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Bargaining Structures and Agendas in an Unconstrained Hotelling Model

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Abstract The present paper investigates the effects of bargaining structures and agendas on the quality differentiation/location in the final-goods market. The framework is a unionized duopoly industry in the context of an unconstrained Hotelling linear city model. The presence of labor union(s) and the bargaining processes (i.e., centralized vs. decentralized structure; right-to-manage vs. participatory framework agenda) change the locational incentives of the firms with respect to the case of exogenous production costs. The results reveal that the effect of centralization on the two bargaining agendas is diametrically opposed. More specifically, in the participatory framework, centralization is a centrifugal force, while it is a centripetal force in the right-to-manage. The social welfare consequences are also briefly discussed.

Keywords Spatial competition, bargaining, firms' locations, unionized oligopoly
JEL classification C72, D43, J51, L13

1. Introduction

Labor-management relations and negotiations are central in the functioning of labor market institutions in advanced economies. The bargaining process is relevant, not only for labor market regulations, but also for the organization of productive activities within the industries and the market of final products. Consequently, the present paper analyzes the impact of different bargaining structures (centralized vs. decentralized structure)[1] and agendas (right-to-manage vs. participatory framework agenda) on firm "quality differentiation"/"incentives to relocate" in the market of final products, as compared to the case of exogenous input prices. In doing so, this work aims at shedding some light on the understanding of some matters of contention in the labor-management relations and the bargaining process. This is essential for the appropriate functioning of labor and product markets and the evaluation of the impact on social welfare. The framework is a unionized duopoly within the context of an unconstrained

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[1] As one referee pointed out, in the present paper, centralization takes place on one side of the labor market only: while employees may unite trade unions in a unique industry-wide union, no such centralization may take place on behalf of the employers. Accordingly, the phenomenon of centralization to which the paper refers should be more properly defined as semi-centralization. In fact, the economic literature usually refers to a situation as centralized negotiations, when a central trade union negotiates with a central employers' association.

Hotelling linear city model. Surprisingly, the incorporation of labor markets and interactions between labor and product markets in a context of spatial economics is scanty in the existing literature. Notable exceptions are the works of Brekke and Straume (2004), Bárcena-Ruiz and Casado-Izaga (2008), Grandner (2010) and Andaluz (2011).

Brekke and Straume (2004) build a duopoly model characterized by bilateral monopoly relations that can be interpreted as decentralized union-firm bargaining units. In their unconstrained Hotelling linear city model, these authors investigate the case where firms can choose their locations simultaneously, or sequentially, with firms always negotiating over input prices (wages) simultaneously. Within the same framework, Bárcena-Ruiz and Casado-Izaga (2008) extend the analysis of Brekke and Straume (2004) by assuming that both wage rates and the timing of wage negotiations are endogenously determined. As such, wage negotiations can take place either simultaneously or sequentially; the different timing affects the equilibrium wages (input prices). This, in turn, has an impact on firm location, because the location essentially depends on the negotiated wages.

Grandner (2010) investigates the impact of a class of transportation costs on firm equilibrium locations in a classical, constrained linear city model with decentralized wage bargaining. The presence of unions is found to intensify the price competition, pushing firms closer to the extremes of the city. The magnitude of this effect depends on the relative unions' bargaining power. The primary results of Grandner (2010) are as follows. In contrast to the model with exogenous production costs, the presence of strong unions leads to price equilibria in pure strategies at a maximal differentiation. However, the presence of unions having intermediate bargaining power can improve the location decision, from the point of view of social welfare, if the curvature of the transportation cost function is sufficiently low.

The work of Andaluz (2011) takes a slightly different approach. The author develops a location-price spatial model in a constrained linear city model, considering a unionized mixed-duopoly. He finds that the presence of a welfare-maximizing public firm implies a lower degree of product differentiation. Andaluz (2011) studies the effects of different wage-regimes for the public firm. The results reveals that when the public firm's union is not allowed to deal in collective bargaining, the public firm is more competitive and product differentiation decreases.

A common feature of these works is that all of them consider firm-specific, decentralized negotiations, in the context of a right-to-manage model, where the scope of the bargaining is only the wage; this is in the same vein as Horn and Wolinsky (1988), Davidson (1988), Dowrick (1989), Naylor (2002) and López and Naylor (2004), just to cite a few. However, it is not uncommon to observe that, in several countries, some sector of the economy is characterized by industry-wide, and therefore, more centralized negotiations. Moreover, as Svejnar (1982) observed, there is some evidence that the worker representatives can be involved, not only in wage negotiations, but also in codetermination rights, and therefore, voiced as regards to other decisional variables relevant to determine the company policy and firms' product market decisions (Kluge and Wilke 2007; worker-participation.eu 2014).

As in Brekke and Straume (2004) and Bárcena-Ruiz and Casado-Izaga (2008),

this paper builds on the unconstrained Hotelling model approach of Lambertini (1994, 1997) and Tabuchi and Thisse (1995), which allow firms' location to be beyond the borders of the city. The standard assumptions of unit demand, uniformly distributed consumers and quadratic transportation costs are adopted in the present work. This study complements those of Brekke and Straume (2004) and Bárcena-Ruiz and Casado-Izaga (2008), because it considers the effects of different bargaining structures (centralized at the industry level and decentralized at the firm level) and the adoption of different negotiation agendas (wages only, that is the right-to-manage and the participatory framework) on market competition and social welfare in a duopoly industry, as compared with the case in which firms hire workers from a competitive labor market. The nature of the institutions in place in the labor market leads to diverse negotiation outcomes and these, in turn, have a different impact on market shares and the degree of firm competition affecting the equilibrium locations. In doing so, the aim of this paper is to contribute to bringing together the literature on spatial competition and labor-management relations.

The primary results of the paper are as follows. In the case of firms having full bargaining power, the locations in the equilibrium are identical to the unconstrained Hotelling model with exogenous production costs. As the relative bargaining power of the union increases, the firms may find it convenient to position themselves further away from each other to take advantage of the price competition effect. The decentralized participatory framework represents an exception, because the equilibrium locations are independent of the relative bargaining power parameter. Moreover, it has been found that the centralization of negotiations has the opposite impact on the two bargaining agenda: centralization is a centrifugal force in the case of the participatory framework, while it is a centripetal force in the right-to-manage agenda. To the best of the author's knowledge, the considerations of these aspects of the labor markets are missing in the spatial economic literature.

The remainder of the article is organized as follows. Section 2 describes the model and derives the subgame-perfect equilibrium firms' locations, under different bargaining structures and agendas, and briefly discusses the results and the impacts on social welfare. Finally, the last section summarizes the main results and implications and suggests directions for further research on the topic.

2. The model and the results

For the purposes of this work, an unconstrained Hotelling model setup is developed (Lambertini 1994, 1997; Tabuchi and Thisse 1995). The interval [0,1] represents a linear market where two firms, indexed by i ($i = A, B$), compete. The duopolists may decide to locate inside or outside the boundaries of the city. Consumers are uniformly distributed along the market, whose total density equals 1. They have unit demands of the goods and non-binding reservation prices.[2] Consumption generates a positive

[2] Wang and Yang (1999) develop a constrained Hotelling's location model with consumers having a binding reservation price. Those authors show that, in the presence of quadratic transportation costs, firms locate closer to the center of the market, because a low reservation price triggers more intense price competition,

willingness-to-pay of S, that is assumed to be large enough for all consumers, such that they are willing to acquire the goods (that is, the market is "covered"). Thus, consumers buy the goods, if and only if, the net utility of consumption is non-negative:

$$U = S - p_i - td^2 \geq 0, \quad i = A, B, \tag{1}$$

where p_i is the price of the goods i and td^2 is the cost that consumers pay to bring their purchase home. In addition, t is a positive constant and d is the distance between the consumer and the firm. The location of firm A is denoted by a, while the location of firm B is given by $1-b$. In the case of $a = 0$, firm A locates to the left boundary of the city. On the other hand, when $a > 0$ $(a < 0)$, firm A locates to the right (left) of this point, inside (outside) the city. In regard to firm B, if $b = 0$, the firm locates on the right border of the city, whereas when $b > 0$ $(b < 0)$, firm B locates to the left (right) of this point, inside (outside) the city. For simplicity, as commonly assumed in the literature, firm A situates to the left or on the identical point as firm B; that is, $1 - a - b \geq 0$. The location choice is a decision in the long run. Therefore, once the firms select their locations, they cannot change them in the short run or immediately after the price choice.

Each firm produces goods using only labor, l_i, as the input. Production exhibits a constant returns-to-scale technology and, for simplicity, it is assumed that each worker produces one unit of the goods, that is, $l_i = q_i$. All workers are unionized and the bargaining outcomes are the result of negotiations between the unions and the firms. The utility of the union is its wage bill, which is equivalent to a utilitarian union's welfare function with risk-neutral workers.

To investigate the effects of the agenda and bargaining structures on the optimal location choice of the firms, the analysis considers the following cases. First, the model investigates a variant of the "right-to-manage" model (Nickell and Andrews 1983), where unionized labor and the firms negotiate wages. Once the wages are set, the firms have the right to choose employment levels. Second, the analysis considers that negotiations are conducted on the basis of the "participatory framework" (Svejnar 1982; Dobson 1997). As such, the firms and unionized labor negotiate simultaneously over the variables which are at the parties' discretion, that is, in the present context, wages and price schedules. With regard to the bargaining structures, centralized negotiations, conducted by an industry-wide labor union negotiating simultaneously albeit separately at each firm (McAfee and Schwartz 1994; Milliou and Petrakis 2007; Mukherjee 2010), and decentralized negotiations, dealt by firm-specific unions (e.g., Brekke and Straume 2004; Bárcena-Ruiz and Casado-Izaga 2008), are inspected.

The solution concept adopted is the generalized Nash bargaining solution, where the relative bargaining power of firm i is measured by $\alpha \in [0,1]$, while $1-\alpha \in [0,1]$ measures the relative strength of the labor union. The bargaining power is exogenous. Given that the primary focus of this work is on the effects of different bargaining structures and agendas on negotiation outcomes, it is assumed that the relative parties' strength is symmetric, an assumption not uncommon in the literature (Horn and

resulting in less than maximal differentiation. Thus, it can be inferred that, also in the model outlined in the present work, a binding reservation price represents a centripetal force.

Wolinsky 1988; Bughin 1999; Naylor and Santoni 2003).

The game is solved by backward induction to derive the subgame-perfect Nash equilibria. The sequence of moves is as follows: first, the firms decide where to locate. Then, wages are negotiated before the price competition (and employment choices) in the case of the "right-to-manage"; or wages and prices are simultaneously negotiated in the case of the "participatory framework".

2.1 "Right-to-manage" bargaining agenda

Let us start the analysis with the "right-to manage" agenda. Firstly, following Bárcena-Ruiz and Casado-Izaga (2008), firms' demand is derived. The consumer indifferent between buying from firm A or B is determined, given (1), from the following expression:

$$p_A + t(x-a)^2 = p_B + t(x-1+b)^2, \tag{2}$$

which leads to

$$x = \frac{p_B - p_A}{2t(1-a-b)} + \frac{1+a-b}{2}, \tag{3}$$

where x denotes the location of those consumers indifferent between buying from either of the firms. It directly follows that the demand of the firms A and B, whenever they do not select the identical location $(1-a-b \neq 0)$, are respectively:

$$q_A = \begin{cases} x & \text{if } 0 \leq x \leq 1 \\ 1 & \text{if } x > 1 \\ 0 & \text{if } x < 0 \end{cases} \qquad q_B = \begin{cases} 1-x & \text{if } 0 \leq 1-x \leq 1 \\ 1 & \text{if } 1-x > 1 \\ 0 & \text{if } 1-x < 0 \end{cases} \tag{4}$$

Given these demand schedules, the firms engage in price competition and, thus, select their output. The objective function of firm i is as follows:

$$\Pi_i = (p_i - w_i)q_i, \quad i = A, B. \tag{5}$$

The maximization of (5) leads to the following reaction functions:

$$p_A = \frac{1}{2}[p_B + w_A + t(1-2b-a^2+b^2)],\ p_B = \frac{1}{2}[p_A + w_B + t(1-2a+a^2-b^2)] \tag{6}$$

with $\partial p_i/\partial p_j > 0$ and $\partial p_i/\partial w_i > 0$. The economic meaning of these comparative statics is immediate: the former states that, for each firm, an increase in the price of the goods of the rival implies an increase in the own price; that is, prices are strategic complements. The latter denotes that an increase in the bargained wage increases the market price of firm i. Solving the system of equations in (6) and solving for p_i, the equilibrium prices are obtained:

$$p_A = \frac{1}{3}[(3+a-b)(1-a+b)t + 2w_A + w_B],\ p_B = \frac{1}{3}[(3-a+b)(1-a-b)t + w_A + 2w_B]. \tag{7}$$

An inspection of (7) illustrates that the equilibrium price increases with the wage of the rival. Making use of (7), and knowing that $l_A = q_A = x$ and $l_B = q_B = 1 - x$, the output and employment level of firms A and B are given by

$$q_A = \frac{(3+a-b)(1-a+b)t - w_A + w_B}{6t(1-a-b)}, q_B = \frac{(3-a+b)(1-a-b)t + w_A - w_B}{6t(1-a-b)} \tag{8}$$

with the standard result that these variables are decreasing with their own wages and increasing with the wage paid by the rival firm. The resulting profits for firms A and B are:

$$\Pi_A = \frac{[(3+a-b)(1-a+b)t - w_A + w_B]^2}{18t(1-a-b)}, \Pi_B = \frac{[(3-a+b)(1-a-b)t - w_A + w_B]^2}{18t(1-a-b)}.$$

Decentralized bargaining and firms' optimal location

Under decentralized, firm level negotiations, the union utility is:

$$\Omega_i^{DR} = w_i q_i, \tag{9}$$

where the upper script DR stands for "decentralized right-to-manage". Therefore, given (5) and (9), the maximization of the following Nash Product determines the wage rate at each bargaining unit:

$$w_i = \arg\max_{w_i} \left\{ NP_i = (\Pi_i^{DR})^{\alpha} (\Omega_i^{DR})^{1-\alpha} \right\}, \quad i = A, B. \tag{10}$$

In the case of a breakdown of negotiations, the outside option of both parties equals zero. Similarly to Horn and Wolinsky (1988), Brekke and Straume (2004) and Bárcena-Ruiz and Casado-Izaga (2008), each firm is cast into a bilateral monopoly relations with the labor union. Using (5) and (7)–(9), the FOCs of (10) leads to the unions' wage reaction function:

$$\begin{aligned} w_A^{DR} &= \frac{1}{2}(1-\alpha)[(3+a-b)(1-a+b)t + w_B^{DR}], \\ w_B^{DR} &= \frac{1}{2}(1-\alpha)[(3-a+b)(1-a-b)t + w_A^{DR}], \end{aligned} \tag{11}$$

with $\partial w_i / \partial w_j > 0$: an increase in the wage set by the union in the rival bargaining unit leads to an increase in the own wage claim, showing strategic complementarities. Furthermore, for symmetric locations ($a = b$), it is possible to show that, as expected, $\partial w_i / \partial \alpha < 0$: an increase in the firms' bargaining power leads to lower wages. Solving the system of equations in (11) and solving for w_i^{DR}, the negotiated wages in equilib-

rium are:

$$w_A^{*DR} = \frac{t(1-\alpha)(1-a-b)[9+a-b+\alpha(a-3-b)]}{(3-\alpha)(1+\alpha)}, \tag{12}$$
$$w_B^{*DR} = \frac{t(1-\alpha)(1-a-b)[9-a+b-\alpha(a+3-b)]}{(3-\alpha)(1+\alpha)}.$$

Substituting (12) into (7), the equilibrium prices as a function of the locations of the firm are:

$$p_A^{*DR} = \frac{2t(2-\alpha)(1-a-b)[9+a-b+\alpha(a-3-b)]}{3(3-\alpha)(1+\alpha)}, \tag{13}$$
$$p_B^{*DR} = \frac{2t(2-\alpha)(1-a-b)[9-a+b-\alpha(a+3-b)]}{3(3-\alpha)(1+\alpha)}.$$

Further substitution of (12) and (13) into (5) determines the firms' profit as the function of the locations, given by:

$$\Pi_A^{DR} = \frac{t(1-a-b)[9+a-b+\alpha(a-3-b)]^2}{18(3-\alpha)^2}, \tag{14}$$
$$\Pi_B^{DR} = \frac{t(1-a-b)[9-a+b-\alpha(a+3-b)]^2}{18(3-\alpha)^2}.$$

Proceeding backward in the first stage of the game, once derived the negotiated wages, the two firms simultaneously select their locations. Firms A and B problems are:

$$a = \arg\max_a \left\{\Pi_A^{DR}\right\}, \quad b = \arg\max_b \left\{\Pi_B^{DR}\right\}. \tag{15}$$

The system of the FOCs has the following roots: $a = b - \frac{3(3-\alpha)}{1+\alpha}$, $a = -\frac{b}{3} - \frac{7-5\alpha}{3(1+\alpha)}$, $b = a - \frac{3(3-\alpha)}{1+\alpha}$ and $b = -\frac{a}{3} - \frac{7-5\alpha}{3(1+\alpha)}$. However, it can be verified that the unique point that simultaneously satisfies the SOCs for the firms' profit maximization is given by the pair

$$a = -\frac{b}{3} - \frac{7-5\alpha}{3(1+\alpha)}, b = -\frac{a}{3} - \frac{7-5\alpha}{3(1+\alpha)}, \tag{16}$$

representing the firms' reaction functions in terms of the location parameters. Solving the system of equations in (16) for a and b yields:

$$a^{*DR}(\alpha) = b^{*DR}(\alpha) = -\frac{7-5\alpha}{4(1+\alpha)}, \tag{17}$$

the optimal values of the firms' location parameters in the equilibrium. Therefore, for $\alpha \in [0,1]$, the location of firm A is within the range $a \in (-1/4; -7/4)$, while firm B locates within the range $1-b = (5/4; 11/4)$, where the first element refers to firms having full bargaining power and the second element refers to the case of monopoly unions. With exogenous input prices (Lambertini 1994), corresponding to the case

$\alpha = 1$, the firms decide to locate outside the city borders. However, with endogenous input prices (in this model, due to wage negotiations), an increase in the bargaining power of the input supplier (the labor union) pushes the firms further away from each other.

Brekke and Straume (2004) provide the rationale for this result. In the Hotelling's linear city model, there are two opposite forces at work: the market share effect and the price competition effect. The former is a centripetal force: firms move towards the center to capture market shares to the detriment of the rival. The latter is a centrifugal force: the more the firms move toward the center and close to each other, the stronger is the price competition which erodes profits, pushing firms in the opposite direction. This result can be obtained by substituting (17) into (5), leading to:

$$\Pi_i^{*DR}(\alpha) = \frac{3t(3-\alpha)}{4(1+\alpha)}, \quad i = A, B,$$

with $\partial \Pi_i / \partial \alpha < 0$: an increase in the firm's bargaining power decreases profits. In fact, as α increases, the wages decrease and this, in turn, causes a reduction in the price of the goods and fiercer competition. Thus, the effect of wage bargaining is that firms relocate further away from each other, because the increase in the price of the goods is larger than the increase in wages. In fact, given that final prices are strategic complements, each bargaining unit has a strategic incentive to move away from the center, increase its own wage and the rival firm's cost of production, transferring higher negotiated wages into the final market price of the products. That is, wage negotiations trigger a less intense competition between the firms. The further substitution of (17) into (12) and (9) leads to:

$$w_i^{*DR}(\alpha) = \frac{9t(1-\alpha)(3-\alpha)}{2(1+\alpha)^2}, \quad \Omega_i^{*DR}(\alpha) = \frac{9t(1-\alpha)(3-\alpha)}{4(1+\alpha)^2}, \quad i = A, B,$$

with $\partial \Omega_i / \partial \alpha < 0$: an increase in the firm's bargaining power decreases the union utility. The intuition behind this result is straight forward: as previously remarked, an increase in α reduces the negotiated wages; on the other hand, in the equilibrium, the firms equally share the market ($q_i = q_j = 1/2$) and, therefore, $\partial q_i / \partial \alpha = 0$.

Centralized bargaining

Under centralized bargaining, wage negotiations are conducted by an industry-wide union and the management of the firms. The union utility takes the following form:

$$\Omega^{CR} = w_i q_i + w_j q_j, \quad i, j = A, B, \tag{18}$$

where the upper script *CR* stands for the "centralized right-to-manage". It is assumed that the negotiations are dealt with by the union simultaneously, although separately, at each firm, like in Mukherjee (2010). This can be represented by a situation where the union sends delegates representing its general interest to conduct negotiations at each firm at the same time. This assumption implies that the union has the incentive to

adapt "opportunism in bargaining" during the negotiations with each firm (McAfee and Schwartz 1994; Milliou and Petrakis 2007). In other words, the union cannot commit to each firm that it will not negotiate for more advantageous conditions to enhance the competitive position of the rival. Thus, given (5) and (18), the maximization of the following Nash Product determines the wage rates at each bargaining unit:

$$w_i = \arg\max_{w_i} \left\{ NP_i = (\Pi_i^{CR})^{\alpha} (\Omega^{CR} - G_j)^{1-\alpha} \right\}, \quad i \neq j,\ i,j = A,B. \tag{19}$$

The outside option, in the case of a breakdown of negotiations, is zero for each firm. The disagreement utility of the industry-wide union may have different specifications (Horn and Wolinsky 1988; Mukherjee, 2010). In the present framework, if the negotiations between the union and firm i break down, firm j produces the anticipated duopoly equilibrium output, q_j^*, at the equilibrium wage w_j^*, that is, $G_j = w_j^* q_j^* = w_j q_j$. In other words, the industry union delegate, who negotiates with firm i, assumes that, during the bargaining process at firm j, the delegate at firm j believes an agreement is stipulated by firm i at the equilibrium wage rate.[3]

The FOCs of the maximization of (19) lead to the bargaining units wage reaction function:

$$\begin{aligned} w_A^{CR} &= \frac{1}{2}(1-\alpha)[(3+a-b)(1-a+b)t + 2w_B^{CR}], \\ w_B^{CR} &= \frac{1}{2}(1-\alpha)[(3-a+b)(1-a-b)t + 2w_A^{CR}]. \end{aligned} \tag{20}$$

As expected, $\partial w_i / \partial w_j > 0$: an increase in the wage set by the union delegate in one firm leads to an increase in the wage the delegate at the other firm demands; wages are strategic complements. However, it should be noted that the magnitude of $\partial w_i / \partial w_j$ is double with respect to the case of decentralized negotiations: hence, the industry-wide union is more sensitive to wage rate changes. Solving the system of equations in (20) for w_i^{CR}, the equilibrium wages are:

$$\begin{aligned} w_A^{*CR} &= \frac{t(1-\alpha)(1-a-b)[(6+\alpha(a-3-b)]}{2(2-\alpha)}, \\ w_B^{*CR} &= \frac{t(1-\alpha)(1-a-b)[(6-\alpha(a+3-b)]}{2(2-\alpha)}. \end{aligned} \tag{21}$$

Substituting (20) into (7), the equilibrium prices in terms of the location parameters

[3] An alternative specification is that the firm not experiencing the breakdown of the negotiations is able to produce the monopoly output. However, as Lambertini (1992) shows, the optimal location and price schedule and, therefore, the profits of a monopolist in a Hotelling linear city, crucially depend on the ratio of the gross surplus over the transportation costs. It follows that, to consider this alternative, the precise value of the ratio of these parameters needs to be characterized.

are:

$$p_A^{*CR} = \frac{t(1-a-b)\left[(6+5\alpha(1+\frac{b}{3}-\frac{a}{3})-\alpha^2(1-a+b)\right]}{2\alpha(2-\alpha)}, \tag{22}$$
$$p_B^{*CR} = \frac{t(1-a-b)\left[(6-5\alpha(1-\frac{b}{3}+\frac{a}{3})+\alpha^2(1+a-b)\right]}{2\alpha(2-\alpha)},$$

and upon subsequent insertion of (21) and (22) into (5), allows for the derivation of the firms' profit as a function of the location parameters, given by:

$$\Pi_A^{CR} = \frac{t(1-a-b)(6+a-b-3\alpha)^2}{18(2-\alpha)^2}, \quad \Pi_B^{CR} = \frac{t(1-a-b)(6-a+b-3\alpha)^2}{18(2-\alpha)^2}. \tag{23}$$

Given the equilibrium wages and proceeding backwards, in the first stage of the game, the firms concurrently choose their locations. The maximization problems of firms A and B are:

$$a = \arg\max_a \left\{\Pi_A^{CR}\right\}, \quad b = \arg\max_b \left\{\Pi_B^{CR}\right\}. \tag{24}$$

The system composed by the FOCs of the two problems has the following roots: $a = \alpha - \frac{4+b}{3}$, $a = 3\alpha - 6 + b$, $b = \alpha - \frac{4+a}{3}$ and $b = 3\alpha - 6 + a$. However, it can be checked that the unique solution simultaneously satisfying the SOCs for the firms' profit maximization is:

$$a = \alpha - \frac{4+b}{3}, b = \alpha - \frac{4+a}{3}, \tag{25}$$

the firms' reaction functions in terms of the location parameters. The substitution of each expression in (25) into each other yields:

$$a^{*CR}(\alpha) = b^{*CR}(\alpha) = \frac{3\alpha-4}{4}, \tag{26}$$

the equilibrium values of the firms' location parameters. As a consequence, for $\alpha \in [0,1]$, firm A locates in the range $a \in (-1/4;-1)$, while firm B locates within the range $1-b = (5/4;2)$, where the first element refers to firms having full bargaining power and the second element refers to the case of monopoly unions. Inserting (26) into (5), (9) and (12) and taking into consideration that all workers are unionized, it is obtained:

$$\Pi_i^{*CR}(\alpha) = \frac{3t(2-\alpha)}{4}, \; w^{*CR}(\alpha) = \Omega^{*CR}(\alpha) = \frac{9t(2-\alpha)(1-\alpha)}{4\alpha}, \quad i = A,B,$$

with $\partial\Pi_i/\partial\alpha < 0$ and $\partial\Omega_i/\partial\alpha < 0$. As for the decentralized wage negotiations, an increase in the bargaining power of the labor union pushes the firms further away from each other. However, comparing the ranges within where the firms locate, it is immediately evident that wage negotiations led by an industry-wide union are a weaker centrifugal force then autonomous firm-level negotiations. This is because, in the equilibrium, $w^{*DR}(\alpha) \geq w^{*CR}(\alpha)$, $\forall\alpha \in [0,1]$. This finding contrasts with the standard re-

sult of union-firm bargaining in an oligopoly that centralized wage negotiations lead to higher bargained wages than decentralized negotiations in the presence of gross substitute goods (Naylor 2003). The reason for this rather counterintuitive, at first glance, result is as follows. In the case of decentralized bargaining, the union is interested only in the effects of the wage demand on firm production; the changes in the bargaining power have a negative impact, but only at the firm level. On the other hand, when the delegates of the industry union negotiate at the bargaining unit i, they consider the impact of their wage demands on the production of the goods at the bargaining unit j. In other words, the "increasing rival's costs" strategic effect is softened by the centralized negotiations. Moreover, changes in the relative bargaining power have a negative impact on the wage rates and the output for both units, placing a larger downward pressure on wage demands, than in the case of firm level negotiations. As a consequence, prices are lower than in the decentralized bargaining process, the price competition effect is slightly lower with industry-wide negotiations and, therefore, the firms are closer to each other; this, in turn, reduces profits and union utility. A closer analytical inspection reveals that both $\Pi_i^{*DR}(\alpha) > \Pi_i^{*CR}(\alpha)$ and $\sum \Omega_i^{*DR}(\alpha) > \Omega^{*CR}(\alpha)$, $\forall \alpha \in [0,1]$.

2.2 "Participatory framework" bargaining agenda

Let us now consider the analysis of the "participatory framework" bargaining agenda. In this case, the union-firm bargaining unit negotiates simultaneously over the variables at their discretion: in the present context, wages and price schedules.

Decentralized bargaining and firms' optimal location

Under decentralized bargaining, the union utility is:

$$\Omega_i^{DP} = w_i q_i, \tag{27}$$

where the upper script DP stands for the "decentralized participatory framework". Thus, given (3), (5) and (27), the maximization of the following Nash Product determines the wage rate and price schedule at each bargaining unit:

$$w_i, p_i = \arg\max_{w_i, p_i} \left\{ NP_i = (\Pi_i^{DP})^{\alpha} (\Omega_i^{DP})^{1-\alpha} \right\}, \quad i = A, B. \tag{28}$$

In the case of a breakdown of negotiations, the outside option of both parties equals zero. Solving for w_i and q_i the FOCs from the maximization of (28), it is possible to obtain:

Contract curve for firm A: $p_A = \dfrac{1}{(1+\alpha)} \{ w_A + \alpha [p_B + t(1 - 2b - a^2 + b^2)] \}$ (29a)

Rent-sharing curve for firm A: $w_A = (1-\alpha) p_A$ (29b)

Contract curve for firm B: $p_B = \dfrac{1}{(1+\alpha)} \{ w_B + \alpha [p_A + t(1 - 2a + a^2 - b^2)] \}$ (30a)

Rent-sharing curve for firm B: $w_B = (1-\alpha) p_B$ (30b)

with $\partial p_i / \partial p_j > 0$ and $\partial p_i / \partial w_i > 0$: prices are strategic complements; an increase in the bargained wage increases the market price of firm i. Inserting (29b) and (30b) into

(29a) and (30a), it is obtained:

$$p_A = \frac{1}{2}[p_B + t(1-2b-a^2+b^2)], \quad p_B = \frac{1}{2}[p_A + t(1-2a+a^2-b^2)], \tag{31}$$

the two firms' price reaction functions. Putting each expression in (31) into each other, the equilibrium prices are derived, given by:

$$p_A^{*DP} = \frac{1}{3}t(1-a-b)(3+a-b), \quad p_B^{*DP} = \frac{1}{3}t(1-a-b)(3-a+b), \tag{32}$$

independent of the bargaining power and identical to the price levels with zero production costs (D'Aspremont et al. 1979; Lambertini 1994). Equilibrium prices immediately lead to the following equilibrium wages:

$$w_A^{*DP} = \frac{1}{3}t(1-\alpha)(1-a-b)(3+a-b), \quad w_B^{*DP} = \frac{1}{3}t(1-\alpha)(1-a-b)(3-a+b). \tag{33}$$

In the participatory framework, the aim of the price schedule negotiations is that the final price maximizes the joint surplus of the bargaining unit, while the wage negotiations determine the size of the surplus created by the unit; and the relative bargaining power determines the parties' share.

Proceeding backwards, in the first stage of the game, the firms simultaneously set their locations. The maximization problems of Firms A and B are:

$$a = \arg\max_a \left\{\Pi_A^{DP}\right\}, \quad b = \arg\max_b \left\{\Pi_B^{DP}\right\}, \tag{34}$$

which, making use of the equilibrium values, the FOCs lead to the following roots $a = -\frac{1+b}{3}$, $a = b-3$, $b = -\frac{1+a}{3}$ and $b = 3-a$. However, it can be verified (see also Lambertini, 1994) that the unique solution simultaneously satisfying the SOCs for the firms' profit maximization is:

$$\left(a = -\frac{1+b}{3}, b = -\frac{1+a}{3}\right), \tag{35}$$

representing the firms' reaction functions in terms of the location parameters. The substitution of each expression in (35) into each other yields:

$$a^{*DP} = b^{*DP} = -\frac{1}{4}, \tag{36}$$

the equilibrium values of the firms' location parameters, independent of the relative strength of the bargaining parties, which has no additional centrifugal effect on the location choice. As a consequence, the firm A locates to $a = -1/4$, while firm B locates to $1-b = 5/4$. Further substitution of (36) into (5), (33) and (27) leads to:

$$\Pi_i^{*DP}(\alpha) = \frac{3\alpha t}{4}, \; w_i^{*DP}(\alpha) = \frac{3t(1-\alpha)}{2}, \; \Omega_i^{*DP}(\alpha) = \frac{3t(1-\alpha)}{4}, \quad i = A, B,$$

with $\partial\Pi_i/\partial\alpha > 0$ and $\partial\Omega_i/\partial\alpha < 0$: in the decentralized participatory framework, the relative bargaining power of the firms recover the standard role of increasing profits and decreasing the union utility through its effect on negotiated wages. Moreover, it is worth to note that, in the equilibrium, $w^{*DR}(\alpha) \geq w^{*DP}(\alpha)$, $\forall\alpha \in [0,1]$. In fact, because the price is one of the decision variables in the participatory framework, each bargaining unit is committed to producing a larger output than in the "right-to-manage" model. As a consequence, prices are driven down and, consequently, so are wages (Dobson 1997). The price competition effect is higher with the decentralized participatory framework than the decentralized right-to-manage: the firms are closer to each other (unless $\alpha = 1$), and this lessen profits and union utility, such that: $\Pi_i^{*DR}(\alpha) > \Pi_i^{*DP}(\alpha)$ and $\Omega_i^{*DR}(\alpha) > \Omega_i^{*DP}(\alpha)$, $\forall\alpha \in [0,1]$.

Centralized bargaining and firms' optimal location

Let us finally consider centralized bargaining under the participatory framework. Negotiations are dealt with by the delegates of the industry-wide union and the management of the firms. Similarly to the centralized bargaining with the right-to-manage agenda, the union utility form is:

$$\Omega^{CP} = w_i q_i + w_j q_j, \quad i,j = A,B, \tag{37}$$

where the upper script *CP* stands for the "centralized participatory framework". As before, it is assumed that negotiations are conducted by the union delegates simultaneously, albeit independently, at each firm. Therefore, given (5) and (36), the maximization of the following Nash Product determines the wage rates and price schedule at each bargaining unit:

$$w_i, p_i = \arg\max_{w_i,p_i} \left\{ NP_i = (\Pi_i^{CP})^{\alpha} (\Omega^{CP} - G_j)^{1-\alpha} \right\}, \quad i \neq j,\ i,j = A,B. \tag{38}$$

The outside option of each firm, in the case of a breakdown of negotiations, is zero. The disagreement utility of the industry-wide union is, as in the case of centralized right-to-manage, $G_j = w_j^* q_j^* = w_j q_j$, that is, the anticipated duopoly equilibrium output, q_j^*, at the equilibrium wage w_j^*. The FOCs of the maximization of (38) lead to:

Contract curve for firm *A*:

$$p_A = \frac{w_A\{w_A - w_B - \alpha[p_B + w_B + t(1-2b-a^2+b^2)]\}}{\alpha(w_A + w_B) + w_A - w_B} \tag{39a}$$

Rent-sharing curve for firm *A*: $w_A = (1-\alpha)p_A$ (39b)

Contract curve for firm *B*:

$$p_B = \frac{w_B\{w_B - w_A + \alpha[p_A + w_A + t(1-2a+a^2-b^2)]\}}{\alpha(w_A + w_B) - w_A + w_B} \tag{40a}$$

Rent-sharing curve for firm *B*: $w_B = (1-\alpha)p_B$ (40b)

Inserting (39b) and (40b) into (39a) and (40a), it is obtained:

$$p_A = \frac{1}{2}[(2-\alpha)p_B + t(1-2b-a^2+b^2)], \tag{41}$$
$$p_B = \frac{1}{2}[(2-\alpha)p_A + t(1-2a+a^2-b^2)],$$

the two price reaction functions of the two bargaining units, with $\partial p_i/\partial p_j > 0$: prices are strategic complements. Inserting each expression in (41) into each other, the equilibrium prices are:

$$p_A^{*CP} = \frac{t(1-a-b)[4+\alpha(a-1-b)]}{\alpha(4-\alpha)}, \tag{42}$$
$$p_B^{*CP} = \frac{t(1-a-b)[4-\alpha(1+a-b)]}{\alpha(4-\alpha)},$$

and, consequently, the equilibrium wages are:

$$w_A^{*CP} = \frac{(1-\alpha)t(1-a-b)[4+\alpha(a-1-b)]}{\alpha(4-\alpha)}, \tag{43}$$
$$w_B^{*CP} = \frac{(1-\alpha)t(1-a-b)[4-\alpha(1+a-b)]}{\alpha(4-\alpha)}.$$

Proceeding backwards, in the first stage of the game, the firms simultaneously set their locations. The maximization problems of firms A and B are:

$$a = \arg\max_a \left\{\Pi_A^{CP}\right\}, \quad b = \arg\max_b \left\{\Pi_B^{CP}\right\}. \tag{44}$$

Given the equilibrium values of the prices and the wages in (42) and (43), the FOCs lead to the following root:[4]

$$a^{*CP}(\alpha) = b^{*CP}(\alpha) = \frac{\alpha-2}{4}, \tag{45}$$

representing the firms' location. Consequently, for $\alpha \in [0,1]$, the firm A locates in the range $a \in (-1/4;-1/2)$, while firm B locates within the range $1-b = (5/4;3/2)$, where the first element is related to the case of the firms having full bargaining power and the second element relates to monopoly unions: an increase in the bargaining power of the labor union moves the firms further away from each other. Comparing the ranges within which the firms locate, it is clear that, in contrast to autonomous firm-level negotiations, the bargaining conducted by an industry-wide union in a participatory framework is a centrifugal force. Inserting (45) into (5), (37) and (43), and

[4] Analytical details are available upon request from the author.

considering that all workers are unionized and $q_i + q_j = 1$, it is derived:

$$\Pi_i^{*CP}(\alpha) = \frac{t(4-\alpha)}{4},\ w^{*CP}(\alpha) = \Omega^{*CP}(\alpha) = \frac{t(4-\alpha)(1-\alpha)}{2\alpha}, \quad i = A, B,$$

with $\partial\Pi_i/\partial\alpha < 0$ and $\partial\Omega_i/\partial\alpha < 0$: the mechanisms described in the right-to-manage agenda are also in place in the case of the centralized participatory framework. The analytical inspection reveals that, in the equilibrium, $w^{*CP}(\alpha) \geq w^{*DP}(\alpha)$, $\forall\alpha \in [0,1]$. This finding reestablishes the standard outcome of the centralized negotiations, leading to higher bargained wages than decentralized negotiations in the presence of gross substitute goods. The intuition behind this result is as follows. In the case of a centralized participatory framework, the delegates of the union at each unit take into consideration the impact of the price and wage bargaining on the negotiation outcomes at the other unit. In the context of centralization, the delegates internalize the negative spillover effect of the autonomous price schedules. They may also commit to a price level that is higher than the decentralized one, boosting wages and, therefore, increasing the rival's costs. Giving the strategic complementarity of prices, this translates into a less competitive market pressure. Changes in the relative bargaining power of the firm have a negative impact on both prices and wage rates. As α increases, the wages decrease and the prices of the goods decrease as well, leading to more intense competition. However, the negative effect of an increase in the bargaining power on wages is larger than on prices. The price competition effect is stronger with industry-wide negotiations and, hence, firms relocate further away: the equilibrium prices under the centralized participatory framework are higher than in the decentralized case. This implies that profits and union utility increase: in fact, the analytical inspection shows that both $\Pi_i^{*CP}(\alpha) > \Pi_i^{*DP}(\alpha)$ and $\Omega^{*CP}(\alpha) > \sum\Omega_i^{*DP}(\alpha)$, $\forall\alpha \in [0,1]$.

2.3 The effect of centralization on bargaining and social welfare considerations

The findings of the previous subsections can be summarized in the following proposition.

Proposition 1. *Centralization acts as a centrifugal force working on the price competition effect in the case of the participatory framework. On the other hand, centralization is a centripetal force working on the market share effect in the right-to-manage agenda.*

These results can be graphically summarized in Figure 1, which depicts the equilibrium locations for all of the bargaining configurations considered. When firms have full bargaining power, their equilibrium locations are identical to the unconstrained Hotelling model with exogenous production costs. As long as the union has some bargaining power, the firms are induced to locate further away from each other to exploit the price competition effect. The decentralized participatory framework represents an exception because the equilibrium locations are independent of α. Furthermore, Figure 1 clearly shows the opposite impact that centralized negotiations have on the two bargaining agendas. This has direct consequences on social welfare.

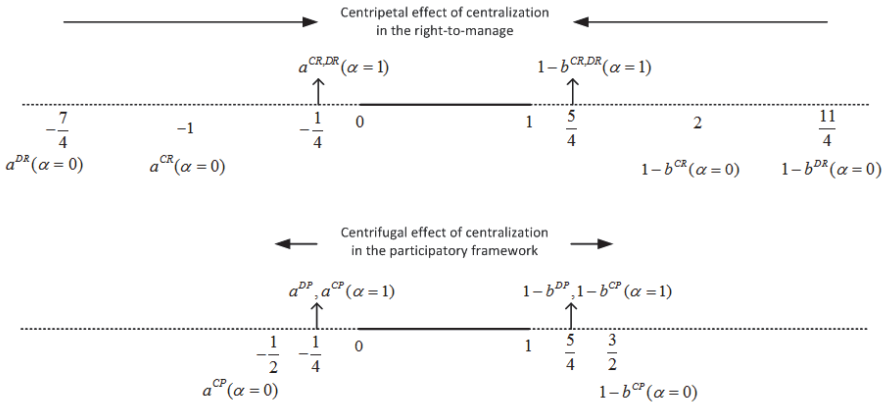

Figure 1. Centripetal/centrifugal impact of centralized negotiations in the different bargaining agenda

Social welfare can be defined as the sum of the utility of the union(s), firms' profits, and consumers' surplus. As well known (Brekke and Straume 2004; Bárcena-Ruiz and Casado-Izaga 2008), due to the assumptions of unit demand and a non-binding consumers' reservation price adopted in the linear city model, changes in the wages and the prices mean monetary transfers from firms to union(s), and from consumers to firms, leaving welfare unaltered. Hence, the minimization of consumers' transportation costs implies the maximization of welfare.

As Hotelling (1929) has first shown, from a social welfare perspective, the optimal locations are $a = 1/4$ and $1 - b = 3/4$. Therefore, it is immediately evident that the presence of endogenous production costs, due to labor union(s)-firm management negotiations, has an adverse impact on social welfare. The bargaining process causes the firms to locate further away (in the same location with the decentralized participatory framework) than in the presence of exogenous production costs, imposing higher transportation costs on the consumers. In this sense, the analysis has shown that the right-to-manage agenda is more disadvantageous in terms of social welfare. Therefore, a public authority that cannot directly affect the location choice of the firms may intervene on the structure of the bargaining and labor market institutions to ameliorate consumers' position and, as a consequence, overall welfare.

3. Conclusion

The present work has analyzed how labor union(s)-firm management relations affect the location choice in an 'unconstrained' Hotelling linear city market model. The paper has focused attention on the impact of different bargaining structures and agendas on the equilibrium locations of the firms. As already highlighted in the literature, the analysis has found that the negotiation process generally induces the firms to locate

further away, with respect to the case of exogenous production costs, unless they have full bargaining power. Therefore, the presence of a unionized labor market, with the related bargaining process, allows the firms to act in a way not to cut their production costs, but rather to implement a raising rivals' costs strategy. This result holds when negotiations are related to wages only (the right-to-manage agenda) and for wages and price schedules (the participatory framework). Only the decentralized participatory framework leads to the same location as the exogenous production costs: the equilibrium locations are independent of the relative strength of the bargaining parties.

The central results identified in the analysis are the following. From the positive viewpoint, the centralization of negotiations has an opposite impact on the two bargaining agendas. In fact, centralization acts as a centrifugal force in the case of the participatory framework, while it is a centripetal force in the right-to-manage agenda. Furthermore, in the equilibrium, the firms locate further away from each other in the case of the right-to-manage, than in the presence of the participatory framework.

Due to the assumptions adopted in this model of unit demand and a non-binding consumers' reservation price, an increase in the total transportation costs for consumers reduces the overall welfare. As a consequence, from the normative viewpoint, the right-to-manage model appears to be the more socially disadvantageous agenda. On the other hand, the firms' profits and the union utilities are larger in the case of decentralized right-to-manage negotiations; both parties would prefer this bargaining configuration. However, by locating in the equilibrium strikingly far away from the city, the firms constrain consumers to bear high transportation costs. These are all elements that a public authority should take into consideration when designing an intervention to improve the market efficiency.

To facilitate analytical tractability, the model presents several limitations. As recognized in the literature, with the assumptions of a uniform distribution of consumers, unit demand and non-binding reservation prices, the bargaining process tends to be a strong centrifugal force. The findings presented in the paper are not exhaustive. A reasonable further step would be to extend the research toward studying the effects of introducing different payment schemes into the negotiations, such as profit sharing and piece rate schemes.

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