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When do firms and unions agree on a monopoly union or an efficient bargaining arrangement?

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Abstract   In this paper we investigate the effects of two popular labour market institutions – namely, Monopoly Union (MU) and Efficient Bargaining (EB) – in a Cournot duopoly, in particular as regards the issue of the bargaining agenda. We show that, while when EB and Right-to-Manage arrangements are considered no agreement on the scope of bargaining may occur, when exogenously given MU and EB arrangements are compared both firms and unions may find more convenient the MU institution. This occurs in particular when the value of the union's bargaining power is included in a "medium-high" range. However this result is not robust to the endogeneization of the scope of bargaining: indeed in the latter case both firms and unions agree with the choice of the EB arrangement for a sizable range of the union's power. Therefore the detection of a set of union bargaining power values for which there exists an agreement between firms and unions either on the MU institution in the case of exogenously given arrangements or on the EB institution in the case of endogenously determined arrangement may be interesting also for policy purposes.

Keywords Efficient bargaining; Monopoly union; Right-to-manage; Cournot duopoly

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1. Introduction

As a stylised fact, labour market institutions[1] are present in most economies, especially in Europe. In particular, three institutions - i.e. Right-to Manage (RTM), Monopoly Union (MU) and Efficient Bargaining (EB) - have been observed and analysed.[2]

In particular, in the words of Lawson (2010, p. 8) "the MU and EB models represent the two most popular alternative economic representations of the wage-employment outcome of collective bargaining, and deciding between these two models is not just an issue of curiosity; there are some clear normative implications which arise from the two models." To summarise: MU implies inefficiently low (high) employment (wages) and from the social point of view the higher the union's power, the lower social welfare, while under EB the employment level it is likely to be efficiently determined (i.e. if the contract curve is vertical) or at least it will be less socially inefficient than that occurring under MU.

On the other hand which type of institution may prevail at market equilibrium and whether there may be accord between firms and unions about this institution (i.e. about the bargaining agenda) are interesting problems not only for the two parties but also for consumers and society.

In this paper we analyse – in a standard Cournot duopolistic market - three different firm-union games with the three different labour market institutions above mentioned and subsequently we compare the exogenously given equilibrium outcomes as well as we determine in an endogenous way the scope of bargaining for firms and unions, by investigating the possibility of an agreement over the bargaining agenda. Moreover we discuss social welfare implications of our analysis.

Preliminarily it is shown that when RTM and EB arrangements are considered there is no agreement on the scope of bargaining: firms always prefer RTM and unions always prefer EB.

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[1] The literature as regards economics of unions as well as its historical evolution is examined, for instance by Pencavel (1991), Kaufman (2002) and McCurdy and Pencavel (1986). A recent survey (Lawson, 2010) deals with the theme of the "efficiency" of trade-unions.

[2] As is known typical models of the trade-union economics (Booth, 1995) are: 1) the EB model (e.g. McDonald and Solow, 1981) which prescribes that the union and the firm are bargaining over both wages and employment (or, more realistically, hours of work); 2) the RTM model where the union and firm bargain over wages only, while the firm is assumed to have the right-to-manage autonomy over employment; 3) the Monopoly Union Model (MU), which argues that the monopoly union has the power to set the wage rate and the firm then chooses the level of employment.

Then, if we are interested to investigate whether and how an agreement on the scope of bargaining by union and firm is possible, we have to investigate the two cases of MU and EB. Indeed the reason for studying these two cases is not only due to their popularity above mentioned, but also to the fact that an agreement might be possible by assuming a different bargaining power for each type of arrangement, that is a full union's power under only wage bargaining and a partial union's power under bargaining on both wage and employment.[3] In particular, also for the sake of symmetry, it seems to be relevant to compare the case in which both parties have a partial power to set jointly wages and employment (i.e. EB) with the case in which unions have all the power in wage negotiations, while firms have all the power to set the employment level (i.e. MU) and not only with the asymmetric case in which firms have all the power to set the employment level while unions have only a partial power in wage negotiations (i.e. RTM). Moreover, note that it is possible that unions are more powerful when they bargain on wages than when they bargain on employment (for example in the latter case they might have lower ability, less information and so on). [4] In other words, if the agreement on the scope of bargaining is an important issue [5] it may be convenient also for firms to find an agreement despite the fact that it is "less" profitable than the unilateral choice of the bargaining agenda. Therefore the question, so far not explored, is: is it possible an agreement on the type of arrangement when the alternatives choices in the bargaining agenda are MU and EB? [6]

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[3] Note that under both RTM and EB alternative arrangements - for which we have shown the agreement's impossibility result - the union's bargaining power is the same.

[4] A reason for justifying the lower power of unions in the bargain over employment is that only the wage contracts are legally binding while the agreements on employment are "enforceable" only if the union is able "to "force" its firm to keep employment at the "efficient" level for any wage rate deal.......a union should convince its firm to set employment along the contract curve, by means of proper punishment strategies" (Petrakis and Vlassis, 2000, p. 262). Thus it is likely that unions are less "able" in bargaining over employment than over wages.

[5] For instance, because without agreement on the bargaining agenda, the party unilaterally excluded by the agenda's choice might have a conflicting behaviour on many issues which are outside the binding rules of the arrangement.

[6] Moreover note that the case of MU is nothing else than the case with the maximal union power of the RTM institution. Thus in this way the present results may seem more paradoxical to the extent that, for instance, firms, as shown by Prop. 1 in section 4, prefer a situation in which unions have all the power (although only over the wage) to a bargaining situation in which the union power (although on both wage and employment) is fairly close to that of firms.

Motivated by the popularity of these two labour market institutions as well as by their different normative implications and by the possibility of an agreement on the bargaining agenda, as above discussed, in this paper we investigate the following issues. Should firms leave unions set wages, while deciding by themselves on the output market or should they negotiate both wage and employment? Which labour market institution does prevail in equilibrium: monopolistic unions or an efficient bargaining? May an agreement between unions and firms over the scope of bargaining endogenously emerge?

We assume that workers form firm-specific unions. Building on the standard unionised duopoly game approach, firstly we compare the exogenously given equilibrium outcomes of both labour markets arrangements and secondly we study the endogenous equilibrium (i.e. the sub-perfect Nash equilibrium (SPNE) arrangement). As to the comparison between exogenously given equilibrium outcomes, the results point out three cases as regards the preferred choice of an institution by the two bargaining parties: *(i)* firms prefer EB when the union bargaining power (which is measured by *$0 \leq b \leq 1$*) is lower, equal or a bit higher than that of firms (i.e. up to *$b<0.555$*); *(ii)* for a fairly high union bargaining power, namely higher than two-third, unions prefer EB; *(iii)* for a medium-high unions' bargaining power, i.e. *$0.555<b<2/3$*, firms and unions agree on the MU institution. By contrast, as for the endogenous outcome (i.e. SPNE) we show that both firms and unions agree with the choice of the EB arrangement for a sizable range of the union's power (i.e. for *$0.715< b < 0.426$*).

Given the "agreement's impossibility" result emerged by the study of the RTM and EB alternative arrangements, therefore it is remarkable our finding that an agreement is possible either only when firms leave to unions the power of fixing wages in the case of exogenously given arrangements or on the EB institution in the case of endogenously determined arrangement.

Finally, the welfare analysis has also shown that while with the monopoly union institution, as expected, output is reduced, price is increased and both consumer surplus and social welfare are reduced, with the efficient bargaining institution output, price, consumer surplus and social welfare are equal to those of the benchmark model with "competitive" labour markets, so, restoring, in this sense, the "efficient" outcomes. As a consequence, the result that the EB arrangement is a sub-perfect game equilibrium emerging for both firms and unions (provided a

fairly wide range of intermediate values of union's power) is beneficial also for consumers and society.[7]

As regards the position of the paper in the current literature, it contributes to the growing literature on unionised oligopoly (e.g., Horn and Wolinsky, 1988; Dowrick 1989; Bughin, 1995; Correa-López and Naylor, 2004; Fanti and Meccheri, 2011, 2013). However this vast literature has paid less attention to the effects of different labour market institutions and on their comparison with respect to the issue of the bargaining agenda. The present paper is one of the few ones that focuses on this issue. Three exceptions which have considered both RTM and EB cases, are Petrakis and Vlassis (2000), Kraft (2006) and Bughin and Vannini (2000). The former authors propose a benchmark equilibrium institution - the RTM institution- and then check whether, or not, it survives all possible deviations which require an agreement between both parties involved, showing that an agreement on EB may never occur, while an agreement on either RTM or a mixed result [8] may occur depending on whether the unions' bargaining power is larger or lower than that of firms. [9] The second author follows the assumption of Petrakis and Vlassis (2000) that if one firm commits itself to EB then the rival firm always becomes a Stackelbeg follower in the output market; however he argues, in sharp contrast with Petrakis and Vlassis (2000), that for a large range of parameter values EB is the dominant strategies for firms. Vannini and Bughin (2000) focus on oligopoly firms' decision whether or not to adopt cost-raising strategies finding some benefit in recognizing unions and show that (under low union power, low product differentiation and centralised bargaining) an EB arrangement may be preferred to a RTM arrangement by firms despite the corresponding higher unit wage costs. In any case both Kraft (2006) and Vannini and Bughin (2000) abstract from the issue of the agreement between firms

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[7] While the result under exogenously given (and thus not "robust") equilibrium situations, i.e. an agreement on MU arrangement, may seem relatively harming for consumers and society.

[8] That is at equilibrium one firm/union pair chooses EB while the other pair chooses RTM.

[9] That is the veto of either the firm or its own union over the inclusion of employment on the negotiations agenda is sufficient for right-to-manage bargaining to be sustained. By contrast the authors postulate that the union is unable to unilaterally impose bargaining over employment. This line of reasoning implies that if it is assumed that one firm commits itself to EB and thus also commits itself to a given production, the rival firm always prefers to postpone at a subsequent stage its output decision - thus becoming Stackelbeg follower in the output market - in order to avoid a Stackelberg warfare. As a consequence, the result that both firms choose EB is prevented by construction.

and unions on the scope of bargaining. Thus the approach of these papers as regards the scope of bargaining issue is at all different by the present paper's one and their results are not directly comparable with those of the present paper, which revisited such an issue in a standard game-theoretic approach.

The rest of the paper is organized as follows. Section 2 presents the unionised duopoly model. Section 3 (section 4) investigates EB and RTM (MU) labour market institutions. Both sections discuss the exogenously given as well as the sub-game perfect Nash equilibrium outcomes of such labour market institutions. Section 5 comments the previous results as to the "efficiency" issue. Section 6 concludes.

2. The model

We consider a duopolistic Cournot market. There is a single homogenous product and its standard normalised linear inverse demand is given by
$$p = 1 - Q, [10] \tag{1}$$
where p denotes price and Q is the sum of the output levels q_1 and q_2 of the two firms.

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:
$$C_i(q_i) = w_i L_i = w_i q_i . \tag{3}$$
For each firm, the cost of producing one unit equals $w_i < 1$. Π_i denotes the profits of the i-th firm, as follows:
$$\Pi_i = (1 - w_i - Q)q_i \tag{4}$$
Following the standard unionised oligopoly literature above mentioned, we build a firm-union two-stage game: in the first stage simultaneously firm-specific unions either monopolistically fix wages (MU) or bargain with firms over wages (RTM) and in the second stage firms simultaneously choose their output (for given wages). We solve for the equilibrium in the standard backward fashion. An equilibrium of the second stage of the game (the market game) satisfies the system of first-order conditions

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[10] Note that the standard inverse demand model $p' = a - Q'$ can be transformed into this normalised model using $p = p'/a$ and $Q = (1/a)Q'$.

$$\frac{\partial \Pi_1}{\partial q_1} = 0 \Leftrightarrow (1 - w_1 - 2q_1 - q_2) = 0 \qquad (5.1)$$

$$\frac{\partial \Pi_2}{\partial q_2} = 0 \Leftrightarrow (1 - w_2 - q_1 - 2q_2) = 0 \qquad (5.2)$$

Therefore, the reaction functions of firms 1 and 2 are respectively given by:

$$q_1(q_2) = \frac{1}{2}[1 - w_1 - q_2] \qquad (6.1)$$

$$q_2(q_1) = \frac{1}{2}[1 - w_2 - q_1] \qquad (6.2)$$

From (6.1) and its equivalent for firm 2, (eq. 6.2) we obtain output, respectively, by firm i, for given w_i, w_j:

$$q_i(w_i, w_j) = \frac{[1 - 2w_i + w_j]}{3} \qquad (7)$$

Each firm-specific union has the following utility function: [11]

$$V_i = w_i L_i \qquad (8).$$

We assume that unions are identical. Therefore, by recalling that $q_i = L_i$, eq. (8) becomes: $\qquad V_i = w_i q_i \qquad$ (9).

This means that unions aim to maximise the total wage bill.

Let's begin by illustrating the cases of RTM, EB and MU, respectively.

2.1. Right-to-manage institution

At the first stage of the game, under Right-to Manage, firm's manager - union bargaining unit i selects w_i, to maximize the following generalized Nash product,

$$\underset{w.r.t.\ w_i}{\max} \ N_i = (\Pi_i)^{1-b}(V_i)^b = [(1 - w_i - Q)q_i]^{1-b}(w_i q_i)^b \qquad (10),$$

Maximising eq. (10) with respect to w, after substitution of eq. (7) in (9), we obtain the sub-game perfect best-reply function in wages of union–firm pair i - i.e. $w_i(w_j)$ - under the assumption of a non-cooperative Cournot–Nash equilibrium in the product market. Solving the system composed by

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[11] This a specific case of the more general Stone-Geary utility function, i.e., Pencavel (1984, 1985), Dowrick and Spencer (1994):

$$V = (w - w°)^\theta L,$$

where $w°$ is the reservation or competitive wage . 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). Moreover, the unions aims to maximise the wage bill when $w° = 0$.

$w_i(w_j)$ and its counterpart for j, we obtain the sub-game perfect equilibrium wages:

$$w_i = w_j = w *^{RTM} = \frac{b}{(4-b)} \qquad (10)$$

By exploiting (10), after the usual algebra, the equilibrium values of output, profit and union's utility are derived:

$$q_i = q_j = q *^{RTM} = \frac{2(2-b)}{3(4-b)} \qquad (11)$$

$$\Pi_i = \Pi_j = \Pi *^{RTM} = \frac{4(2-b)^2}{9(4-b)^2} \qquad (12)$$

$$V_i = V_j = V *^{RTM} = \frac{2b(2-b)}{3(4-b)^2} \qquad (13)$$

2.2. Efficient Bargaining institution.

Under efficient-bargaining and with the assumption that unions are identical and have the same bargaining power during the negotiations with their firms, we have that firm's manager - union bargaining unit i selects w_i and L_i, or equivalently q_i, to maximize the following generalised Nash product,

$$\max_{w.r.t. \ w_i, q_i} N_i = (\Pi_i)^{1-b}(V_i)^b = [(1-w_i-Q)q_i]^{1-b}(w_i q_i)^b \qquad (14),$$

where b represents the bargaining union's power. From the system of first-order conditions of the efficient bargaining game between firms and unions, the reaction functions of firms 1 and 2 as well as unions 1 and 2 are the following:

$$q_1(q_2, w_1) = \frac{1}{2-b}[1-w_1-q_2], \qquad (15.1)$$

$$q_2(q_1, w_2) = \frac{1}{2-b}[1-w_2-q_1]. \qquad (15.2)$$

$$w_1(q_1, q_2) = [-b(q_1+q_2-1)] \qquad (15.3)$$

$$w_2(q_1, q_2) = [-b(q_1+q_2-1)] \qquad (15.4)$$

From eqs. (15.1) and (15.2) we obtain output, respectively, by firm i, for given w_i, w_j $(i, j=1,2; i \neq j)$:

$$q_i(w_i, w_j) = \frac{[(1-w_j)+(-1+w_i)(2-b)]}{(3-b)(b-1)} \qquad (16)$$

After substitution of eq. (16) in (15.3-15.4), we obtain

$$w_i(w_j) = \frac{b[(2-b)-1+w_j]}{3-2b} \qquad (17)$$

which defines the sub-game perfect best-reply function in wages of union–firm pair i. Solving the system composed by (17) and its counterpart for j, we obtain the sub-game perfect equilibrium wages, $w_i=w_j=w*^{EB}$:

$$w_i = w_j = w*^{EB} = \frac{b}{3} \tag{18}$$

By substituting (18) in (16) we obtain output and price:

$$q_i = q_j = q* = \frac{1}{3} \tag{19}$$

$$p_1 = p_2 = p*^{EB} = \frac{1}{3} \tag{20}$$

Finally by substituting eqs. (18) and (19) in $\Pi_i = (1 - w_i - Q)q_i$ we obtain profits:

$$\Pi_i = \Pi_j = \Pi*^{EB} = \frac{1-b}{9} \tag{21}$$

By using eqs. (18) and (19), the equilibrium union's utility is given by:

$$V_i = V_j = V*^{EB} = \frac{b}{9} \tag{22}$$

2.3. Monopoly Union institution

At the first stage of the game, a decentralised union unilaterally chooses the wage, according to the following utility function (9), so obtaining the sub-game perfect best-reply function in wages of union–firm pair i

$$w_i(w_j) = \frac{1 + w_j}{4} \tag{23}$$

and then the sub-game perfect equilibrium wages, $w_i = w_j = w*^{MU}$:

$$w_i = w_j = w*^{MU} = \frac{1}{3} \tag{24}$$

By substituting (24) in (6) we obtain output and price:

$$q_i = q_j = q*^{MU} = \frac{2}{9} \tag{25}$$

$$p_1 = p_2 = p*^{MU} = \frac{5}{9} \tag{26}$$

Finally by substituting both eq. (24) and eq. (25) in $\Pi_i = (1 - w_i - Q)q_i$ we obtain equilibrium profits: $\Pi_1 = \Pi_2 = \Pi*^{MU} = \frac{4}{81}$ (27)

By using eqs. (24) and (25), the equilibrium union's utility is given by:

$$V_i = V_j = V*^{MU} = \frac{2}{27} \tag{28}$$

3. Firms and unions: Efficient Bargaining or Right-to-Manage?

In this section we compare two institutions – Efficient Bargaining and Right-to-Manage - under the usual assumption of identical union power in both institutions. We show that there is never agreement between firms and unions as regards the scope of bargaining.

First, we compare both profits and union's utility in the case of RTM institution with the case of EB institution at *exogenously given* situations of equilibrium. Therefore the following results hold:

Result 1. *Firms always prefer the right-to-manage institution.*

Proof: From (12) and (21) we derive the difference between profits in both cases: $\Pi*^{EB} - \Pi*^{RTM} = \frac{b(-b^2 + 5b - 8)}{9(4 - b)^2} < 0$, which shows that profits are always higher under the right-to-manage institution.

Result 2. *Unions always prefer the efficient bargaining institution.*

Proof: From (13) and (22) we derive the difference between union's welfares in both cases: $V*^{EB} - V*^{RTM} = \frac{b(b^2 - 2b + 4)}{9(4 - b)^2} > 0$, which shows that union's welfare is always higher under the efficient bargaining institution. Therefore an agreement between parties on the scope of bargaining is always prevented. In this section we have compared two exogenously given equilibrium situations for the two different institutions. However, it must be noted that the result (i.e. no agreement between parties on the scope of bargaining) is also robust to the *endogenous* determination of the scope of bargaining, as shown in Appendix. Therefore any agreement either on the EB or the RTM scope of bargaining is prevented in the case of exogenously given arrangements as well as in endogenously emerged arrangements.

These results lead to the following question: if under the two labour market institutions - EB and RTM - in which the union's bargaining power is the same in both institution, an agreement between firms and unions as regards the scope of bargaining is not possible, may be such an agreement possible when the alternatives in the bargaining agenda are MU (i.e. full union's power) and EB (i.e. partial union's power)? The answer is yes, as shown in the next section.

4. Which labour market institution: monopolistic unions or an efficient bargaining?

Armed with the exogenously given equilibrium outcomes under both labour market arrangements (Eqs. 21,22 and 27, 28), we are in position to answer the basic question tackled in this paper: may both firms and unions find more convenient the same labour market institution when the

alternative arrangements are MU and EB? Therefore the following proposition holds:

Result 3. *i) For a unions' bargaining power less, equal or slightly higher than that of firms (0<b<0.55), the latter prefer efficient bargaining; (ii) for a unions' bargaining power relatively high (i.e. b higher than two-third), unions prefer efficient bargaining; iii) for a medium-high unions' bargaining power (i.e. 0.555<b<2/3), firms and unions agree on the monopoly union institution.*

Proof: It straightforwardly follows by the study of the following inequalities:

$$\Pi^{*EB} = \left(\frac{1-b}{9}\right) \underset{<}{\overset{>}{=}} \Pi^{*MU} = \left(\frac{4}{81}\right) \Leftrightarrow b \underset{>}{\overset{<}{=}} 0.55\bar{5}; \quad V^{*EB} = \left(\frac{b}{9}\right) \underset{<}{\overset{>}{=}} V^{*MU} = \left(\frac{2}{27}\right) \Leftrightarrow b \underset{<}{\overset{>}{=}} 0.66\bar{6};$$

Q.E.D.

Fig. 1 illustrates the preceding Result 3. For values of *b <0.555* firms would prefer EB an efficient bargaining (because their profits under EB are larger than those under MU, while unions would prefer to be monopolist (because their utility under EB is below that under MU). When *b >0.555* firms would prefer MU (because their profits under MU are larger than those under EB), while unions continue to prefer to be monopolist (because their utility under EB is still below that under MU). Therefore both parties prefer a relationship union-firm in which unions are wage-makers and firms decide on employment (output). However this agreement on MU holds only until *b ≤ 2/3*, because while firms always continue to prefer MU for further increases in the unions' power (because their profits under EB are more and more lower with increasing *b*), unions would prefer to switch to EB when their power's parameter becomes larger than *2/3* (because beyond such a value their utility under BE surmounts that under MU and the difference is always increasing with further increases of *b*).
Therefore, for values of *b* either higher than *2/3* or lower than *0.55* unions and firms are again diametrically opposed to each other as regards the choice of type of labour market institution.
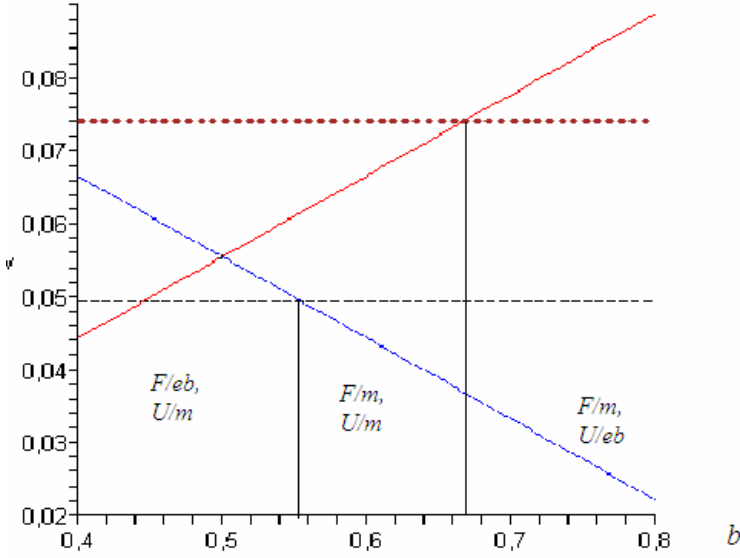
Fig. 1. *Plot of: profits under EB (dashed-dotted blue line), profits under MU (dashed grey line), union's utility under EB (solid red line) and union's utility under MU (dotted brown line) for varying b (zoomed in the interval (0.4-0.8)).*
Legend: F/eb (U/eb), F/m (U/m) denote that firms (F) (unions, U) prefer either efficient bargaining (eb) or monopoly union (m), respectively.

Since the above Result 3 might not be "robust" to an endogenous determination of the equilibrium outcomes (i.e. a subgame perfect Nash equilibrium (SPNE)), then now we extend the previous investigation by endogeneizing the equilibrium choice of the bargaining agenda by firms and unions. Thus we will show that, on the one hand, the agreement on MU for $0.55<b<2/3$ does no longer emerge as a SPNE, but, on the other hand, an agreement on EB appears as a SPNE for a noticeable range of values of b.

Let firm/union pair 1 choose to negotiate simultaneously over both wages and employment at stage two and firm/union pair 2 choose the RTM arrangement giving firm the power to fix output (for a given wage) at stage two and giving union the power of fixing wages at the first stage of the game. This means that the union of the firm 2 becomes Stackelberg leader with respect to the firm/union pair 1 in the subgame of wage determination. Recalling that the MU case collapses into the RTM case when $b=1$ and thus following the procedure shown in Appendix (for the case RTM), it is easy to derive the following equilibrium outcomes:

$$w_2 = \frac{1}{4} \qquad\qquad (29)$$

13

and thus[12]

$$w_1 = \frac{5b}{12} \tag{30}$$

$$q_1 = \frac{5}{12} \tag{31}$$

$$q_2 = \frac{1}{6} \tag{32}$$

$$\Pi_1 *^{EB/MU} = \frac{25(1-b)}{144} \tag{33}$$

$$\Pi_2 *^{MU/EB} = \frac{1}{36} \tag{34}$$

$$V_1 *^{EB/MU} = \frac{25b}{144} \tag{35}$$

$$V_2 *^{MU/EB} = \frac{1}{24} \tag{36}$$

By using Eqs. 12, 27, 33 and 34, it is easy to see that the following inequalities hold:

$$\Pi_1 *^{MU/EB} - \Pi_2 *^{EB/MU} \gtrless 0 \Leftrightarrow b \gtrless 0.84; \quad \Pi_1 *^{MU/EB} - \Pi *^{EB/EB} \gtrless 0 \Leftrightarrow b \gtrless 0.75;$$

$$\Pi_2 *^{EB/MU} - \Pi *^{MU/MU} \gtrless 0 \Leftrightarrow b \lessgtr 0.71555$$

and recalling the part i) of Result 3, the following Lemma 1 holds:

Lemma 1- *The unique sub-game perfect Nash equilibrium for firms is MU for 1>b>0.75 and EB for 0.71555>b>0, while for 0.75≥b≥0.71555 there are two SPNE (i.e. MU and EB).*

In a similar way, by using Eqs. 13 and 28, 35 and 36, it can be easily shown that:

$$V^{EB/EB} - V^{MU/MU} \gtrless 0 \Leftrightarrow b \gtrless 0.666; \quad V_1^{MU/EB} - V^{EB/EB} \gtrless 0 \Leftrightarrow b \lessgtr 0.375;$$

$$V_2^{EB/MU} - V^{MU/MU} \gtrless 0 \Leftrightarrow b \gtrless 0.42666$$

and recalling part ii) of Result 3, the following Lemma 2 holds:

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[12] The apex – e.g. EB/MU – denotes the choice of the type of bargaining arrangement by firms *i* and *j*, respectively.

Lemma 2- *The EB (MU) institution is the sub-game perfect Nash equilibrium for unions for 1>b>0.42666 (for b<0.375), while for 0.42666≥b≥0.375 there are two SPNE (i.e. MU and EB).*

From Lemmas 1 and 2, it follows that:

Result 4. *Firms and unions agree only with the EB arrangement as the scope of bargaining, when 0.7155> b>0.42666.*[13]

Result 4 stressed that under the endogenous determination of the subgame perfect equilibrium an agreement on the bargaining agenda (i.e. on EB) may occur between union and firm for a wide range of values of *b* [14] and the choice of EB is also socially efficient, as shown in the following section.

5. Welfare analysis

In this section we perform a welfare analysis and we compare the equilibrium results between the two cases (MU and EB), also considering those of the benchmark model without unions.

5.1. Consumer's welfare

In equilibrium consumer's surplus $(CS = \frac{(q_1*+q_2*)^2}{2})$ is in the MU and EB cases, respectively:

$$CS*^{MU} = \frac{8}{81} \qquad\qquad (30)$$

$$CS*^{EB} = \frac{2}{9} \qquad\qquad (31)$$

5.2. Social welfare

Social welfare (SW) is defined as $SW* = CS*+2\Pi*+2V*$, and in equilibrium in the MU and EB cases is given by, respectively:

$$SW*^{MU} = \frac{28}{81} \qquad\qquad (32)$$

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[13] Moreover, note that since EB is also one of the two SPNE equilibria i) for firms when *0.75>b>0.71555*, and ii) for unions when *0.4266>b>0.37*, then, if the coordination between parties leads to choose EB as the endogenous equilibrium for both firms and unions, the range for which the agreement on the EB arrangement holds could be, in principle, extended to *0.75>b>0.37*.

[14] Note that Result 4 predicts an agreement on EB when, for example, the power of unions is close to 0.70 when they bargain also on employment and close to one when they bargain only on wages, which may be, at the light of the reasons discussed in the Introduction and in footnote 4, also rather realistic.

$$SW *^{EB} = \frac{4}{9} \qquad\qquad (33)$$

Therefore, by comparing the equilibrium outcomes of the duopoly model in the various cases (i.e. those in the benchmark case with "competitive" labour market and those emerged in the present model), reported in Table 1 below, the following result is derived:

Result 5. *While with MU output is reduced, price is increased and both consumer surplus and social welfare are reduced, with EB output, price, consumer surplus and social welfare are equal to those of the benchmark model with "competitive" labour market. In this sense with EB the "efficiency" is restored.*

Table 1. *A comparison of the equilibrium outcomes of the duopoly model under EB, MU and without unions.*

Equilibrium outcomes	EB	MU	Duopoly without unions
q^*	1/3	2/9	1/3
p^*	1/3	5/9	1/3
w^*	b/3	1/3	0
Π^*	(1-b)/9	4/81	1/9
V^*	b/9	2/27	0
CS^*	2/9	8/81	2/9
SW^*	4/9	28/81	4/9

In this partial equilibrium framework, we are also able to clarify the impact of union power on the "efficiency" properties of wage and employment outcomes in unionized labour markets. If we measure the relative efficiency of institutional arrangements in terms of their industry output, consumer surplus and societal welfare, then MU is clearly less "efficient" than EB. However the most important comparison is with the benchmark situation in which labour markets are "competitive" (i.e. without unionisation). As displayed in Table 1 when unions efficiently bargains with EB the "efficiency" of the benchmark model is restored:

when the union power increases only wages are increased, while employment (output) remains the same of the case in which the labour market is competitive.

Therefore, from the point of view of "efficiency" the results emerged by the present analysis (i.e. Result 3 and 4) show that: i) in the case of the comparison between the exogenous situations of equilibrium both parties would prefer the "inefficient" monopoly union institution (when the value of the union's power is relatively "medium-high"); ii) by contrast, in the endogenous game-theoretic approach, the "efficient" agreement on the scope of bargaining would emerge as a SPNE equilibrium for a wide range of the value of the union's power.

6. Conclusions

The agreement on the scope of bargaining between firms and unions is a relevant issue but so far only sporadically explored. Therefore in this paper we have investigated in the frame of a unionised Cournot duopoly the effects of the different labour market institutions (i.e. RTM, MU and EB) with respect to market and welfare outcomes, with the aim to evidence whether and how an agreement between firms and unions on a institution may emerge.

First, the comparison between the EB and RTM arrangements – where the union's power is uniform in both cases - has revealed that the interest of both parties with respect to the scope of bargaining is always conflicting and thus no agreement on the choice of one of these institutions may occur. Subsequently, motivated by *i)* the popularity of the MU and EB models as typical institutions in the labour market, *ii)* the possibility that unions' power is higher when they bargain on wages than on employment, *iii)* the conjecture that, when the alternatives on the bargaining agenda are EB and MU, an agreement on the scope of bargaining may emerge, the alternatives EB and MU on the bargaining agenda have been investigated.

Our results have shown that when exogenously given MU and EB arrangements are compared, only the MU institution may be preferred by both parties, in particular when the value of the union's power is included in a "medium-high" range.[15] However this result is not robust to the endogeneization of the scope of bargaining: indeed in the latter case both

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[15] This is a rather interesting result because it implies that firms prefer to leave unions monopolistically set wages rather than to bargain with them on both wages and employment even when the union's power in the efficient bargaining is not too high.

firms and unions agree with the choice of the EB arrangement for a noticeably wide range of the union's power. Therefore the detection of a set of union bargaining power values for which there exists an agreement between firms and unions - either on the MU institution in the case of exogenously given arrangements or on the EB institution in the case of endogenously determined arrangement - may be interesting also for policy purposes.

To the extent that an agreement on the scope of bargaining is important even if less profitable than a unilateral choice and/or the union's power is larger when the bargaining is on wages rather than on employment, our results challenge a conventional wisdom and suggest that MU and mainly EB institutions may deserve more attention than it is currently the case. In particular, the endogenously determined agreement on EB is an interesting finding because this institution is "efficient".

Needless to say, our model is simple. However, it is based on the standard industrial organization literature approach. The results obtained in a simple duopoly framework can enhance our understanding of basic labour market institutions.

In order to test the robustness of these results, other real-world features, for instance, on the one side, different union's objectives such as the rent-maximising one or different union's preferences for wages and employment, and on the other side industries with differentiated products and price competition should also be considered. We believe that those are subjects for future research.

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Appendix.

In this section, we show that - irrespective of the unions' bargaining power - the endogenous choice of the scope of bargaining by firms is the bargain about wages alone (i.e. RTM). By contrast, the endogenous choice by unions is the negotiation over both wages and employment (i.e. EB).

Let firm/union pair 1 choose to negotiate over both wages and employment and firm/union pair 2 choose to bargain over wages alone.

Firm/union bargaining unit 1 chooses w and q to maximize the following generalised Nash product,

$$\max_{\substack{w.r.t. \ w_1,q_1}} N_1 = (\Pi_1)^{1-b}(V_1)^b = [(1 - w_1 - Q)q_1]^{1-b}(w_1 q_1)^b \qquad (A1),$$

taking as given the negotiated wage w_2, and firm 2's output.
Solving for w_1 and q_1 as functions of w_2, we get:

$$q_1(q_2, w_1) = \frac{1}{2 - b}[1 - w_1 - q_2], \qquad (A2)$$

$$w_1(q_1, q_2) = [b(1 - q_1 - q_2)] \qquad (A3)$$

Note that $dw_1/dw_2 > 0$, i.e., w_1 is a strategic complement to w_2: an increase in the negotiated wage of firm/union 2 makes more profitable an increase in the negotiated wage for firm/union bargaining unit 1.
On the other hand firm 2 chooses the output maximising its profit function, for given q_1, w_1, w_2, yielding the standard reaction Cournot output function

$$q_2(q_1) = \frac{1}{2}[1 - w_2 - q_1]. \qquad (A.4)$$

Solving the system of linear equations Eqs. A.2-A.4, we obtain a unique solution

$$q_1(w_1, w_2) = \frac{1 + w_2 - 2w_1}{3 - 2b} \qquad (A.5)$$

$$q_2(w_1, w_2) = \frac{-2w_2 - b(1 - w_2) + 1 + w_1}{3 - 2b} \qquad (A.6)$$

$$w_1(w_2) = \frac{b(1 + w_2)}{3} \qquad (A.7)$$

Then, firm/union bargaining unit 2 chooses w to maximize the following generalized Nash product,

$$\max_{\substack{w.r.t. \ w_2}} N_2 = (\Pi_2)^{1-b}(V_2)^b = [(1 - w_2 - Q)q_2]^{1-b}(w_2 q_2)^b \qquad (A.8),$$

taking as given the solutions of the previous stage w_1, q_1, and q_2.
As firm/union 2 pair conducts right-to-manage bargaining, while firm/union 1 pair conducts bargaining simultaneously over wage and employment, the firm /union 2 pair becomes a Stackelberg leader in the wage determination game.[16] This leads to the following choice of w_2:

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[16] Alternatively, it can be assumed, as in Petrakis and Vlassis (2000) and Kraft (2006), that when firm/union 2 conducts right-to-manage bargaining, while firm/union 1 conducts wage-employment bargaining, firm 2 becomes a Stackelberg follower in the

$$w_2 = \frac{b}{4} \tag{A.9}$$

and thus
$$w_1 = \frac{b(4+b)}{12} \tag{A.10}$$

$$q_1 = \frac{4+b}{12} \tag{A.11}$$

$$q_2 = \frac{2-b}{6} \tag{A.12}$$

$$\Pi_1^{EB/RTM} = \frac{(4+b)(b^2+3b-4)}{144} \tag{A.13}$$

$$\Pi_2^{RTM/EB} = \frac{(2-b)^2}{36} \tag{A.14}$$

$$V_1^{EB/RTM} = \frac{b(b+4)^2}{144} \tag{A.15}$$

$$V_2^{RTM/EB} = \frac{b(2-b)}{24} \tag{A.16}$$

By using Eqs. 12, 21, A.13 and A.14 it is easy to see that the following inequalities hold:

$$\Pi_1^{RTM/EB} - \Pi_2^{EB/EB} > 0; \quad \Pi_1^{EB/RTM} - \Pi_2^{RTM/RTM} < 0$$

$$\Pi_1^{RTM/EB} - \Pi_2^{EB/RTM} \gtrless 0 \Leftrightarrow b \gtrless 0.685$$

and recalling Result 1, the following Result holds:

Result A.1- *The RTM institution is the sub-game perfect Nash equilibrium for firms.*

In a similar way, by using Eqs. 13, 22, A.15 and A.16 and recalling Result 2, it can be easily shown that:

Result A.2- *The EB institution is the sub-game perfect Nash equilibrium for unions.*

From both Result A.1.and A.2 it emerges that also under the endogenous determination of the subgame perfect equilibrium no agreement on the bargaining agenda may occur between union and firm.

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product market. This case is investigated by Fanti (2014), who shows that - differently from the present appendix - multiple Nash equilibria may emerge.