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When unionisation is profitable for firms in network industries

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Abstract
In an industry characterised by the presence of network effects, this paper investigates a duopolistic game in which firms may choose whether to bargain over wages and employment with unions or to face a competitive labour market (i.e. without unions). If unions are sufficiently risk-averse, it is shown that the presence of strong network effects makes unionisation the Pareto-efficient sub-game perfect Nash equilibrium outcome for firms. The issue of entry is also investigated.

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Keywords Unionised oligopoly; competitive labour market; efficient bargaining; market entry and entry deterrence

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1. Introduction

The existence of unionized workers in oligopolistic industries is a widely observed phenomenon in real world. Indeed, Booth (1995, p. 95) notices: ‘‘It appears to be an empirical regularity that imperfections in the labour market are correlated with imperfections in the product market’’.

The classical microeconomic logic for the presence of unions in labour markets is that organised work represent a “decision-making unit” which maximises an objective function subject to some constraints. That basic idea dates back to the work of Dunlop (1944) who assumes that the unions maximise the “wage bill for the total membership”, raising the wage above the competitive level. Based on Dunlop’s (1944) contribution, several scholars have further developed the analysis introducing alternative unions’ utility functions (e.g. Oswald 1982, 1985; Booth 1995) and different economic behaviour models such as the monopoly union model (Fellner 1949), where the union is assumed to fix wages unilaterally and then the firm freely chooses the employment level according to it labour demand curve, and the bargaining models known as the “right-to-manage” (RTM) and “efficient bargaining” (EB). In the RTM model (e.g. Nickell and Andrews 1983), the firms and unionised labour negotiate over wage levels; however, once the levels are set, the firms have the right to choose employment. On the other hand, according to the EB model, the firms and unionised labour bargain over wages and employment. Negotiations over wages and employment may be conducted either simultaneously (e.g. McDonald and Solow 1981; Ashenfelter and Brown 1986), or in a sequential way (Manning 1987a,b). Interested readers can refer to Drakopoulos and Katselidis (2014) for an exhaustive treatment of the historical development of the trade union theory.

All models of union behaviour lead to the result that unionisation increases the wages above the competitive level. Given that in imperfectly competitive markets the firms generate rents, unions are able to capture part of them. This represent one plausible explanation why unionisation can usually be observed in oligopolies. However, the aim of this paper is to justify the presence of unions from a complete different perspective. In fact, the following questions are addressed: Is there a strategic rationale for the observation of labour unions in oligopoly firms in real life? In other words, may unionisation arise at equilibrium in oligopolistic markets as a result of the firms’ strategic interactions?

To answer the above questions, the reference framework adopted in the article is a duopoly where firms produce homogeneous goods and compete á la Cournot. Firms can hire workers at the competitive wage or decide to be unionised. In case of unionisation, negotiations between firms and unions take place according to the simultaneous EB model. The rationale for this choice is that several empirical studies, as Kraft (2006) notices, have shown that the EB model has been implemented and is not a simple theoretical possibility (e.g. Bughin 1993; MaCurdy and Pencavel 1986; Dobbaleare and Mairesse 2011; Moreno and Rodriguez 2011).

A large strand of the literature on oligopoly markets has assumed as given the analysis that the labour market is characterised by the presence of unions and, as a consequence, the firms operating in the market are unionised (e.g. Petrakis and Vlassis 2000; Kraft 2006; Fanti 2014, 2015). A notable exception is the work of Vannini and Bughin (2000) which is the paper closer to the present paper. In an duopoly framework, those authors focus on the firms’ decision under Cournot competition whether to adopt a cost-raising strategy via the recognition of labour unions. The authors demonstrate that unionisation can generate vertical interdependence between the labour and the product markets, that firms can strategically exploit to improve their profitability. However, the firms’ profitability crucially change depending on the institutional features of the bargaining process, e.g. the structure and the scope. In particular, Vannini and Bughin (2000) show that, under specific conditions (low union power, low product differentiation, centralised bargaining), firms can prefer EB rather than RTM negotiations, despite higher unit wage costs.

The present paper further develops some aspects of the Vannini and Bughin’s (2000) study. First, the paper introduces a wage-sensitivity (or, alternatively, risk-adversity) parameter into the union utility function. Second, the analysis considers goods having network externalities (Katz and Shapiro, 1985; Hoernig, 2012; Chirco and Scrimitore, 2103; and Battacharjee and Pal, 2013). Actually, several products are characterised by the fact that the utility one consumer derives from those goods increases with the number of other consumers of those goods as, for example, in the

cases of phones and software goods. Third, while Vannini and Bughin (2000) consider a framework where duopoly is the given industry structure, the present paper investigates in depth the subject of the potential strategic advantages of unionisation in the context of market entry. In doing so, the present paper adds to the literature investigating unionisation, and its institutional aspects, as entry deterrence mechanism (e.g. Bughin 1999; Buccella 2011; Fanti and Buccella 2015).

The key results of the paper are as follows. In line with Vannini and Bughin (2000), unionisation emerges as the sub-game perfect equilibrium (SPE) of the game, provided that labour unions have not too bargaining strength. In the simultaneous move game, provided that the network effects are sufficiently strong, unionisation is not only the sub-game perfect Nash equilibrium (SPNE), but it is also the Pareto-efficient outcome from the firms standpoint.

As regards entry, a sequential game with different modes and constraints on the bargaining process has been investigated: duopoly the given market structure and monopoly with threat of entry. We focus our attention on the case of committed bargaining in which the entrant follows the established industry practice, i.e. it "joins the pack". We show that labour relations can be used as deterrence tool in the context of market entry. In a sequential game, we show that, for a given duopoly, depending on the intensity of the network externalities, the SPNE can be either a non-unionised industry (relatively high network intensity) or a unionised industry (relatively low intensity). On the other hand, in case of monopoly with threat of entry, the incumbent firm can use in a strategic way the internal labour relations to deter market entry. The equilibrium structure of the industry depends on the interaction between union bargaining power, its wage sensitivity and the intensity of network externality, and their impact on the threshold level the fixed costs: in fact, the industry can be characterised by a unionised/non-unionised monopoly/duopoly. Nonetheless, it can be identified the role of the network effects: they tend to reduce the ability of the incumbent to use labour relations to deter market entry. A rather paradoxical consequence is that a monopolist may strategically find advantageous to unionise its labour force to deter entry in the industry. Therefore, the present paper provides contributes in shedding lights on the game-theoretical foundation to explain the existence of unionised firms in imperfectly competitive markets.

The remainder of the article is organized as follows. Section 2 describes the basic duopoly model in the presence of network goods. Section 3 develops the entry game and derive the SPNE equilibrium outcomes. Finally, Section 4 summarises the key results, and proposes possible directions for further research on the subject.

2. The model

We consider a duopolistic Cournot market in a network industry. Following the standard literature (e.g. Katz and Shapiro, 1985) that the surplus that a firm's client obtains increases directly with the number of other clients of this firm, the inverse demand functions are as follows (Fanti and Buccella, 2016; Buccella and Fanti, 2016):

$$p_i = a - q_i - q_j + n(y_i + y_j) \tag{1}$$

where p_i is the price of good *i*, y_i denotes the consumers' expectation about firm *i*'s equilibrium market share, the parameter $n \in [0,1)$ indicates the strength of network effects (i.e. the higher the value of the parameter the stronger the network effects).

We assume the following production function – identical for both firms - with constant (marginal) returns to labour:

$$q_i = L_i \tag{2}$$

where L_i represents the labour force employed by firm i. The i-th firm faces an average and marginal cost $w_i \geq 0$ for every unit of output produced, where w_i is the wage per unit of labour. Therefore, the firm i's cost function is linear and described by:

$$C_i(q_i) = w_i L_i = w_i q_i . \tag{3}$$

Π_i denotes the profits of the i-th firm, as follows:

$$\Pi_i = (p_i - w_i)q_i \tag{4}$$

We investigate the case of unionisation of the firms with a standard efficient bargaining (EB) arrangement (e.g. McDonald and Solow 1981; Ashenfelter and Brown 1986) which prescribes that the union and the firm simultaneously bargain over both wages and employment (or, more realistically, hours of work). We assume identical firm-specific unions and each of them has, as usual, the following utility function (Pencavel 1984, 1985; Dowrick and Spencer 1994):

$$V = \left(w - w^{\circ}\right)^{\theta} L . \tag{5}$$

where w° is the reservation or competitive wage. While a value of $\theta = 1$ gives the rent-maximising case (i.e., the union seeks to maximise the total rent), values of θ smaller (higher) than 1 imply that the union is less (more) concerned about wages and more (less) concerned about jobs). For simplicity we assume in the rest of the paper that $w^{\circ} = 0$.

2.1. Efficient Bargaining institution.

Under efficient-bargaining we have that firm - union bargaining unit i selects w_i and L_i or equivalently q_i, to maximize the following generalised Nash product,

$$\underbrace{\max}_{w.r.t.\ w_i, q_i} N_i = \left(\Pi_i\right)^{1-b} \left(V_i\right)^{b} = \left\{[a - q_i - q_j + n(y_i + y_j) - w_i]q_i\right\}^{1-b} \left(w_i^{\theta} q_i\right)^{b} \tag{6}$$

Following Katz and Shapiro (1985) and the above mentioned literature, we impose the additional "rational expectations" conditions $y_1 = q_1$ and $y_2 = q_2$. From the system of first-order conditions of the efficient bargaining game, standard calculations allow to derive the firms' reaction functions in output as well as unions' wages functions (for analytical details, see Fanti and Buccella 2016). Solving the corresponding equations system, the following equilibrium results are obtained:

$$w_1^{EB/EB} = \frac{ab\theta}{b(\theta - 1) - 2n + 3} \tag{7}$$

$$q^{EB/EB} = \frac{a}{b(\theta - 1) - 2n + 3} \tag{8}$$

$$\Pi^{EB/EB} = \frac{a^2(1-b)}{\left[b(\theta - 1) - 2n + 3\right]^2} \tag{9}$$

2.2 The mixed case: one bargaining unit applies an EB arrangement and the other one pays the competitive wage.

Let firm/union pair 1 (2) choose EB (PM). Taking into account the "rational expectations" conditions $y_1 = q_1$ and $y_2 = q_2$, the reaction functions, satisfying the system of first-order conditions, of firms 1 and 2 , are respectively given by:

$$q_1\left(q_2, w_1\right) = \frac{a - 2w_1 + nq_2}{3 - n - 2b}, \tag{10}$$

$$w_1(q_1, q_2) = \frac{b\theta[a - q_1 - q_2 + n(q_1 + q_2)\}}{1 + b(\theta - 1)} \tag{11}$$

$$q_2\left(q_1, w_1\right) = \frac{[(1-b)(a + nq_1) - w_1]}{3 - n - b(2 - n)}. \tag{12}$$

The equilibrium outcomes are then easily derived

$$w_1^{EB/PM} = \frac{ab\theta}{b\left[(2-n)(\theta-1)\right] - 2n + 3} \tag{13}$$

$$q_1^{EB/PM} = \frac{a}{b(\theta-1)(n-2) + 2n - 3} \tag{14}$$

$$q_2^{EB/PM} = \frac{a\left[b(\theta-1) + 1\right]}{b(\theta-1)(n-2) + 2n - 3} \tag{15}$$

$$\Pi_1^{EB/PM} = \frac{a^2(1-b)}{\left[b(\theta-1)(n-2) + 2n - 3\right]^2} \tag{16}$$

$$\Pi_2^{EB/PM} = \frac{a^2(1 + b(\theta-1))^2}{\left[b(\theta-1)(n-2) + 2n - 3\right]^2} \tag{17}$$

2.3 The benchmark case of the competitive labour market model

The equilibrium outcomes are, as known (Buccella and Fanti 2016):

$$w^{PM/PM} = 0 \tag{18}$$

$$q^{PM/PM} = \frac{a}{3 - 2n} \tag{19}$$

$$\Pi^{PM/PM} = \frac{a^2}{(3-2n)^2} \tag{20}$$

2.4 Results

Let us define the following profit differentials:

$$\Delta\pi^1 = \pi^{PM/PM} - \pi^{EB/EB};\ \Delta\pi^2 = \pi^{PM/EB} - \pi^{EB/EB}; \Delta\pi^3 = \pi^{EB/PM} - \pi^{PM/PM}\ .$$

Using equations (9), (16), (17) and (20), we derive the following expressions

$$\Delta\pi^1 = \frac{a^2 b\left[(3-2n)(-1+2(n-\theta)) - b(1-\theta)^2\right]}{(2n-3)^2\left[b(\theta-1)+2n-3\right]^2};$$

$$\Delta\pi^2 = -\frac{a^2 b\left[(2n-3)(2n\theta+1-4\theta) + b(1-\theta)^2(n-2)^2\right]}{(2n-3)^2\left[b(\theta-1)-3\right]^2};$$

$$\Delta\pi^3 = \frac{a^2 b\left[\begin{array}{l} b^3(\theta-1)^4 + 4b^2(1-\theta)^2(n-2(2\theta-1))(n-2) + \\ b(\theta-1)(n(3\theta+1) - 2n(8\theta-1) + 6(3\theta-1) + 4n^2\theta - 2n(7\theta-1) + 3(4\theta-1)) \end{array}\right]}{\left[b(\theta-1)+2n-3\right]^2\left[(n-2)b(\theta-1)+2n-3\right]^2}$$

Figure 1 below graphically depicts the profit differential expressions for the case of zero (standard goods) (a), medium-high (b) and high values (c) of the network effects strength.

Result 1. *The higher the network effects, the more likely bargaining with unions may emerge as the unique SPNE, in the sense that such an equilibrium may emerge with larger intervals of the values of the bargaining union's power and the union's risk aversion.*

Proof: $\Delta\pi^2 \underset{<}{\overset{>}{-}} 0 \Leftarrow b \underset{>}{\overset{<}{-}} b^{\circ\circ} = \frac{3(1-4\theta)+2n(7\theta-1)-4n^2\theta}{(n-2)^2(1-\theta)^2}$; $\lim_{n\to 1} b^{\circ\circ} = \frac{1-2\theta}{(\theta-1)^2} \underset{<}{\overset{>}{-}} 0 \Leftarrow \theta \underset{<}{\overset{>}{-}} 0.5$;

$\Delta\pi^3 \underset{<}{\overset{>}{-}} 0$ *depending on the parameters n, b and* θ *as shown in Fig.1. boxes (a), (b) and (c).*

Result 2. *The SPNE EB can pay-off dominate PM, provided that network effects are sufficiently high.*

Proof: $\Delta\pi^1 \underset{<}{\overset{>}{-}} 0 \Leftarrow n \underset{<}{\overset{>}{-}} n^* \equiv 1 + \frac{\theta}{2} - \frac{(\theta-1)\sqrt{1-b}}{2}$.

The rationale for this result can be explained as follows. If the unions are not too wage oriented, the employment level under EB negotiations is larger than under perfectly competitive labour market. On the one hand, this increase the total costs of the firms. On the other hand, given the network effects, the larger the output the firms produce, the higher the final price they can charge to consumers. If the network externalities are sufficiently intense, the price level for EB firms becomes high enough to increase the firms' profitability with respect to the non-unionised case. To sum up, when the network effects are adequately strong, the EB not only more likely emerges as the SPNE but it also tends to be the Pareto-optimal one; otherwise, if network externalities are not sufficiently intense, the firms' game has the structure of a classical prisoner's dilemma.

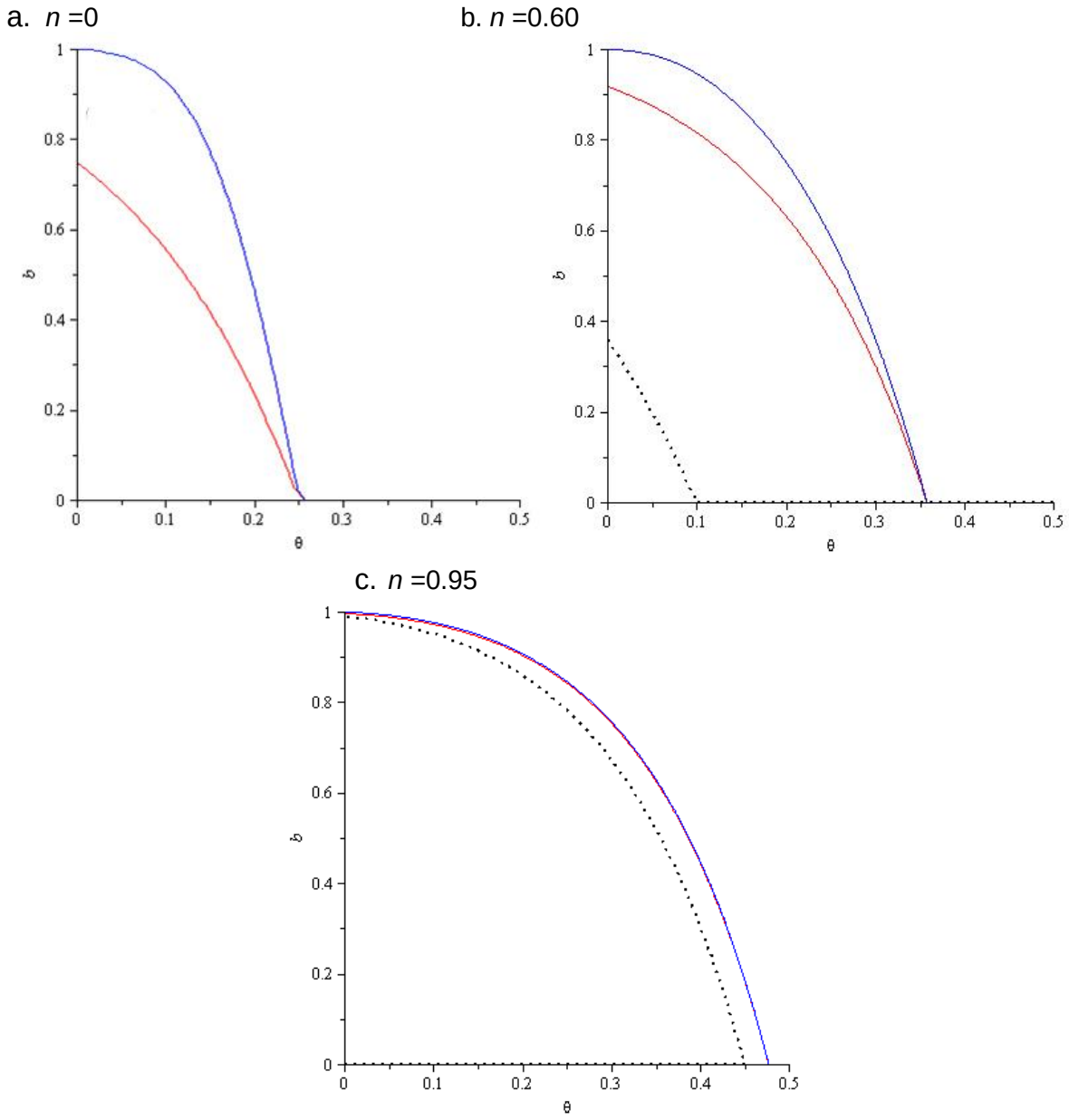

Fig. 1. Plot of the threshold curves $\Delta\pi^1$, $\Delta\pi^2$ and $\Delta\pi^3$ in the $\{\theta, b\}-$space for selected values of the network externality parameter: box (a), $n=0$; box (b), $n=.6$; box (c), $n=.95$. Legend: Each curve is drawn for a given value of a=1, ($\Delta\pi^1=0$: black dotted line; $\Delta\pi^2=0$: red line; $\Delta\pi^3=0$: blue line). $\Delta\pi^1=0$ does not appear in box (a) because it exists only for negative values of θ. For all $\{\theta, b\}$ combinations: 1) above the $\Delta\pi^3=0$ (blue line) curve the unique SPNE is PM; 2) above the $\Delta\pi^2=0$ (red line) curve and below the $\Delta\pi^3=0$ (blue line) curve the multiple SPNE are EB and PM; 3) below the $\Delta\pi^2=0$ (red line) above the $\Delta\pi^1=0$ (black dotted line) curve the unique SPNE is EB, 4) below the $\Delta\pi^1=0$ curve the unique SPNE is EB and $\mathrm{EB}>\mathrm{PM}$.

3 The entry game

In the previous section, we have investigated the firms' choice as regards unionisation and the introduction of EB negotiations in the context of a simultaneous game between firms. In other words, we have analysed the situation where duopoly is the already existing market structure. In

the next, we study the subject of the potential strategic advantages of unionisation in the context of market entry.

In the present paper we investigate the strategic decision of introducing organised workers in a company, and then conducting negotiations with them. Similarly to Bughin (1999), Buccella (2011) and Fanti and Buccella (2015, 2016), we consider different market structures, namely duopoly vs. monopoly with threat of entry. However, as Fanti and Buccella (2016), we restrict the analysis to the so-called "committed bargaining", in which the incumbent firm first selects how to relate with workers (i.e. whether to be unionised), and the entrant "joins the pack", (i.e. follows the established practice in the industry). Therefore, in case of unionisation, the incumbent conducts negotiations, and then the entrant also recognizes unionised labour within the company and conducts negotiations according to the EB agenda. As in Bughin (1999), Buccella (2011) and Fanti and Buccella (2015, 2016), a change from a monopoly to a duopoly market structure models entry in the industry. We define firm 1 as the incumbent and firm 2 as the potential entrant. The profit function in eq. (4) for the potential entrant firm now includes the term E, which defines an exogenous fixed cost; in addition we have $w_i = 0$ when the entrant is not unionised.

As usual, we solve the game by backward induction; therefore, we use the SPNE solution concept. The market structure affects the timing of the game. As a consequence, we have a three/four-stage game with the following timing. At the pre-stage, the incumbent firm decides whether to be unionised. In the first stage, if unionised, the incumbent bargains wages and employment with the union according to the EB agenda; otherwise, it solves the profit maximisation problem and hires workers at the competitive wage. In the case of duopoly the given market structure, in the second stage the entrant firm follows the incumbent's practice. Then, in the third stage, the entrant eventually negotiates with the union.

In case of monopoly with threat of entry, in the second stage, the potential entrant decides whether to enter in the industry. In the third stage, the entrant follows the incumbent practice. In the fourth stage, wages and employment negotiations take place in the unionised firm(s) or the profit maximising quantity is selected in case of no-unionisation. Figure 2 simplifies the framework with committed bargaining. Let us investigates the outlined market configurations.

3.1 Duopoly given market structure

Under committed bargaining the entrant follows the established practice in the industry. Therefore, if the incumbent is unionised, the entrant is unionised as well. A similar reasoning applies in the case of non-unionisation. Consequently, the entrant and the incumbent compare the

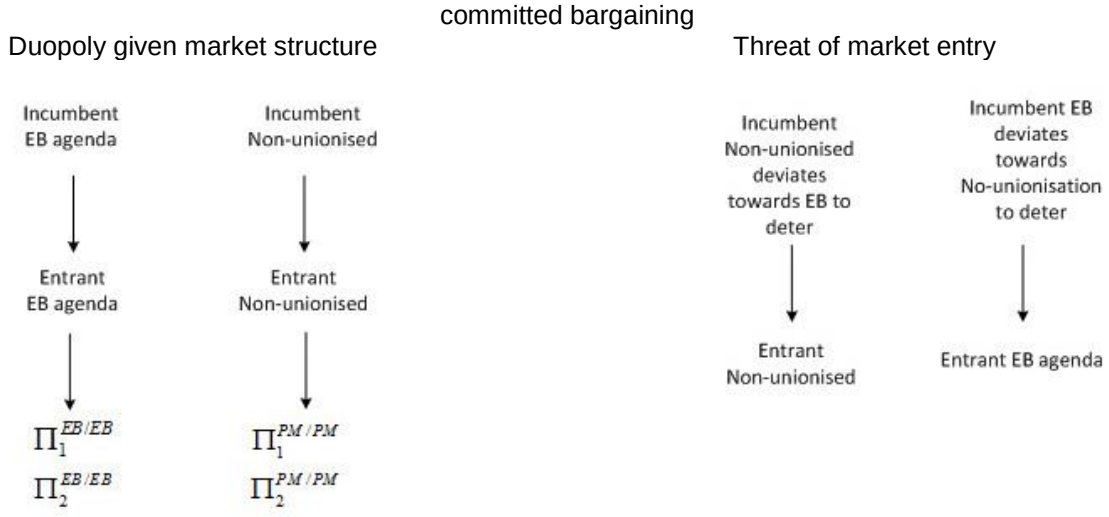

Fig. 2. Framework of the committed bargaining

following payoffs: $\Pi_i^{PM/PM}$, $\Pi_i^{EB/EB}$ $i=1,2$. Given (9), (20) and result 2, we have that $\Pi_i^{PM/PM} \underset{<}{\overset{>}{-}} \Pi_i^{EB/EB}$ $i=1,2$ if $n \underset{<}{\overset{>}{-}} n^*$. In other words, depending on the strength of the network effects, both firms in equilibrium can be either unionised or not. However, as the network effects become more intense, the parametric area in which $\Pi_i^{EB/EB}$ is the SPNE enlarges, as depicted in Figure 1, boxes (a), (b) and (c).

Result 3. *When duopoly is the given market structure, in the presence of committed bargaining, the SPNE is characterised by a unionised industry if* $n < n^*$ *and a non-unionised industry if* $n \geq n^*$.

3.2. Threat of entry

Let us now consider the case of threat of entry. Similar to the reasoning of Bughin (1999) and Buccella (2011), in the presence of a monopoly with threat of market entry, under "committed bargaining" the incumbent firm (*M*) can strategically select whether to be unionised to deter entry. Standard calculations allow to derive the following monopoly outcomes:

$$\Pi_1^{EB/M} = \frac{a^2(1-b)}{[b(\theta-1)-n+2]^2}; \quad \Pi_1^{PM/M} = \frac{a^2}{(2-n)^2}. \tag{21}$$

Given the payoff structure in the "committed bargaining" game in Fig. 3 below, preliminary observations simplify the subsequent analysis by focusing on a restricted range of the fixed costs size the entrant has to face.

Restriction 1: $\Pi_1^{i,i} > E > \Pi_1^{j,j}$, $i, j = EB, PM; \quad i \neq j$

The economic meaning of Restriction 1 is immediate: if $\Pi_1^{j,j} > E$, the fixed cost level is sufficiently low to guarantee always free entry in the industry. On the other hand, if $E > \Pi_1^{i,i}$, the size of the fixed costs is prohibitively high for the potential entrant: market entry is always blockaded. Given Restriction 1, the following Lemma applies.

Lemma 1: *The incumbent can strategically select whether to be unionised to deter market entry if the following conditions holds:*

$$a)\ \Pi_{1,M}^{i} > E > \Pi_1^{i,i} \quad i = EB, PM; \quad b)\ \Pi_{1,M}^{i} > \Pi_1^{j,j} \quad i, j = EB, PM; \quad i \neq j.$$

Let us describe conditions $(a)-(b)$ in Lemma 1. Condition (a) asserts that, under committed bargaining, if the incumbent is (not) unionised, fixed costs higher than the (non-) unionised duopoly profits block the potential entrant because entry is no longer profitable. Condition (b) defines that the duopoly profits with the alternative workers' organisation do not have to be larger than the monopoly profits of the selected unionised/non-unionised workforce scheme because, otherwise, it is more advantageous for the incumbent to choose the other option and accommodate entry. Simple algebra shows the following Lemma.

Lemma 2. *EB monopoly profits are higher than PM duopoly profits if*

$$n \le n^{\mathrm{O}} \equiv \frac{(\theta+5)b-4+[2(1-\theta)-1]\sqrt{1-b}}{4b-3},$$

while PM monopoly profits are higher than EB duopoly profits if

$$n \le n^{\mathrm{T}} \equiv \frac{2(2+b\theta)+[1+(1-\theta)b]\sqrt{1-b}}{3+b}.$$

The above observations leads to the following result.

Result 4. *The incumbent's profit payoffs generate the following regions in the relevant* $\{\theta, b\}-$*space whose rankings are as follows (see also Fig. 3):*

1) for $n=0$

Region I: $\Pi_1^{PM/M} > \Pi_1^{PM/PM} > \Pi_1^{EB/M} > \Pi_1^{EB/EB}$;
Region II: $\Pi_1^{PM/M} > \Pi_1^{EB/M} > \Pi_1^{PM/PM} > \Pi_1^{EB/EB}$;

2) for $0 < n \le n^*$

Region I: $\Pi_1^{PM/M} > \Pi_1^{PM/PM} > \Pi_1^{EB/M} > \Pi_1^{EB/EB}$;
Region II: $\Pi_1^{PM/M} > \Pi_1^{EB/M} > \Pi_1^{PM/PM} > \Pi_1^{EB/EB}$;
Region III: $\Pi_1^{EB/M} > \Pi_1^{PM/M} > \Pi_1^{PM/PM} > \Pi_1^{EB/EB}$;

3) for $n^* < n \le n^{\mathrm{T}}$

Region I: $\Pi_1^{PM/M} > \Pi_1^{PM/PM} > \Pi_1^{EB/M} > \Pi_1^{EB/EB}$;
Region II: $\Pi_1^{PM/M} > \Pi_1^{EB/M} > \Pi_1^{PM/PM} > \Pi_1^{EB/EB}$;
Region III: $\Pi_1^{EB/M} > \Pi_1^{PM/M} > \Pi_1^{PM/PM} > \Pi_1^{EB/EB}$;
Region IV: $\Pi_1^{EB/M} > \Pi_1^{PM/M} > \Pi_1^{EB/EB} > \Pi_1^{PM/PM}$;

4) for $n^{\mathrm{T}} < n$

Region I: $\Pi_1^{PM/M} > \Pi_1^{PM/PM} > \Pi_1^{EB/M} > \Pi_1^{EB/EB}$;
Region II: $\Pi_1^{PM/M} > \Pi_1^{EB/M} > \Pi_1^{PM/PM} > \Pi_1^{EB/EB}$;
Region III: $\Pi_1^{EB/M} > \Pi_1^{PM/M} > \Pi_1^{PM/PM} > \Pi_1^{EB/EB}$;
Region IV: $\Pi_1^{EB/M} > \Pi_1^{PM/M} > \Pi_1^{EB/EB} > \Pi_1^{PM/PM}$;
Region V: $\Pi_1^{EB/M} > \Pi_1^{EB/EB} > \Pi_1^{PM/M} > \Pi_1^{PM/PM}$.

Application of Lemma 1 under Restriction 1 to Result 4 leads to the following result.

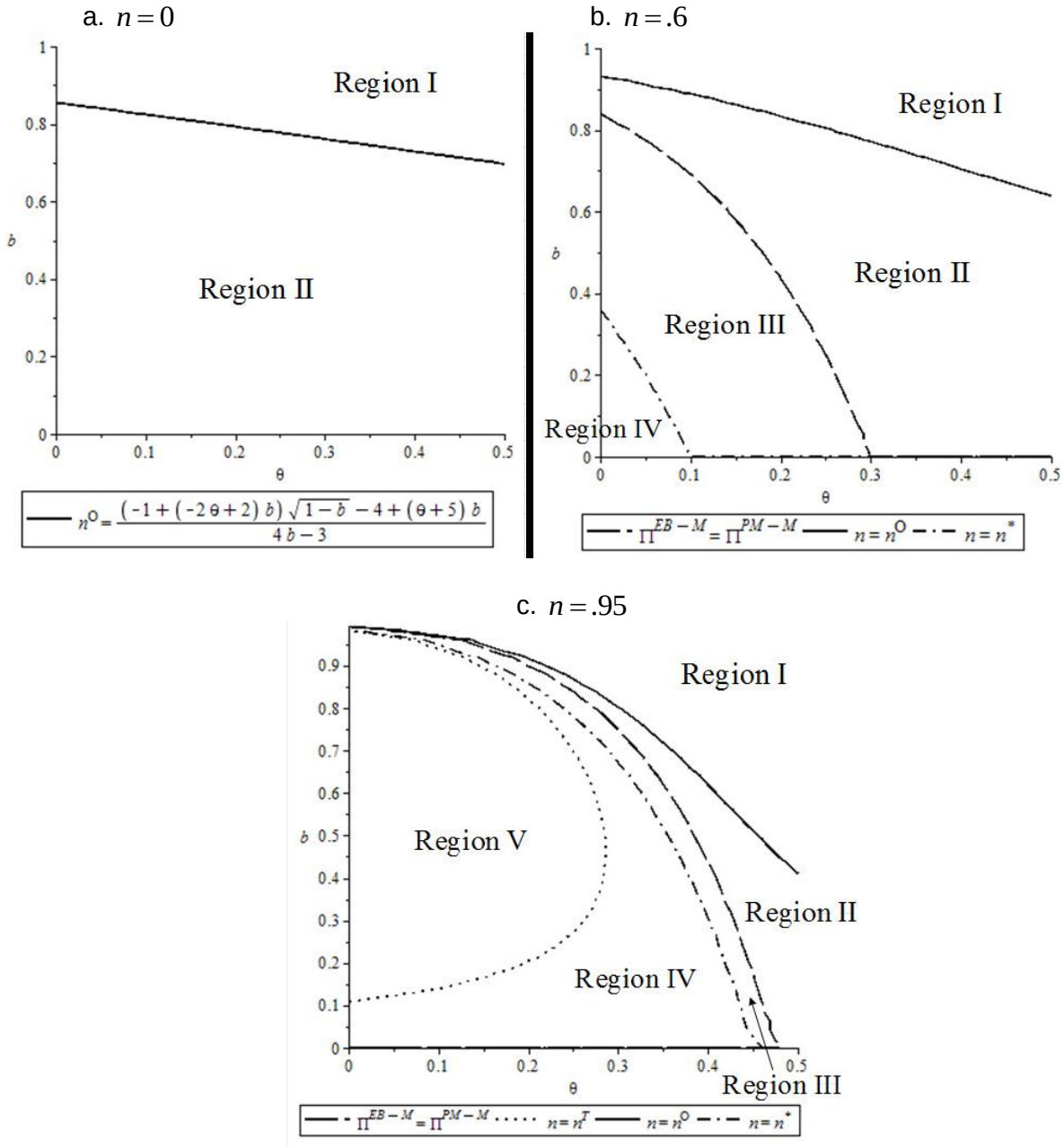

Fig. 3. Graphical representation of Result 4 for selected values of the network externality parameter: box (a), $n=0$; box (b), $n=.6$; box (c), $n=.95$.

Result 5. *The incumbent may strategically use labour relations to deter entry in the following cases:*

1) *without network externalities ($n=0$): unionisation in Region II;*
2) *for $0<n\leq n^{*}$: unionisation in Regions II and III;*
3) *for $n^{*}<n$: unionisation in Regions II and III and non-unionisation in Region IV.*

Proof: See the Appendix.

The analysis evidences that labour relations can be used as an entry deterrence tool, and network externalities play a crucial role. In particular, the following effects of the network externalities can be underlined. First, irrespective of the magnitude of the entry costs for the potential competitor, the network effects tends to shrink the possibility of using the labour relations

to deter entry. Second, adequately high intensity level of the network effects leads the incumbent to block entry by selecting of being not-unionised, a result in sharp contrast with the common wisdom that unions are a tool for entry deterrence. The rationale for this results can be explained as follows. A high intensity of the network effects works in the direction of making the monopoly profitability without unions higher than the EB duopoly: the total output in the market increases to a such an extent that the final price falls to a level that actually reduces firms' profitability.

Therefore, governments and antitrust authorities, if interested in avoiding the creation of dominant positions in network industries, have to be extremely careful in designing the appropriate policies and regulation in product and labour markets. It is extremely important to have knowledge of the predominant labour market relation in the target network industry. In fact, in those sectors, the conventional wisdom of the strict interconnection between imperfectly competitive product and labour markets may prove not to hold true.

4. Conclusions

In a network industry, this paper has studied the issue of the firms' unionisation in a duopolistic game in which firms may choose whether to negotiate over wages and employment with unions or face a competitive, non-unionised labour market. In the simultaneous move game, we have shown that, when the network effects are not adequately intense, firm profits with a competitive labour market are always larger than those in the presence of unions. However, the choice of being unionised arises as the SPNE of the game, provided that labour unions are not too strong. In such a case, the game presents the characteristics of the Prisoner's dilemma. However, if the network effects become adequately intense, unionisation is not only the SPNE, but also the Pareto-efficient outcome for both firms.

The paper has also analysed the use of labour relations as deterrence tool in the context of market entry. In a sequential game, we have studied different entry modes: duopoly as the given market structure, and monopoly with threat of entry. We have focused the analysis on committed bargaining. We have found that, for a given duopoly, depending on the intensity of the network externalities, the SPNE can be either a non-unionised industry (high intensity) or a unionised industry (low intensity).

In case of monopoly with threat of entry, the incumbent may strategically use labour relations within the company to deter market entry. Depending on the intensity of the network externalities and the size of the fixed costs, the equilibrium structure of the industry can be characterised by a unionised/non-unionised monopoly or a unionised/non-unionised duopoly. The overall picture is rather complex because of the interaction also of the union bargaining power and wage sensitivity parameter. However, in general, it can be recognised that the network effects tend to reduce the ability of the incumbent to use labour relations to deter market entry. Rather paradoxical it is the result that an incumbent may strategically recognize the presence of a union in the company to ensure a monopoly industry.

The results of the present model are based on precise assumptions as regards the product market competition and the analytical forms for the demand and cost functions. A further step would be to study price competition and differentiated products, and the robustness of the present findings can be substantiated in an expanded framework where R&D investments and capacity choices are introduced. Moreover, the present paper has considered, in case of unionisation, that negotiations take place over standard fixed wage contracts. Performance related payment schemes such as the profit sharing and piece rates can be introduced into the negotiations. Additionally, only the simultaneous EB arrangement has been analysed. A key extension of the present work would be to investigate to what extent other bargaining agendas, for instance the Right-to-Manage model and the sequential EB, may arise as SPNE of the game, and their potential effectiveness in deterring market entry. Furthermore, we have assumed that the entrant "joins the pack". More flexibility in the entrant strategic choice (see Bughin 1999; Buccella 2011) may definitively alter the equilibrium structure of the industry in the entry game.

The overall implications on social welfare need to be deeply investigated because of their impact on the governments' decision-making process and antitrust authorities activities. The simultaneous EB arrangement is "efficient" from a societal point of view. However, the result that

such an agenda can arise as SPE, is interesting also for policy. In fact, given the potential market deterrence effect of the labour relations, the present analysis suggests that those institutions should attentively take into consideration the prevalent industry practices, before designing any intervention to regulate labour and product markets.

Appendix

Proof of Result 5

1) $n = 0$: *benchmark, no network effects*

To prevent entry, under Restriction 1, (a)-(b) of Lemma1 must be satisfied. In Region I, characterised by extremely high union bargaining power, the profits payoff ranking for the incumbent firm is $\Pi_1^{PM/M} > \Pi_1^{PM/PM} > \Pi_1^{EB/M} > \Pi_1^{EB/EB}$. Thus, given Restriction 1, $E \in (\Pi_1^{PM/PM}, \Pi_1^{EB/EB})$. If the fixed costs are such that $\Pi_1^{PM/M} > \Pi_1^{PM/PM} > \Pi_1^{EB/M} > E > \Pi_1^{EB/EB}$, negotiations under EB meet part (a) of Lemma 1; however, part (b) is not satisfied: the incumbent's profits with non-unionised labour force in duopoly are larger than monopoly profits with unionized labour under EB negotiations. Therefore, unionization cannot be used to deter entry.
On the other hand, in Region II, the profits payoff ranking for the incumbent firm is $\Pi_1^{PM/M} > \Pi_1^{EB/M} > \Pi_1^{PM/PM} > \Pi_1^{EB/EB}$. Thus, under Restriction 1, $E \in (\Pi_1^{PM/PM}, \Pi_1^{EB/EB})$. If the fixed costs are such that $\Pi_1^{PM/M} > \Pi_1^{EB/M} > \Pi_1^{PM/PM} > E > \Pi_1^{EB/EB}$, EB negotiations completely satisfy Lemma 1. The size of the fixed cost cannot prevent entry in case of no unionization. However, the incumbent's monopoly profits with unionized labour under EB are now larger than non-unionised duopoly profits. Therefore, the incumbent can use EB to deter entry.

2) *for* $0 < n \leq n^*$

The analysis of Regions I and II is identical to part 1). Therefore, let us focus on Region III, whose payoff structure is $\Pi_1^{EB/M} > \Pi_1^{PM/M} > \Pi_1^{PM/PM} > \Pi_1^{EB/EB}$. Under Restriction 1, $E \in (\Pi_1^{PM/PM}, \Pi_1^{EB/EB})$. If the size of the fixed costs is $\Pi_1^{EB/M} > \Pi_1^{PM/M} > \Pi_1^{PM/PM} > E > \Pi_1^{EB/EB}$, EB satisfies Lemma 1: the fixed costs cannot deter entry without unions, but the incumbent's profit under unionized monopoly is the largest payoff it can reach. Thus, the incumbent uses EB to deter entry.

3) *for* $n^* < n \leq n^{\mathrm{T}}$

The payoffs' structure in Regions I-III is equal to part 2). Thus, we focus on Region IV in which $\Pi_1^{EB/M} > \Pi_1^{PM/M} > \Pi_1^{EB/EB} > \Pi_1^{PM/PM}$. Given Restriction 1, $E \in (\Pi_1^{EB/EB}, \Pi_1^{PM/PM})$. If the fixed costs are $\Pi_1^{EB/M} > \Pi_1^{PM/M} > \Pi_1^{EB/EB} > E > \Pi_1^{PM/PM}$, non-unionisation (PM) meets the conditions of Lemma 1. As a consequence, the incumbent prefers having non-unionised labour force: the fixed costs cannot prevent the introduction of EB negotiations; however, monopoly profits with non-unionised labour force are higher than duopoly profits with unionized labour under EB negotiations. Therefore, being not unionised can deter market entry.

4) $n^{\mathrm{T}} < n$

The analysis of Regions I-IV reflects that of part 3). Let us consider Region V, whose payoff structure is $\Pi_1^{EB/M} > \Pi_1^{EB/EB} > \Pi_1^{PM/M} > \Pi_1^{PM/PM}$. Therefore, given Restriction 1, $E \in (\Pi_1^{EB/EB}, \Pi_1^{PM/PM})$. If the fixed costs are such that $\Pi_1^{EB/M} > \Pi_1^{EB/EB} > \Pi_1^{PM/M} > E > \Pi_1^{PM/PM}$,

PM meets part (a) of Lemma 1; however, part (b) is not satisfied: the incumbent's profits with unionised labour force in duopoly are larger than monopoly profits with non-unionised labour. Therefore, the decision of being not unionised cannot deter entry.

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