue that the less differentiated the products are the more impatient the players are to start the production and to concede. However, one can show that if the discount factor depends on the product differentiation and is given by $\exp(-r_i \cdot \Delta \cdot (1-b))$, then the equilibrium wage outcome at the industry-level is still independent of the degree of product differentiation.

from the set $[r_i^P, r_i^I]$ according to the probability distribution p_i , for $i = u, f$. We allow for general distributions over discount rates. This uncertainty implies bounds on the CU bargaining power which are denoted by $\underline{\alpha} = r_f^P \cdot [r_u^I + r_f^P]^{-1}$ and $\bar{\alpha} = r_f^I \cdot [r_u^P + r_f^I]^{-1}$.

Lemma 1. *Consider the industry-level wage bargaining with incomplete information in which the distributions p_f and p_u are common knowledge, and in which the period length shrinks to zero. For any perfect Bayesian equilibria (PBE), the payoff of the CU belongs to $[U_{c,\cdot}^*(\underline{\alpha}), U_{c,\cdot}^*(\bar{\alpha})]$ and the payoff of the CF belongs to $[\Pi_{c,\cdot}^*(\bar{\alpha}), \Pi_{c,\cdot}^*(\underline{\alpha})]$.*

This lemma follows from Watson’s (1998) analysis of Rubinstein’s alternating-offer bargaining model with two-sided incomplete information.⁸ Lemma 1 is not a direct corollary to Watson’s (1998) Theorem 1 because Watson’s work focuses on linear preferences, but the analysis can be modified to handle the present case. Translating Watson’s (1998) Theorem 2 to our framework completes the characterisation of the PBE payoffs.

Lemma 2. *Consider the industry-level wage bargaining with incomplete information in which the period length shrinks to zero. For any $\tilde{U} \in [U_{c,\cdot}^*(\underline{\alpha}), U_{c,\cdot}^*(\bar{\alpha})]$, $\tilde{\Pi} \in [\Pi_{c,\cdot}^*(\bar{\alpha}), \Pi_{c,\cdot}^*(\underline{\alpha})]$, there exists distributions p_u and p_f , and a PBE such that the PBE payoffs are \tilde{U} and $\tilde{\Pi}$.*

In other words, whether or not all payoffs within the intervals given in Lemma 1 are possible depends on the distributions over types. As Watson (1998) has stated, Lemma 1 and Lemma 2 establish that “each player will be no worse than he would be in equilibrium if it were common knowledge that he were his least patient type and the opponent were his most patient type. Furthermore, each player will be no better than he would be in equilibrium with the roles reversed”. From Lemma 1 we have that the PBE wage outcome in case of Cournot competition, $w_{c,c}^*(\underline{\alpha}, \bar{\alpha})$, satisfies the following inequalities:

$$\bar{w} + \frac{r_f^P(a - \bar{w})}{2(r_u^I + r_f^P)} \leq w_{c,c}^*(\underline{\alpha}, \bar{\alpha}) \leq \bar{w} + \frac{r_f^I(a - \bar{w})}{2(r_u^P + r_f^I)}. \tag{10}$$

Notice that each wage satisfying these bounds can be the outcome by choosing appropriately the distribution over types. The lower (upper) bound is the wage

⁸Watson (1998) has characterised the set of PBE payoffs which may arise in Rubinstein’s alternating-offer bargaining game and has constructed bounds (which are met) on the agreements that may be made. The bounds and the PBE payoffs set are determined by the range of incomplete information and are easy to compute because they correspond to the SPE payoffs of two bargaining games of complete information. These two games are defined by matching one player’s most impatient type with the opponent’s most patient type.

outcome of the complete information game, when it is common knowledge that the CU's type is r_u^I (r_u^P) and the CF's type is r_f^P (r_f^I) (and the CU bargaining power is $\underline{\alpha}$ ($\bar{\alpha}$)). Expression (10) implies bounds on the firm's employment level, as well as on the firm's output, at equilibrium. In case of Bertrand competition, the PBE wage outcome, $w_{c,B}^*(\underline{\alpha}, \bar{\alpha})$, will also satisfy those inequalities:

$$\bar{w} + \frac{r_f^P(a - \bar{w})}{2(r_u^I + r_f^P)} \leq w_{c,B}^*(\underline{\alpha}, \bar{\alpha}) \leq \bar{w} + \frac{r_f^I(a - \bar{w})}{2(r_u^P + r_f^I)}. \quad (11)$$

Obviously, from Lemma 1 and Lemma 2 inefficient outcomes are possible, even as the period length shrinks to zero. Inefficiency can occur in two ways. First, players might agree to throw away some of the resource over which they are bargaining, even when agreement is reached without delay. Second, the negotiation may involve considerable delay, even if the eventual agreement is efficient on its own. While the scope of possible inefficiency is clear from Lemma 1 and Lemma 2, what is not so obvious is the potential for delay. In fact, the wage bargaining game may involve delay (strikes or lock-outs), but not perpetual disagreement, at equilibrium. Indeed, Watson (1998) has constructed a bound on delay in equilibrium which shows that an agreement is reached in finite time and that delay time equals zero as incomplete information vanishes.

3.3. Strike activity and industry-level bargaining

In the literature on strikes (see e.g. Cheung and Davidson, 1991; Kennan and Wilson, 1989), three different measures of strike activity are usually proposed: the strike incidence, the strike duration, and the number of work days lost due to work stoppages. Since we allow for general distributions over types and we may encounter a multiplicity of PBE, we are unable to compute measures of strike activity as the ones just mentioned.⁹ Nevertheless, we propose to identify the strike activity (strikes or lock-outs) with the potential inefficiency in reaching a wage agreement. Following Watson's (1998) Theorem 3, the larger is the difference between the upper bound and lower bound on the bargaining outcome, the larger is the potential inefficiency for obtaining an agreement and the larger is the possibility of delay in reaching an agreement. Therefore, the strike activity is given by the difference between the upper bound and the lower bound on the wage outcome and it can be interpreted as an indicator of both the level of potential inefficiency and the strike duration (see also Vannetelbosch, 1997).¹⁰

⁹In order to compute an expected strike duration one would need to fix some parameters of the model such as the distribution over types (see e.g. Cheung and Davidson, 1991; Kennan and Wilson, 1993) but it would imply a substantial loss of generality.

¹⁰Our measure of strike activity gives the scope each player has for screening his opponent by making wage proposals satisfying the expressions (10) or (11), and hence, for delaying the wage agreement. Only *in average* this measure is a good proxy of actual strike duration.

So, when bargaining takes place at the industry-level, the strike activity is given by the following expression under both types of market competition.

$$\Psi_{c,c} = \Psi_{c,b} = \frac{\bar{\alpha} - \alpha}{2}(a - \bar{w}) = \frac{[r_f^I r_u^I - r_f^P r_u^P]}{2[r_f^P + r_u^I][r_f^I + r_u^P]}(a - \bar{w}). \tag{12}$$

Therefore, both $\Psi_{c,c}$ and $\Psi_{c,b}$ are increasing (decreasing) functions of r_u^I (r_u^P), are decreasing (increasing) functions of r_f^P (r_f^I), and are decreasing with the reservation wage \bar{w} . However, the strike activity does not depend on the degree of product differentiation because wage spillover effects are internalised when negotiations are centralised. The next proposition summarises our results with respect to industry-level bargaining.

Proposition 1. *If the wage bargaining takes place at the industry-level, then the strike activity is the same in both Cournot and Bertrand markets, and is independent of the degree of product differentiation.*

We could question whether Proposition 1 is robust to other specifications than the linear form of product differentiation. For example, if we consider a demand function that displays a constant elasticity of substitution (CES) between the differentiated goods (see e.g. Anderson et al., 1992; Vives, 1999), then the answer is negative. Indeed, we can show that, in case of a CES demand, the strike activity at the industry-level depends on the substitutability between the products and is increasing with the degree of product differentiation both under Cournot and Bertrand competition.

However, Proposition 1 holds in a broad class of industry specifications widely used in the literature. Indeed, Dhillon and Petrakis (2002) have provided conditions under which the negotiated wage at the industry level is independent of a list of market parameters (such as the number of firms, the degree of product differentiation and the intensity of market competition) as well as the mode of negotiations (right-to-manage or efficient bargaining), for constant elasticity of substitution union objective functions and identical firms endowed with log-linear labour technology (see Proposition 1 of Dhillon–Petrakis). If the wage elasticities of the firm’s equilibrium (induced) output and profits are independent of the market features (stay constant across industries), then the negotiated wage does not depend on the specific industry characteristics. Moreover, if the wage elasticities of the firm’s equilibrium output and profits are equal to the wage elasticities of the firm’s induced output and profits in the efficient bargaining model, respectively, the negotiated wage does not depend on the mode of negotiations (wage or wage–employment bargaining) either. This result is shown to hold in a broad class of industry specifications widely used in the literature, not only for linear demand–linear technology economies. For example, it holds in a version of Dixit and Stiglitz (1977) model where firms compete in prices and the strategic

interaction among firms which was absent in the initial Dixit–Stiglitz model is added (see Dhillon and Petrakis, 2002).

4. Firm-level wage bargaining

At the firm-level, workers are represented by a local union representative (LU) whose objective function is to maximise the local union's utility given by Expression (2). Inside each firm, the LU negotiates the local wage level with the local firm representative (LF) whose objective function is to maximise its profit given by Expression (3). Bargaining is decentralised: LU–LF pairs conduct simultaneous negotiations. Two assumptions are made. First, when one set of negotiations is taking place, the agents are unaware of any proposals made (or settlement reached) in related negotiations. Second, the production and market competition occur only when either both firms have come to terms with their workers or when one firm settles with its union and the other union decides to leave the bargaining table forever. Hence, each LU–LF pair takes the decisions of its rivals as given while conducting its own negotiation. Moreover, each LU–LF pair always correctly anticipates the effect of wages on the subsequent Bertrand or Cournot competition. This is the standard approach used in the literature to solve for firm-level negotiations in oligopolistic industries (see e.g. Davidson, 1988; Horn and Wolinsky, 1988).

Before considering the firm-level wage negotiations with private information we first analyse the complete information setting as a benchmark.

4.1. Firm-level agreements under complete information

Under complete information, the firm-level equilibrium wages are given by

$$\begin{cases} w_{1d}^{\text{SPE}} = \operatorname{argmax}[U_1 - U_1^0]^\alpha [\Pi_1 - \Pi_1^0]^{1-\alpha} \\ w_{2d}^{\text{SPE}} = \operatorname{argmax}[U_2 - U_2^0]^\alpha [\Pi_2 - \Pi_2^0]^{1-\alpha} \end{cases} \quad (13)$$

where α is the LU's bargaining power and it is given by expression $r_f/(r_u + r_f)$, and where $U_1^0 = U_2^0 = 0$ and $\Pi_1^0 = \Pi_2^0 = 0$ are the disagreement payoffs of the LUs and the LFs.¹¹ The lowerscript 'd' means that negotiations are decentralised (or firm-level). In case of Cournot competition, simple computations give us

¹¹The disagreement payoffs are zero because of the assumptions made with respect to the bargaining stage (union–firm pairs are fixed and negotiations are behind closed doors until agreements are reached) and the production stage. An alternative is to introduce some matching and bargaining between unions and firms (see e.g. Osborne and Rubinstein, 1990) and to allow that if negotiations fail with one firm a union can go to the other firm. This would make the analysis quite complicated since we cannot use anymore both Rubinstein's (1982) model to describe the wage bargaining and Watson's (1998) incomplete information extension.

$$\begin{aligned}
 w_{d,C}^{SPE} &= \bar{w} + \frac{\alpha(2-b)}{4-b\alpha}(a-\bar{w}) = w_{1d,C}^{SPE} = w_{2d,C}^{SPE} \\
 &= \bar{w} + \frac{r_f(2-b)}{4r_u+(4-b)r_f}(a-\bar{w}).
 \end{aligned}
 \tag{14}$$

Expression (14) tells us that, in complete information, the wage is increasing with the reservation wage \bar{w} , with the LU bargaining power α , and with the degree of product differentiation. Contrary to industry-level bargaining, firm-level bargaining does not internalise the wage spillover effects. Moreover, the smaller the degree of product differentiation (i.e. the larger b is) the larger the spillover effects are. As a consequence, we observe that the firm-level wage outcome is smaller than the industry-level one, and that it is decreasing with b . One can easily obtain the equilibrium employment level as well as the LU and LF equilibrium payoffs, which are denoted $U_{d,C}^*(\alpha)$ and $\Pi_{d,C}^*(\alpha)$, and are given by

$$\begin{aligned}
 U_{d,C}^*(\alpha) &= \frac{2\alpha(2-\alpha)(2-b)}{(4-b\alpha)^2(2+b)} \cdot (a-\bar{w})^2, \\
 \Pi_{d,C}^*(\alpha) &= \frac{4(2-\alpha)^2}{(4-b\alpha)^2(2+b)^2} \cdot (a-\bar{w})^2.
 \end{aligned}$$

Both the LU and the LF equilibrium payoffs are increasing with the degree of product differentiation. The equilibrium employment in firm i is $2(2-\alpha)(a-\bar{w})[(4-b\alpha)(2+b)]^{-1}$ and is also increasing with the differentiation.

In case of Bertrand competition, simple computations give us

$$\begin{aligned}
 w_{d,B}^{SPE} &= \bar{w} + \frac{\alpha(1-b)(2+b)}{2(2-b^2)-b\alpha}(a-\bar{w}) = w_{1d,B}^{SPE} = w_{2d,B}^{SPE} \\
 &= \bar{w} + \frac{r_f(1-b)(2+b)}{2(2-b^2)r_u+(2(2-b^2)-b)r_f}(a-\bar{w}).
 \end{aligned}
 \tag{15}$$

Expression (15) is now different than Expression (14): the wage level under Bertrand competition is smaller than under Cournot competition. This is due to the fact that wage spillover effects are greater under Bertrand competition. Indeed, a small decrease in a Bertrand firm’s marginal cost (due to a wage decrease) makes it win a substantial market share of its rival, while a Cournot firm would win only a small part of it. Therefore, a wage drop will increase more the output under Bertrand than under Cournot competition.

Nevertheless, the wage outcome is again increasing with the reservation wage \bar{w} , with the LU bargaining power α , and with the degree of product differentiation. One can easily obtain the equilibrium employment level as well as the LU and LF equilibrium payoffs, which are denoted $U_{d,B}^*(\alpha)$ and $\Pi_{d,B}^*(\alpha)$, and are given by

$$U_{d,B}^*(\alpha) = \frac{\alpha(2-\alpha)(2-b^2)(1-b)(2+b)}{(1+b)(2-b)(2(2-b^2)-b\alpha)^2} \cdot (a-\bar{w})^2,$$

$$\Pi_{d,B}^*(\alpha) = \frac{(1-b)(2-b^2)^2(2-\alpha)^2}{(1+b)(2-b)^2(2(2-b^2)-b\alpha)^2} \cdot (a-\bar{w})^2.$$

The LF equilibrium payoff is increasing with the differentiation. However, the LU equilibrium payoff and the equilibrium employment in firm i , which is equal to $(2-\alpha)(2-b^2)(a-\bar{w})[(2(2-b^2)-b\alpha)(2-b)(1+b)]^{-1}$, are still decreasing with the degree of product differentiation if $b > 1/2$, but are now undetermined otherwise.

Finally, notice that the results we obtain are robust to different types of union objective functions. For example, suppose that both unions only care about wages and do not care about the employment level. Then, one can show that the equilibrium wage outcome when bargaining takes place at the firm-level is larger than the wage we obtain when unions care for both wages and employment. Moreover, the wage outcome is still increasing with the degree of product differentiation. This is due to the fact that wage spillover effects to lower wages in order to increase the firm's market share and the surplus to be divided are still present and not internalised. But, these spillover effects are weaker compared to the case where unions care for both wages and employment, and so it explains why negotiations result in higher wages under complete information.

4.2. Firm-level agreements under incomplete information

We consider now the firm-level wage bargaining with private information about the discount rates. Given the symmetry of the model, we look for symmetric PBE, that is, an equilibrium in which $w_{1d,\cdot}^* = w_{2d,\cdot}^*$.

Lemma 3. *Consider the firm-level wage negotiations with incomplete information in which the distributions p_f and p_u are common knowledge, and in which the period length shrinks to zero. Assume each LU–LF pair i takes the other wage settlement in the industry as given during the bargaining at firm i . Then, for any symmetric perfect Bayesian equilibria (PBE), the payoff of the LU belongs to $[U_{d,\cdot}^*(\underline{\alpha}), U_{d,\cdot}^*(\bar{\alpha})]$ and the payoff of the LF belongs to $[\Pi_{d,\cdot}^*(\bar{\alpha}), \Pi_{d,\cdot}^*(\underline{\alpha})]$.*

Lemma 3 is the counterpart of Lemma 1 for the firm-level wage negotiations. Following Lemma 3 and the complete information results we are able to state some properties about the firm-level wage outcomes. In case of Cournot competition, the symmetric PBE wage outcome $w_{d,C}^*(\underline{\alpha}, \bar{\alpha})$ will satisfy the following inequalities:

$$\bar{w} + \frac{r_f^P(2-b)}{4r_u^I + (4-b)r_f^P}(a-\bar{w}) \leq w_{d,C}^*(\underline{\alpha}, \bar{\alpha}) \leq \bar{w} + \frac{r_f^I(2-b)}{4r_u^P + (4-b)r_f^I}(a-\bar{w}). \quad (16)$$

Notice that each wage satisfying these bounds can be the outcome by choosing appropriately the distribution over types. The lower (upper) bound is the wage outcome of the complete information game, when it is common knowledge that the LU's type is r_u^I (r_u^P) and the LF's type is r_f^P (r_f^I) (and the LU bargaining power is $\underline{\alpha}$ ($\bar{\alpha}$)). In case of Bertrand competition, the symmetric PBE wage outcome, $w_{d,B}^*(\underline{\alpha}, \bar{\alpha})$, will satisfy the following inequalities:

$$\begin{aligned} \bar{w} + \frac{r_f^P(1-b)(2+b)(a-\bar{w})}{2(2-b^2)r_u^I + (2(2-b^2)-b)r_f^P} &\leq w_{d,B}^*(\underline{\alpha}, \bar{\alpha}) \\ &\leq \bar{w} + \frac{r_f^I(1-b)(2+b)(a-\bar{w})}{2(2-b^2)r_u^P + (2(2-b^2)-b)r_f^I}. \end{aligned} \tag{17}$$

In the model we have developed of wage determination in a duopolistic industry, we can rank the wage outcomes as follows when there is complete information: $w_{d,B}^{SPE} < w_{d,C}^{SPE} < w_{c,B}^{SPE} = w_{c,B}^{SPE}$. But once the LU and the LF have private information, this ranking does not necessarily hold. The necessary and sufficient condition to recover the complete information result that the firm-level wage outcome under Bertrand competition is always strictly smaller than the firm-level wage outcome under Cournot competition is $4(\bar{\alpha} - \underline{\alpha})(2 - b - b^2) < \underline{\alpha}(2 - \bar{\alpha})b^3$. Finally, the necessary and sufficient condition to recover the complete information result that the firm-level wage outcome under Cournot competition is always strictly smaller than the industry-level wage outcome under Cournot (or Bertrand) competition is $(4 - 2b)\bar{\alpha} < (4 - b\bar{\alpha})\underline{\alpha}$. The above conditions are satisfied the smaller the amount of private information $|\bar{\alpha} - \underline{\alpha}|$ and the degree of product differentiation $1 - b$ are.

However, if it is commonly known that the local union is much stronger than the local firm and the degree of product differentiation is small (e.g. $\underline{\alpha} \geq 0.75$ and $b \geq 0.85$), then we get $w_{d,B}^*(\underline{\alpha}, \bar{\alpha}) < w_{d,C}^*(\underline{\alpha}, \bar{\alpha}) < w_{c,B}^*(\underline{\alpha}, \bar{\alpha})$ and $w_{d,B}^*(\underline{\alpha}, \bar{\alpha}) < w_{d,C}^*(\underline{\alpha}, \bar{\alpha}) < w_{c,C}^*(\underline{\alpha}, \bar{\alpha})$. The intuition behind this result is the following one. Incomplete information in the model takes into account two main features. The first one is the amount of private information in possession of the players. By the amount of private information we mean the size of the set in which player's discount rate is contained and which is common knowledge between the players. The second one is the uncertainty about who is the more patient player, i.e. who is the stronger player. When it is common knowledge that the local union is stronger, this second feature disappears, and information tends to play a less crucial role in the process of the negotiation between firms and unions. Therefore, we recover the above complete information results once it is common knowledge that the local union is much stronger than the local firm and the substitutability between the products is high enough.

The next proposition summarises these results.

Proposition 2. *If it is commonly known that the local union is much stronger than*

the local firm and the degree of product differentiation is small, then: (i) the firm-level wage under Bertrand competition is smaller than the firm-level wage under Cournot competition; and (ii) the firm-level wage under Cournot competition is smaller than the industry-level wage under Cournot (or Bertrand) competition.

What happens if the industry consists of more than two firms? One can show that the wage equilibrium outcome is independent of the number of firms in the industry when bargaining is at the industry-level. However, the wage equilibrium outcome is decreasing with the number of firms when bargaining takes place at the firm-level whatever the type of competition.¹² Therefore, the firm-level wage outcome is more likely to be lower than the industry-level wage outcome the larger is the number of firms in the industry. The negative relationship between the number of firms and the wage outcome may be explained by the following argument. As already mentioned, if each union–firm pair expects to be able to alter its relative wage position in the industrial sector, then union–firm pairs have incentives to cut wages in order to gain a larger share of the product market. This incentive increases with the number of firms operating in the industrial sector and with the substitutability of the products. So, when the number of firms becomes large and the products are close substitutes, the firm-level (symmetric) wage outcome will be closer to the reservation wage.

4.3. Strike activity and firm-level bargaining

Now we turn to the analysis of the strike activity. Remember that the strike activity is given by the difference between the upper bound and the lower bound on the wage outcome and it can be interpreted as an indicator of both the strike duration and the level of potential inefficiency (players might agree to throw away some of the resource over which they are bargaining, even when agreement is reached without delay). In case of Cournot competition, the strike activity when bargaining takes place at the firm-level, $\Psi_{d,C}$, is given by the following expression.

$$\begin{aligned} \Psi_{d,C} &= \left[\frac{\bar{\alpha}}{4 - b\bar{\alpha}} - \frac{\alpha}{4 - b\alpha} \right] (2 - b)(a - \bar{w}), \\ &= \frac{4(2 - b)(r_u^I r_u^I - r_f^P r_u^P)}{(4r_u^P + (4 - b)r_f^I)(4r_u^I + (4 - b)r_f^P)} (a - \bar{w}). \end{aligned} \quad (18)$$

In case of Bertrand competition, the strike activity when bargaining takes place at the firm-level, $\Psi_{d,B}$, is given by the following expression.

¹²Dhillon and Petrakis (2002) have shown this result, but for the complete information framework. It can be shown that this result is robust to the private information assumption as Vannetelbosch (1997) did for the case of homogeneous goods and Cournot competition.

$$\Psi_{d,B} = \left[\frac{\bar{\alpha}}{2(2-b^2)-b\bar{\alpha}} - \frac{\alpha}{2(2-b^2)-b\alpha} \right] (1-b)(2+b)(a-\bar{w}), \tag{19}$$

$$= \frac{2(2-b^2)(2+b)(1-b)(r_f^I r_u^I - r_f^P r_u^P)}{[2(2-b^2)r_u^P + (2(2-b^2)-b)r_f^I][2(2-b^2)r_u^I + (2(2-b^2)-b)r_f^P]} (a-\bar{w}).$$

Similarly to the industry-level case, we observe that, both $\Psi_{d,C}$ and $\Psi_{d,B}$ are increasing (decreasing) functions of r_u^I (r_u^P), are decreasing (increasing) functions of r_f^P (r_f^I), and are decreasing with the reservation wage \bar{w} . But now, the strike activity is increasing with the degree of product differentiation. Moreover, we observe that the strike activity is smaller under Bertrand than under Cournot competition. The intuition behind this result has to do with the competition on the product market. As already mentioned, when the wage bargaining takes place at the firm-level, each LU–LF pair expects to be able to alter its relative wage position in the industry; and it leads to wage spillover effects. Each LU–LF pair has an incentive to lower wages in order to gain a larger share of the product market. This incentive is stronger once Bertrand competition takes place since now a wage decrease makes the LU–LF pair win a quite large market share of its rival, while Cournot competition would give them only a small part of it. This explain why it is likely that more concessions and less conflicts in wage negotiations will occur under Bertrand competition. The next proposition summarises our results with respect to firm-level bargaining.

Proposition 3. *If the wage bargaining takes place at the firm-level, then the strike activity is smaller in Bertrand than in Cournot markets, and is increasing with the degree of product differentiation.*

Under Cournot competition in a oligopolistic industry, Vannetelbosch (1997) has shown that the strike activity is larger if the wage bargaining takes place at the industry level rather than at the firm level, because spillover effects are internalised at the industry level. Comparing the expressions (12), (18), and (19), we observe that

$$\Psi_{d,B} < \Psi_{d,C} < \Psi_{c,B} = \Psi_{c,C}.$$

That is, the Bertrand competition increases the disparity, in terms of strike activity, of both bargaining structures.

Finally, notice that when bargaining takes place at the firm-level, one can show that the strike activity or the potential efficiency loss depends negatively on the number of firms producing in the market whatever the type of market competition. Vannetelbosch (1997) has shown this result for the case of homogeneous goods and Cournot competition. Moreover, as the number of firms becomes large and the products become close substitutes, the strike activity tends to disappear. This last

result is not valid under industry-level bargaining because wages and strikes do not depend on the number of firms.

5. Conclusion

Empirical evidence suggests that in countries with decentralised wage bargaining the strike activity will tend to be smaller in industries competing à la Bertrand rather than in industries competing à la Cournot. In this paper we have provided a theoretical explanation of such observations. Within an incomplete information framework, we have developed a model of wage determination in a unionised imperfectly competitive industry. Under two different bargaining structures (firm-level vs. industry-level), we have investigated the effects of the degree of product differentiation and the type of market competition (Bertrand vs. Cournot competition) on the negotiated wage and the strike activity.

The analysis we have done offers some predictions regarding the actual strike duration and the efficiency loss incurred during wage negotiations and work stoppages on the basis of observable industry characteristics (bargaining structure, product differentiation, type of market competition, number of firms).

1. The strike activity tends to be larger when bargaining takes place at the industry-level rather than at the firm-level.

2. If the wage bargaining takes place at the firm-level, the strike activity is increasing with the degree of product differentiation. On the contrary, if the wage bargaining takes place at the industry-level, the strike activity does not depend on the degree of product differentiation. So, less differentiation increases the disparity, in terms of strike activity, of both bargaining structures.

3. If the wage bargaining takes place at the firm-level, the strike activity is smaller under Bertrand competition than under Cournot competition. But, if the wage bargaining takes place at the industry-level, the strike activity is the same whatever the type of competition. So, the Bertrand competition increases the disparity, in terms of strike activity, of both bargaining structures.

4. If the wage bargaining is at the industry-level, the strike activity does not depend on the number of firms producing in the market. On the contrary, if the wage bargaining is at the firm-level, the strike duration and the efficiency loss depend negatively on the industry size. Precisely, the strike activity is decreasing in the number of firms and the degree of product substitutability. Moreover, as the number of firms becomes very large and the products become close substitutes, the potential inefficiency tends to disappear.

Finally, Calmfors and Driffill (1988) have related empirically and theoretically for the OECD countries the macroeconomic performance (measured e.g. by the unemployment rate) to the level of wage negotiations. The evidence they obtained

provides support for the existence of a hump-shaped relation between the level of negotiations and the macroeconomic performance. Indeed, the employment performance in both centralised (national-level negotiations) and decentralised (firm-level negotiations) economies is better than in economies with intermediate centralisation (industry-level negotiations). So, our work seems to reinforce their conclusion by showing that firm-level wage negotiations are preferred to industry-level negotiations not only in terms of macroeconomic performance but also in terms of microeconomic performance.

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