A GAME-THEORETIC APPROACH TO THE CHOICE OF UNION-OLIGOPOLY BARGAINING AGENDA

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ABSTRACT

This paper investigates the selection of the bargaining agenda in a unionized industry with decentralized negotiations for different competition modes. The firms choose the agenda (right-to-manage, RTM, *versus* efficient bargaining, EB), considering alternative timing of the bargaining game in the case of mixed duopoly. In fact, the EB (RTM) firm can be either Stackelberg wage follower (leader) or Stackelberg output leader (follower). A two-stage game is developed in which the typology as well as the timing of the negotiations is endogenous. It is shown that, in pure strategies, no equilibria arise for a wide set of the parameters' space while RTM appears as the unique equilibrium agenda for a different combination of the parameters; moreover, multiple, asymmetric equilibria emerge in a limited area of the parameters' space. These results are in sharp contrast to the received literature in which EB can arise as an industry bargaining institution in equilibrium.

Key words: Efficient bargaining, right-to-manage, union-oligopoly bargaining agenda.
JEL Classification: J50, J51, L20.

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UN ENFOQUE DE TEORÍA DE JUEGOS PARA LA SELECCIÓN DE LA AGENDA DE NEGOCIACIÓN DEL OLIGOPOLIO SINDICAL

RESUMEN

Este artículo investiga la selección de la agenda de negociación en una industria sindicalizada con negociaciones descentralizadas para diferentes modos de competencia. Las empresas eligen la agenda (negociación con derecho de administrar, NDA, frente a negociación eficiente, NE) considerando casos alternativos de la sucesión de eventos en el juego de negociación con duopolio mixto. De hecho, la empresa NE (NDA) puede ser seguidora de salarios Stackelberg (líder) o líder de cantidades Stackelberg (seguidora). Se desarrolla un juego de dos etapas en el que la tipología y el momento de las negociaciones son endógenos. Se muestra que en estrategias puras no surgen equilibrios para un amplio conjunto del espacio de los parámetros, mientras que NDA aparece como la agenda de equilibrio única para una combinación diferente de los parámetros; además, los equilibrios múltiples y asimétricos emergen en un área limitada del espacio de los parámetros. Estos resultados contrastan con la literatura existente, en la que NE puede surgir como una institución de negociación de la industria en equilibrio.
Palabras clave: negociación eficiente, negociación con derecho de administrar, agenda de negociación del oligopolio sindical.
Clasificación JEL: J50, J51, L20.

1. INTRODUCTION

Empirical and anecdotal evidence supports the idea that unionization and imperfectly competitive markets go hand in hand. As Booth (1995) recognizes, "it appears to be an empirical regularity that imperfections in the labor market are correlated with imperfections in the product market". Moreover, the presence of unionized labor markets, the related bargaining institutions, as well as the degree of competition play a vital role in determining the organizational shape of an industry. These subjects are relevant for economists, policymakers and antitrust authorities, in particular for the proper design and implementation of labor, industrial and regulatory policies.

In this framework, the issue of the union(s)-firm(s) bargaining scope is notably relevant. The most commonly detected bargaining models in the real world are, on the one hand, the right-to-manage (RTM) model (*e.g.* Nickell and Andrews, 1983) in which unionized labor and firms negotiate only wages; and, on the other hand, the efficient bargaining (EB) model (*e.g.* McDonald and Solow, 1981) in which the firms and unions bargain simultaneously over wages and employment levels.

The analysis of the more profitable bargaining agenda in unionized industries has been first analyzed by Dowrick (1990). As reported in the International Handbook of Trade Unions, that author finds "that profits under the right-to-manage (RTM) model exceed those under efficient bargaining (EB)" (Naylor, 2003, p. 59). Moreover, this result with regard to the RTM agenda is valid irrespective of whether simultaneous or sequential EB (SEB) are considered: "under unionised monopoly, the firm will prefer to keep employment off the bargaining agenda, whatever the degree of union influence over employment. In other words, the right-to-manage outcome generates higher profits than either the efficient or sequential bargains, for a given level of union influence over the wage" (Naylor, 2003, p. 61).

At the current stage, these findings represent the benchmark of the literature on the negotiation agenda between firms and unions at decentralized level.[1] However, it should be noted that those results can sharply change once a more robust analysis conducted in terms of a "game-theoretic approach" is applied. For instance, using this "game-theoretic approach", Fanti and Buccella (2017) have extended the analysis of the Handbook as regards the choice of the agenda introducing the SEB model (Manning, 1987a, 1987b). Nonetheless, those authors have restricted the study 1) to the case of quantity competition and 2) without considering a game on the timing of the negotiations.

The question is not whether RTM or EB are more profitable for firms when exogenously compared between them (as made by most of the

[1] The choice of the analysis at decentralized level is dictated by the fact that, in latest decades, a continuous move towards decentralized forms has characterized the features of collective bargaining in the European Union and other Organisation for Economic Co-operation and Development (OECD) countries, with the company level becoming predominant *vis-à-vis* the sector and cross-industry level (see *e.g.* OECD, 2004; European Commission, 2015).

established literature) as much as whether the strategic interaction between firms leads to a robust equilibrium in a "game-theoretic" sense. This paper contributes to shed lights on this issue as regards the bargaining agenda, being the first paper to look at the possibility that the timing of the agenda's moves influences the occurrence (if any) of an equilibrium agenda.

In fact, the received economic literature has not dealt with the natural possibility that, in the presence of the mixed case in which one firm selects EB and the other RTM, the EB arrangement leads also the timing of the negotiations to be a decisional variable at the discretion of firms. More precisely, the EB firm in the mixed case can be either Stackelberg wage follower or Stackelberg output leader. To date, the timing of the game of a EB firm against a rival RTM has been always assumed as exogenously given. If the timing of the game is endogenous, the game passes from a 2×2 (two choice variables for each player) to a 3×3 structure of the payoff matrix (three choice variables for each player). Therefore, making use of this correct game-theoretic approach in the presence of a conjectural variation (CV) model[2], the current paper studies how the interaction between alternative bargaining arrangements and the different degrees of market competition affect the firms' endogenous preferences over the negotiation agenda in a duopoly industry. Thus, the work aims to answer the following research question. If firms can strategically select the bargaining scope[3], what is the effect of a not univocal specification of the game rules in the case of EB on the endogenous selection of the agenda?

[2] Up to the current stage, the received literature has mainly analyzed the issue of the bargaining agenda either considering the Cournot or the Bertrand competition mode in the product market. Despite the theoretical shortcomings (*e.g.*, Varian, 1992), this paper proposes the CV model because it is extremely versatile as a simple tool that allows to analyze different market structures, ranging from Bertrand competition to collusion, therefore leading to general results.

[3] Theoretically, the choice of the union-firm bargaining agenda can be modeled in several ways. First, the bargaining agenda itself can be subject of negotiations between the firm and the union. Second, the selection of the bargaining agenda is the result of an endogenous (and simultaneous) agreement among the parties (see *e.g.* Fanti and Buccella, 2017). Third, the endogenous agreement with regard to the bargaining agenda can be reached whenever the firms (Petrakis and Vlassis, 2000) or both the firm and the union would raise no veto against the pair's unilateral switch from one negotiation agenda to another (Vlassis and Mamakis, 2016). However, this paper postulates the European institutional

The change from a 2×2 to a 3×3 structure with the endogenous choice of the timing strongly modifies the solutions of the game. New and, somehow, disquieting results emerge. In fact, a first striking result is that, for a large set of the parameters' space (union bargaining power and conjectural parameter), no equilibria arise in pure strategies. On the other hand, RTM emerges as the unique equilibrium agenda first in the presence of high competition and lower unions' bargaining power and then, as the unions' strength increases, for a wider range of the conjectural parameter. Moreover, multiple, asymmetric equilibria emerge in a small area of the parameters' space characterized by concurrent collusive firms' behavior and significantly high bargaining power. Finally, in contrast to the received literature, the EB agenda disappears as sub-game perfect equilibrium. Of course, the presence of a wide area in which no agenda emerges in equilibrium under pure strategies may call for the investigation of mixed strategies. However, given that the focus of this paper is on the existence of a "rational" choice of the agenda in a deterministic context, it is beyond the scope of the present work.

The fact that, in the real-world industries, different agendas and timings are often present without a precise motivation supporting such choices may be coherent with our finding of the non-existence of a "rational" choice in a deterministic context for an ample parametric set. Furthermore, our finding may have a testable implication: for instance, in industries characterized by a competition according to the Cournot conjecture (*i.e.* in our model, a value of the CV parameter about zero) if unions are relatively "weak" it should be more often detected a multiplicity of agendas, while if unions are relatively "strong" (for instance, it suffices a near-parity in the bargaining power) it should be more often detected the presence of the RTM agenda. Thus, these findings seem to suggest that authorities and policymakers need to intervene in labor market regula-

framework in which, despite the fact that collective bargaining is defined as a voluntary process that has to be carried out freely, it is empirically, and recently relevant, observed that the scope and application of collective agreements show a common convergence trend towards flexibility, providing the option for companies to opt out from collective agreements signed at a higher level (Eurofound, 2015). In other words, it is the firm that mainly proposes the scope of negotiations.

tions to fix the specification of the timing in negotiations to guarantee the existence of a "common bargaining practice" in the industry.

The paper contributes to a line of research in the literature dealing with the analysis of the bargaining scope and selection of union-oligopoly negotiation agendas, and represented by Dobson (1997), Bughin (1999), Petrakis and Vlassis (2000), Vannini and Bughin (2000), Kraft (2006), Buccella (2011) and, more recently, Fanti (2014, 2015), Buccella and Fanti (2015) and Fanti and Buccella (2018).

The rest of the paper is organized as follows. Section 2 reviews the related literature. Section 3 develops the model and derives the results. Section 4 closes with a brief discussion.

2. LITERATURE REVIEW

Petrakis and Vlassis (2000) focus on the possibility of an agreement between firms and unions on the bargaining agenda. The rules of the game are peculiar. At stage 1 each firm/union unit simultaneously decides on the bargaining agenda which can be: 1) EB, if there is a consensus by the firm and its union, or 2) RTM, if the firm poses a veto on the inclusion of employment in the agenda. At stage 2, the EB firm implements its employment level while the RTM firm chooses its employment taking into account the rival's choices. Given these hypotheses, the main results are that universal (all firms adopting) EB can never arise as the industry bargaining practice in pure strategy equilibrium; on the other hand, either RTM is universally selected only if the unions' bargaining power is adequately large, or a mixed duopoly equilibrium (one firm selects RTM, the rival EB) if their power is sufficiently low. In the same vein, Kraft (2006) assumes that the EB firm is Stackelberg wage follower. However, in contrast to Petrakis and Vlassis (2000), that author draws the conclusion that EB is the dominant strategy for firms but firms are cast into a "prisoner's dilemma" situation concerning profits.

Under the assumption that the EB firm in the mixed case is Stackelberg wage follower, Bughin (1999) considers the issue of the strategic selection of the bargaining agenda first in a given duopoly, and then in a monopoly with the threat of entry. Using a CV model, Buccella (2011) revisits Bughin's (1999) and derives the following sub-game perfect Nash equilibria (SPNE) agendas: No matter the degree of competitiveness of the industry, the RTM model is the SPNE 1) in a given duopoly with committed bargaining; and 2) in a given duopoly with flexible bargaining, also in presence of potential entry. Likewise, Fanti (2014) investigates this subject in a duopoly and remarks that the previous results crucially depend on the hypothesis that, in the mixed case of duopoly, the EB firm is Stackelberg wage follower: in the first stage, the RTM firm and its union negotiate the wage; then, in the second stage, the RTM firm selects employment, and the EB firm simultaneously bargains with its union wage and employment levels.

In a Cournot duopoly framework, Vannini and Bughin (2000) focus on the firms' decision whether to adopt a cost-raising strategy via the recognition of labor unions. Those authors show that unionization can generate vertical interdependence between the labor and the product markets, that firms can strategically exploit to raise profits. Nonetheless, the firms' profitability is crucially altered by the institutional features of the bargaining process, *e.g.* the structure and the scope. In particular, Vannini and Bughin (2000) show that, under precise conditions (low union power, low product differentiation, centralized bargaining, EB firm Stackelberg wage follower), firms can prefer EB rather than RTM negotiations, although they have to pay higher wages.

However, as Buccella (2011) points up, and Fanti (2015), Buccella and Fanti (2015), and Fanti and Buccella (2017) study, it is possible to specify an alternative timing for the game in which the EB is Stackelberg output leader: in the first stage, the EB firm and its union concurrently bargain wage and employment levels while the RTM firm and the respective union negotiate the wage; in the second stage, the RTM firm selects its employment level. This modification is not innocuous because different equilibria arise: the set of cases in which the equilibrium implies the selection of EB considerably increases. Thus, the equilibrium bargaining agenda in the industry is sensitive both to the scope and how negotiations are conducted, *i.e.* the rules and timeline of the game.

The analysis of the bargaining agenda is currently subject of renewed interest. Recent extensions have been devoted to the selection of the negotiation agenda in network industries (Fanti and Buccella, 2016a), in a context of international trade with strategic trade policy (Bandyopadhyay and Bandyopadhyay, 2001; Fanti and Buccella, 2016b), and in the presence of different union preferences toward wages (Fanti and

Buccella, 2018). Nonetheless, all those contributions have abstracted from the game-theoretically founded choice of the timing of the bargaining model.

3. THE MODEL AND THE RESULTS

All the works described in the previous section consider 2×2 games in which firms can select RTM *vis-à-vis* EB, and in the case of mixed duopoly, the EB firm can be either Stackelberg wage follower or Stackelberg output leader. This paper makes a step further: it builds a 3×3 game with a CV model in which firms can negotiate under RTM or EB, and in the case of mixed duopoly, the EB firm can choose to be either Stackelberg wage follower or Stackelberg output leader, therefore making endogenous the choice of the timing.

Consider a duopoly market where firms 1 and 2 compete for homogeneous goods with labor the unique factor of production. A constant returns-to-scale technology characterizes the industry, so that one unit of labor (l) is needed for one unit of output (q). The linear (inverse) market demand is:

$$p = 1 - Q \tag{1}$$

where p denotes the price and $Q = \sum_i q_i = \sum_i l_i,\ i = 1,2$, is the total production. Firm's profits are:

$$\Pi_1 = (1 - Q - w_1)l_1 \tag{2}$$

$$\Pi_2 = (1 - Q - w_2)l_2 \tag{3}$$

for firm 1 and 2, respectively. The model assumes that the firms decide their production levels according to a CV model (see De Fraja, 1993). Thus, define $\phi \in (-1,1)$ as $\phi = \mathrm{d}q_j(q_i)/\mathrm{d}q_i$: if $\phi = 0$, the model collapses in the Cournot model; for $\phi > 0$, the firms act in a more collusive way, whereas for $\phi < 0$ the industry is more competitive. Both firms are unionized. Unions maximize the following objective function:

$$\Omega_i = w_i l_i \tag{4}$$

The bargaining structure in the industry is decentralized at the firm level. The bargaining solution is modelled by the following generalized Nash product:

$$NP = (\Omega_i)^{\alpha}(\Pi_i)^{1-\alpha} \qquad [5]$$

where the parameter $\alpha \in (0,1)$ measures the parties' relative strength, assumed identical across bargaining units. The game is solved by backward induction to derive the sub-game perfect Nash equilibria. The sequence of moves is the following. Each firm selects its bargaining agenda, EB or RTM. The wage and employment levels are simultaneously negotiated in the case of EB; or wages are negotiated before the output decisions in the case of RTM. When both firms select EB, it emerges a situation where one firm acts as the leader while the rival acts as the follower. With respect to the duopoly mixed case (firm i chooses EB, the rival j selects RTM), the timing of the game can be as follows:

- Mixed case 1 (EB1) (Bughin, 1999; Buccella, 2011; Fanti, 2014). Stage 1: Firm j and union j bargain over the wage. Stage 2: Firm j chooses employment and firm i and union i bargain over wage and employment. With this timing, firm i and union i, when bargaining over wage and employment, can observe the wage that resulted from bargaining between firm j and union j. In this case, firm i acts as Stackelberg wage follower: $i, j = 1, 2, i \neq j$.
- Mixed case 2 (EB2) (Fanti, 2015; Buccella and Fanti, 2015). Stage 1: Firm i and union i bargain over wage and employment while firm j and union j bargain over the wage. Stage 2: Firm j chooses employment. With this timing, firm j when chooses output can observe the wage and employment that resulted from bargaining between firm i and union i. In this case, firm i is Stackelberg output leader: $i, j = 1, 2, i \neq j$.

In other words, in the mixed case, when a firm chooses RTM, it means that in the first stage it and its corresponding union bargain over wage and in the second stage they bargain over output/employment. In EB1, the wage and employment bargaining in the EB unit takes place in the second period while, in EB2, the bargaining takes place in the first period.

Table 1. Unionized duopoly firms' profits, alternative timing of the game

Firm 2 → Firm 1↓	RTM
RTM	$\frac{(2-\alpha)^2(1+\phi)(2+\phi)^2}{(2\phi+4-\alpha)^2(3+\phi)^2};\frac{(2-\alpha)^2(1+\phi)(2+\phi)^2}{(2\phi+4-\alpha)^2(3+\phi)^2}$
EB1	$\frac{[2(1+\phi)+\alpha][(2+\phi)\alpha^3+(4\phi^2+12\phi+10)\alpha^2+(4\alpha-16)(1+\phi)^2]}{2(2+\phi)(4+\alpha)[4(1+\phi)+\alpha]^2};\frac{(1+\phi)^3(2-\alpha)^2}{(2+\phi)^2[4(1+\phi)+\alpha]^2}$
EB2	$\frac{(1-\alpha)(1+\phi)(2\phi+\alpha+4)^2}{4(3+\phi)^2(2+\phi)^2};\frac{(2-\alpha)^2(1+\phi)}{4(3+\phi)^2}$

Using equations [2]-[4] and solving the Nash Product in equation [5], direct computations (see the Appendix) allow obtaining the expressions in Table 1. With the firms' payoffs in Table 1, it is possible to construct Figure 1 that defines the regions in which the firms' profits have different rankings. The non-negativity condition on profits implies that $\Pi_i \geq 0$.

However, it can be verified that under EB2:

$$\Pi_i^{\text{EB2,RTM}} \geq 0 \Rightarrow \phi^T(\alpha) > \frac{\alpha^3+12\alpha^2+8\alpha-32+\sqrt{\alpha^6-8\alpha^5-32\alpha^4+32\alpha^3+128\alpha^2}}{8(4-\alpha-\alpha^2)}$$

while $\Pi_i^{\text{EB2,RTM}} < 0 \Rightarrow \phi \leq \phi^T(\alpha)$, where the first upper script denotes the agenda selected by firm *i* while the second upper script refers to the rival firm *j*'s choice. If firm 1 selects RTM negotiations, firm 2 best-reply is RTM if $\phi \geq \phi^1(\alpha)$, while it chooses EB1 if $\phi < \phi^1(\alpha)$. On the other hand, if firm 1 plays EB1, firm 2 replies RTM if $\phi \geq \phi^2(\alpha)$ while it chooses EB2 if $\phi < \phi^2(\alpha)$. Finally, if firm 1 chooses EB2, firm 2 unequivocally replies RTM. Given symmetry, an identical reasoning applies for the strategic choices of firm 2. Those firms' strategic moves generate four regions. Figure 2 graphically shows the game equilibria in the (α,ϕ) – *space*.

	EB1	EB2
	$\dfrac{(1+\phi)^3(2-\alpha)^2}{(2+\phi)^2[4(1+\phi)+\alpha]^2};\dfrac{[2(1+\phi)+\alpha][(2+\phi)\alpha^3+(4\phi^2+12\phi+10)\alpha^2+(4\alpha-16)(1+\phi)^2]}{2(2+\phi)(4+\alpha)[4(1+\phi)+\alpha]^2}$	$\dfrac{(2-\alpha)^2(1+\phi)}{4(3+\phi)^2};\dfrac{(1-\alpha)(1+\phi)(2\phi+\alpha+4)^2}{4(3+\phi)^2(2+\phi)^2}$
	$\dfrac{(1-\alpha)(1+\phi)}{(3+\phi)^2};\dfrac{(1-\alpha)(1+\phi)}{(3+\phi)^2}$	$\dfrac{(1-\alpha)(1+\phi)}{4(2+\phi)^2};\dfrac{(1-\alpha)(1+\phi)}{4(2+\phi)}$
	$\dfrac{(1-\alpha)(1+\phi)}{4(2+\phi)};\dfrac{(1-\alpha)(1+\phi)}{4(2+\phi)^2}$	$\dfrac{(1-\alpha)(1+\phi)}{(3+\phi)^2};\dfrac{(1-\alpha)(1+\phi)}{(3+\phi)^2}$

Figure 1. Duopoly profits in the (α, ϕ) – *space*

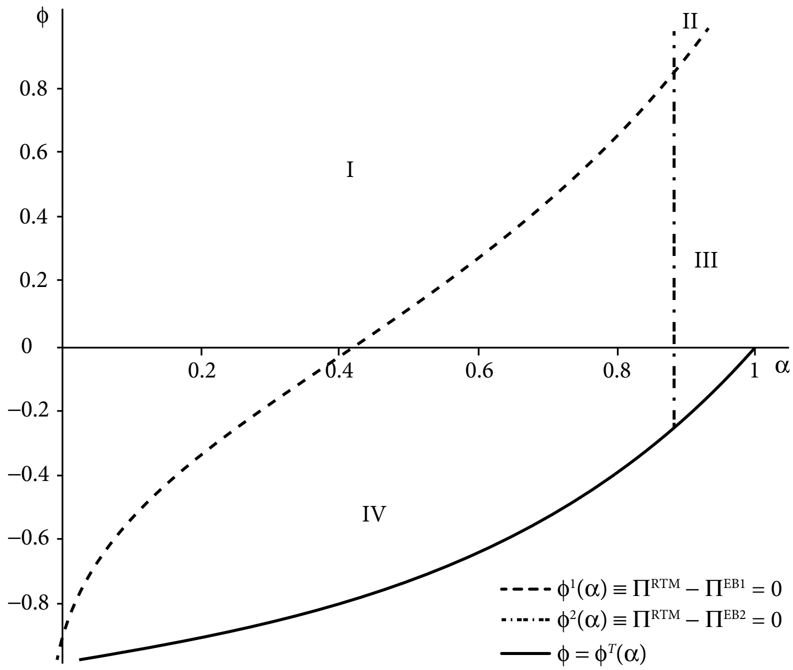
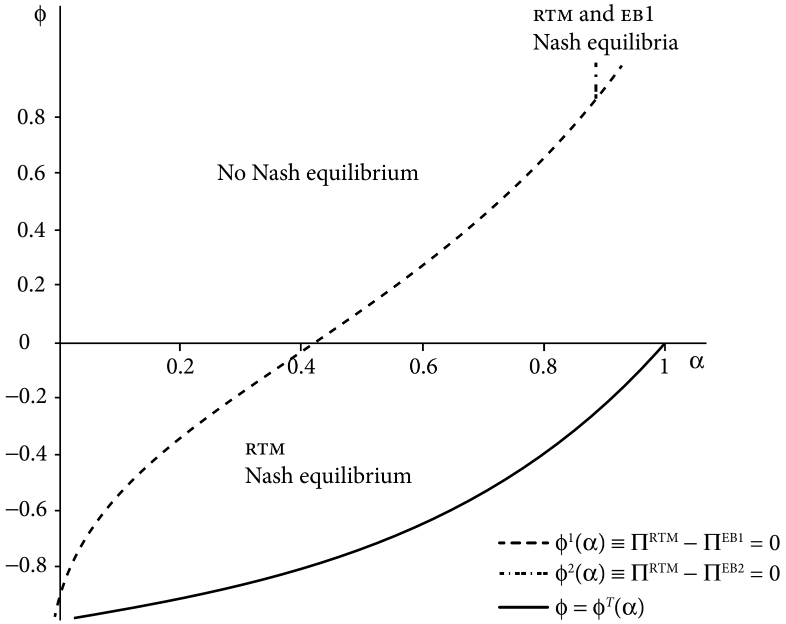


Figure 2. Game equilibria in the (α,ϕ) – *space*



In region I, when firm 1 plays RTM, firm 2 replies EB1. However, when firm 2 plays EB1, in that area the firm 1's best reply is EB2. As a consequence, in region I no Nash Equilibrium arises. In region II, when firm 1 plays RTM, firm 2 again replies EB1. However, in this area, when firm 2 plays EB1, firm 1's best reply is RTM. Thus, multiple asymmetric equilibria emerge. In region III, RTM is the best reply for firms whatever is the strategic choice of the rival: RTM is the dominant strategy. In region IV, RTM is a mutual best response for firms; therefore, RTM is the Nash equilibrium. Proposition 1 summarizes these findings.

Proposition 1. Under the CV model, in a 3×3 game in which firms strategically choose the bargaining agenda (RTM, EB1 and EB2): *a)* in the set $(\phi\in (\alpha = 0) \mid -1 < \phi< 1) \cup \phi\in \phi^1(\alpha) \mid 0 \leq \alpha < \approx 0.883 < \phi \leq \phi\in \phi^2(\alpha) \mid \approx 0.887 \leq \alpha < \approx 0.888$, there are no Nash equilibria; *b)* in the set $\phi\in \phi^2(\alpha) \mid \approx 0.887 \leq \alpha < \approx 0.888 < \phi < \phi\in \phi^1(\alpha) \mid 0.883 \leq \alpha < 1$ multiple asymmetric RTM/EB1 equilibria arise; and *c)* in the parameters' set $\phi^T(\alpha) \leq \phi \leq \phi^1(\alpha)$, RTM is the unique Nash equilibrium of the game.

With regard to region I, the interconnections between the unions' bargaining power, the strategic choice of the negotiations' timing (and, in particular, the strategic wage undercutting under EB1), and the firms' more/less collusive behavior in the market, are extremely complex. Each of those elements has an impact on the negotiated wage and output level, and therefore on market price, firms' total revenues and margins, which affects the selection of the agenda. Whichever the agenda's choice of a bargaining unit, the rival has a strategic incentive to shift towards a different one; however, given the strategic selection of the rival unit, the other unit has an incentive to move to a different agenda from the initial one. On the other hand, with regard to region II, every union has an incentive to deviate towards the RTM agenda, provided that the rival unit bargains under the EB1, and vice versa. Thus, two asymmetric equilibria arise. The rationale for this finding can be explained as follows. For each bargaining unit it is beneficial to switch to RTM when the union's power is adequately high and the degree of competition low because, due to the identical market price for the homogeneous products, lower negotiated wages and lower output for the RTM unit (an effect magnified by a higher degree of collusion) lead to margins higher than the EB1 firm.

However, if also the rival unit selects RTM, the effect of an increase in price because of lower production is not sufficiently large to counterbalance the related revenues reduction due to lower output. Therefore, to be profitable the switch towards RTM, the rival bargaining unit has to keep the EB1 negotiation agenda. Thus, EB1 emerges as equilibrium because wages are not concurrently negotiated in the rival units, suggesting that, having knowledge of the wage rate at the RTM rival firm, the EB unit undercuts the negotiated wage to a level which keeps a relative profitability in the mixed case. The non-trivial result of no Nash equilibria in a relevant area of the economy's feasible set in Proposition 1 is in sharp contrast to the existing literature that considers 2×2 games. In fact, in a 2×2 game characterized by EB1, Buccella (2011) and Fanti (2014, Appendix) show that the RTM model is the dominant strategy for firms. Therefore, if the duopolists have the right to select the negotiation agenda, RTM arises as the unique equilibrium, regardless of the degree of competitiveness of the industry. On the other hand, in a 2×2 game characterized by EB2, Fanti (2015) and Fanti and Buccella (2017) find that in a Cournot duopoly as regards firms, RTM is the unique equilibrium for high values of the union bargaining power; for intermediate values, multiple symmetric equilibria arise in which both firms opt either for RTM or EB while, when the unions are sufficiently weak, the EB becomes the unique equilibrium agenda. Making use of a CV model with EB2, Buccella and Fanti (2015) further extend the results of Fanti (2015). Those authors show that EB is the unique equilibrium for almost all the degree of market competition when the unions are extremely weak. When the unions' bargaining power increases, both RTM and EB arise as equilibria of the game for large degrees of market competition while EB is the unique equilibrium in the presence of collusive-like behaviours. Finally, if the union is strong, RTM emerges as the unique equilibrium.

Therefore, these findings may provide with a useful insight for authorities and policy makers. Even if the bargaining parties have large degrees of freedom in the conduct of negotiations, a clear intervention in labour regulations is needed to set the rules of the timing to ensure the rise of a "common practice" in the industry, especially in the most observed and realistic cases in which the unions' power is not too high, and whenever firms tend to restrict market rivalry.

4. CONCLUSION

As known the issue of the bargaining agenda investigates how firms may strategically choose how to conduct their negotiations opting either for the RTM or the EB institution. However, in the mixed case of duopoly, the specification of the timing of the game leads the firm which selects EB to act either as the Stackelberg wage follower (EB1) or the Stackelberg output leader (EB2). So far the literature has assumed either EB1 or EB2 as exogenously given. Consequently, the conclusions of the literature may appear assumption-dependent. In fact, depending on the exogenous hypotheses with regard to the timing, there are different economic parameters that qualifies either the RTM or the EB equilibrium. However, the timing itself is a decision variable that have to be taken into consideration in a correct game-theoretic approach. This paper shows that using this approach the results are surprising.

It is shown that, in a large area of the parameters' space, the game presents no equilibria in pure strategies. On the other hand, the RTM institution endogenously emerges as the unique equilibrium agenda with low unions' bargaining power and a high degree of competition and, as the unions' strength rises, for larger ranges of the CV parameter. In addition, a restricted area of the parameters' space, characterized by collusive firms' behavior and extremely high bargaining power, shows multiple, asymmetric equilibria. Moreover, the EB institution disappears as the industry bargaining institution in equilibrium, in contrast to what has recently established the received literature. Therefore, this result suggests, on the one hand, that the exogenous assumption of a certain bargaining agenda as commonly made by the received literature may be not robust and, on the other hand, that policymakers and antitrust authorities need to intervene in labor market regulations to set the timing in negotiations in order to ensure that a "common bargaining practice" may emerge in the industry.

The present work has been built on precise assumptions. The intensity of competition in the product market, for instance, can be modeled by introducing product differentiation. Price competition *à la* Bertrand or *à la* Hotelling (1929) represent other extensions of the model. Moreover, with regard to the labor unions, different production technologies (*e.g.*, decreasing returns to scale), and the introduction of a more general utility function to weight the preferences over wages and employment, are all elements requiring further analysis. This is left for future research. ◂

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APPENDIX

This Appendix shows the extensive derivations of the equilibrium outcomes in Table 1.

A. Both firms negotiate under RTM

Let us first derive the outcomes of the regime in which both bargaining units negotiate under RTM.

Given symmetry, consider simply firm 1. Given equation [2], the first order condition for firm 1 of the maximization with respect to the output level leads to the following reaction function:

$$\frac{\partial \Pi_1}{\partial q_1} = 0 \Rightarrow q_1 = \frac{1 - q_2 - w_1}{2 + \phi} \qquad [A1]$$

Substituting [A1] into the rival's reaction function (simply switch the index 1 with 2) and solving the system, it is obtained the output as function of the wages:

$$q_1 = \frac{1+\phi+w_2-w_1(2+\phi)}{3+4\phi+\phi^2}, q_2 = \frac{1+\phi+w_1-w_2(2+\phi)}{3+4\phi+\phi^2} \quad [A2]$$

Inserting [A2] into the Nash product in equation [5] which, for the bargaining unit 1, is:

$$NP_1 = (w_1 q_1(w_1,w_2)^{\alpha}[1 - q_1(w_1,w_2) - q_2(w_1,w_2) - w_1)q_1(w_1,w_2)]^{1-\alpha} \quad [A3]$$

and maximizing with respect to w_1, obtains the wage reaction function:

$$w_1 = \frac{\alpha(1+\phi+w_2)}{2(2+\phi)} \quad [A4]$$

Solving the system made by [A4] and the rival's reaction function, the equilibrium wages are:

$$w_1 = w_2 = \frac{\alpha(1+\phi)}{4+2\phi-\alpha} \quad [A5]$$

Inserting [A5] into [A2], the equilibrium output is obtained:

$$q_1 = q_2 = \frac{(2-\alpha)(1+\phi)(2+\phi)}{(4+2\phi-\alpha)(3+4\phi+\phi^2)} \quad [A6]$$

Subsequent substitutions of [A5] and [A6] into equations [2]-[3] yield the equilibrium profits in Table 1.

B. No leadership with the EB agenda

Consider the case in which both units negotiate under EB with no Stackelberg leadership (*i.e.* the EB1-EB1 regime). Making use of equations [1], [2] and [4], the maximization problem of the Nash product in [5] for the firm/union bargaining unit 1 is:

$$\max NP_1(w_1,q_1) = (w_1,q_1)^{\alpha}[(1 - q_1 - q_2(q_1) - w_1)q_1]^{1-\alpha} \quad \text{[B1]}$$

First order conditions lead to the following expressions:

$$w_1 = \alpha(1 - q_1 - q_2) \text{ (\textit{rent sharing curve})} \quad \text{[B2]}$$

$$w_1 = 1 - q_2 + q_1[\alpha(1 + \phi) - (2 + \phi)] \text{ (\textit{contract curve})} \quad \text{[B3]}$$

Equating [B2] and [B3], obtains:

$$q_1 = \frac{(1-q_2)}{(2+\phi)} \quad \text{[B4]}$$

which is firm 1 production as function of the rival firm's output. Identical results (simply shifting the indices 1 with 2) hold for the firm/union bargaining unit 2. Therefore, substituting the counterpart's reaction function into [B4] (and vice versa), and solving the system, the output in equilibrium is:

$$q_1 = q_2 = \frac{1}{3+\phi} \quad \text{[B5]}$$

and further substitutions into the rent sharing curves lead to the equilibrium wage:

$$w_1 = w_2 = \frac{\alpha(1+\phi)}{3+\phi} \quad \text{[B6]}$$

Given [B5]-[B6], the equilibrium profits reported in Table 1 are immediately derived.

C. Stackelberg competition with the EB agenda

Assume now that firm 1 is the follower while firm 2 the leader (*i.e.* the EB1-EB2 regime). Both firms bargain with their unions under the EB agenda. Therefore, the maximization problem in equation [5] for the follower is:

$$\max NP_1(w_1,q_1) = (w_1,q_1)^{\alpha}[(1 - q_1 - q_2(q_1) - w_1)q_1]^{1-\alpha} \qquad [C1]$$

First order conditions yield the following expressions:

$$w_1 = \alpha(1 - q_1 - q_2) \ (\textit{rent sharing curve}) \qquad [C2]$$

$$w_1 = 1 + [\alpha(1 + \phi) - (2 + \phi)]q_1 - q_2 \ (\textit{contract curve}) \qquad [C3]$$

Using [C2] and [C3], it follows that firm 1's reaction function is:

$$\frac{(1 \qquad)}{(2+\phi)} \qquad [C4]$$

The leader, firm 2, in solving its bargaining problem, takes into account the follower optimal output response in the successive stage of the game. Thus, the leader bargaining problem is to maximize:

$$\max NP_2(w_2,q_2) = (w_2 q_2)^{\alpha}\left[\left(1 - q_2 - w_2 - \frac{(1-q_2)}{(2+\phi)}\right)q_2\right]^{1-\alpha} \qquad [C5]$$

First order conditions lead to:

$$w_2 = \frac{\alpha[(1+\phi)(1-q_2)]}{(2+\phi)} \ (\textit{rent sharing curve}) \qquad [C6]$$

$$w_2 = \frac{(1+\phi)[1-(2-\alpha)q_2]}{(2+\phi)} \ (\textit{contract curve}) \qquad [C7]$$

Solving the system [C6]-[C7] for q_2, obtains:

$$q_2 = \frac{1}{2} \qquad [C8]$$

Replacing [C8] into [C6], the leader equilibrium wage is:

$$w_2 = \frac{\alpha(1+\phi)}{2(2+\phi)} \qquad [C9]$$

Finally, substitution of [C8] into [C4] leads to the follower's output level in equilibrium:

$$q_1 = \frac{1}{2+\phi} \qquad \text{[C10]}$$

Direct substitutions of equations [C8]-[C10] into equation [C2] allow deriving the follower wage level in equilibrium:

$$w_1 = \frac{\alpha(1+\phi)}{2(2+\phi)} \qquad \text{[C11]}$$

identical to the leader's wage. Given [C8]-[C11], the equilibrium profits in Table 1 are derived.

D. Outcomes of the mixed case in duopoly, EB1

The analytical derivations of the outcomes concerning the mixed duopoly case with EB1 are here reported (see also Buccella, 2011, Appendix). Firm 1 negotiates with its union under EB, while firm 2 bargains with its union under RTM. Making use of equations [1], [2] and [4], the maximization problem of the Nash product in equation [5] for the firm/union bargaining unit 1 is:

$$\max NP_1(w_1,q_1) = (w_1,q_1)^{\alpha}[(1 - q_1 - q_2(q_1) - w_1)q_1]^{1-\alpha} \qquad \text{[D1]}$$

First order conditions lead to the following expressions:

$$w_1 = \alpha(1 - q_1 - q_2) \text{ (\textit{rent sharing curve})} \qquad \text{[D2]}$$

$$w_1 = 1 - q_2 + q_1[\alpha(1 + \phi) - (2 + \phi)] \text{ (\textit{contract curve})} \qquad \text{[D3]}$$

Equating [D2] and [D3], obtains:

$$q_1 = \frac{(1-q_2)}{(2+\phi)} \qquad \text{[D4]}$$

which is firm 1 production as function of the rival firm's output. The firm/union bargaining unit 2 under RTM chooses w_2 to maximize:

$$\max NP_2(w_2) = (w_2 q_2)^{\alpha}[(1 - q_1(q_2) - q_2 - w_2)q_2]^{1-\alpha} \qquad [D5]$$

taking as given w_1, q_1 and firm's 2 optimal output response. Given equation [3], the first order condition for firm 2 determines the following firm's 2 reaction function:

$$\frac{\partial \Pi_2}{\partial q_2} = 0 \Rightarrow q_2 = \frac{(1 - q_1 - w_2)}{(2 + \phi)} \qquad [D6]$$

Substitution of [D6] into [D4] yields:

$$q_1 = \frac{(1 + \phi + w_2)}{(3 + 4\phi + \phi^2)} \qquad [D7]$$

that is, firm's 1 output as function of the rival firm's wage rate. Putting [D7] into [D6], it is obtained:

$$q_2 = \frac{[1 + \phi - (2 + \phi)w_2]}{(3 + 4\phi + \phi^2)} \qquad [D8]$$

the firm's 2 optimal output response as function of w_2. Inserting [D7] and [D8] into [D5], the first order condition leads to:

$$w_2 = \frac{\alpha(1 + \phi)}{2(2 + \phi)} \qquad [D9]$$

the optimal firm/union bargaining unit 2 wage rate under RTM. Substituting back [D9] into [D7], one obtains:

$$q_1 = \frac{(2\phi + \alpha + 4)}{2(3 + \phi)(2 + \phi)} \qquad [D10]$$

which is firm's 1 equilibrium output. Further substitution of [D9] into [D8] leads to:

$$q_2 = \frac{(2-\alpha)}{2(3+\phi)} \quad \text{[D11]}$$

representing the firm's 2 production in equilibrium. Finally, inserting [D10] and [D11] into [D2], the bargained wage rate in firm 1 is:

$$w_1 = \frac{\alpha(1+\phi)(2\phi+\alpha+4)}{2(3+\phi)(2+\phi)} \quad \text{[D12]}$$

Straightforward substitutions in equations [2]-[4] yield the profits' expressions reported in Table 1.

E. Outcomes of the mixed case in duopoly, EB2

Let us consider now the case of the mixed duopoly under EB2 (see also Buccella and Fanti, 2015, Appendix). As reported in the main text, firm 1 bargains with its union under EB, while firm 2 negotiates with its union under RTM. From equation [3], the first order condition for firm 2 determines the best-reply function:

$$\frac{\partial \Pi_2}{\partial q_2} = 0 \Rightarrow q_2 = \frac{1-q_1-w_2}{2+\phi} \quad \text{[E1]}$$

Therefore, using equations [1], [2] and [4], the maximization problem in equation [5] for firm 1 is:

$$\max NP_1(w_1, q_1) = (w_1 q_1)^{\alpha} \left\{ \left[1 - q_1 - \left(\frac{1-q_1-w_2}{2+\phi} \right) - w_1 \right] q_1 \right\}^{1-\alpha} \quad \text{[E2]}$$

First order conditions yield the following expressions:

$$w_1 = \frac{\alpha[(1+\phi)(1-q_1)+w_2]}{2+\phi} \quad (\textit{rent sharing curve}) \quad \text{[E3]}$$

$$w_1 = \frac{1+w_2+\phi-(1+\phi)(2-\alpha)q_1}{2+\phi} \quad (\textit{contract curve}) \quad \text{[E4]}$$

On the other hand, firm 2 takes into consideration its optimal output response in the successive stage of the game. Therefore, the bargaining problem of firm 2 under RTM is to set w_2 to maximize:

$$\max NP_2(w_2) = \left[\frac{w_2(1-q_1-w_2)}{2(1+\phi)}\right]^{\alpha}\left[\frac{(1-q_1-w_2)^2(1+\phi)}{(2+\phi)^2}\right]^{1-\alpha} \quad [E5]$$

The first order condition leads to:

$$w_2 = \frac{\alpha(1-q_1)}{2} \quad [E6]$$

Substituting back [E6] into [E3] and [E4] and solving for w_1 and q_1, obtains:

$$w_1 = \frac{\alpha(\alpha\phi + 2\phi^2 + \alpha + 4\phi + 2)}{[4(1+\phi)+\alpha](2+\phi)} \quad [E7]$$

$$q_1 = \frac{2(1+\phi)+\alpha}{4(1+\phi)+\alpha} \quad [E8]$$

the equilibrium wage and output of firm 1 under EB. Replacing [E8] into [E6], the firm's 2 equilibrium wage under RTM is:

$$w_2 = \frac{\alpha(1+\phi)}{4(1+\phi)+\alpha} \quad [E9]$$

Finally, substitution of [E8] and [E9] into [E1], leads to the firm's 2 output level in equilibrium:

$$q_2 = \frac{(2-\alpha)(1+\phi)}{[4(1+\phi)+\alpha](2+\phi)} \quad [E10]$$

Direct substitutions of equations [E7]-[E10] into equations [2]-[4] in the main text allow deriving the expressions for profits in Table 1.