

**IDIOSYNCRATIC WAGE BARGAINING IN
AN OLIGOPOLISTIC SINGLE MARKET**

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Idiosyncratic wage bargaining in an oligopolistic single market

by

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Abstract. This paper presents a game-theoretic model of a common market for a homogeneous good supplied by an oligopolistic industry and of separated labor markets, differing because of country-specific bargaining systems. According to the move structure, first, unions and firms negotiate the wage according to national patterns; second, firms choose their level of employment. It is shown that the equilibrium wage is higher in countries with industry-level negotiations. Furthermore, sequential bargaining between countries leads to higher wages and lower employment than synchronized bargaining. If bargainers can choose the date of their negotiation, sequential wage settlements characterize the noncooperative equilibrium.

JEL Classification N.: J51, L13.

Keywords: Trade Unions, Oligopoly, Wage Bargaining, Single Market.

Négociations salariales idiosyncratiques et marché unique

par

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Résumé. On présente un modèle de la relation entre un marché d'un produit homogène fourni par une industrie oligopolistique et plusieurs marchés du travail segmentés et caractérisés par des systèmes nationaux de négociation salariale. Cette relation est représentée par un jeu dans lequel les salaires sont d'abord négociés selon des procédures spécifiques à chaque pays, à la suite de quoi les entreprises déterminent l'emploi et la production. On montre que le salaire d'équilibre est le plus élevé dans les pays où la négociation est conduite au niveau de la branche. En outre, si les négociations salariales sont synchronisées entre pays, les salaires sont plus bas et l'emploi total est plus élevé que dans le cas des négociations séquentielles. Pourtant, si les acteurs des négociations peuvent choisir quand négocier, les salaires sont fixés de façon séquentielle à l'équilibre noncoopératif.

Nomenclature JEL: J51, L13.

Mots clés: Syndicats, Oligopole, Négociations Salariales, Marché Unique.

IDIOSYNCRATIC WAGE BARGAINING IN AN OLIGOPOLISTIC SINGLE MARKET

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1. Introduction

International economic integration confronts wage bargainers in each country with new constraints arising out of the free circulation of goods, services, labor and capital. This is relevant e.g. in the case of the European community, where progressive economic integration towards the Single Market puts an increasing pressure on national pay bargaining systems (Boyer, 1993). In order to assess the impact of economic integration on European labor markets, the great variability of national labor institutions within the Community must be taken into account. This feature of labor markets has been stressed by a number of empirical studies and it is crucial for highly institutionalized markets for intermediate level blue- and white-collar skills (Marsden, 1992). So, whilst European product markets are becoming increasingly integrated, the degree of centralization of wage bargaining, trade union density, minimum wage regulations, unemployment benefits, and the role played by the government in the bargaining process, differ strikingly across countries¹ (Flanagan *et al.*, 1992). Moreover, the inertia which characterizes labor institutions suggests that heterogeneity in national pay bargaining systems should be viewed as a long-run phenomenon, which raises the issue of the structural coherence between the European economic and monetary union and the persistence of national patterns of wage determination.

In this paper I develop a partial equilibrium model of the relationship between a single product market supplied by an oligopolistic industry and segmented labor markets characterized by idiosyncratic wage bargaining. The issue of the links between the way in which unions and management bargain inside each firm and how firms compete with

each other in the product market is not novel, providing a natural interface for debate between industrial and labor economists. Previous work on this topic includes important studies carried out by Dixon (1988), Dowrick (1989), Cahuc and Zylberberg (1991), Hoel (1991) and De Fraja (1993). The contribution of the present paper to this literature consists of abandoning the hypothesis of homogeneous institutions in modelling how the labor market works. Various groups of firms with different bargaining systems are allowed to coexist instead, i.e. to compete in the same product market. A natural interpretation of this framework is that each group consists of firms which are located in the same country, and that these countries form a single integrated market. By comparing this situation with one in which there is a unique bargaining system, questions of the type previously raised may be discussed².

The model is analyzed under the following standard assumption about the move structure: first unions and firms bargain over the wage level according to national patterns, and then firms compete in the single product market by choosing their level of employment and output. This assumption is meant to capture the fact that whereas wages are often fixed by long-term contracts, firms' output decisions are commonly variable over a much shorter period of time³.

The paper is organized as follows. Section 2 sets up the general model. In Section 3 the benchmark case of a unique bargaining system is presented. Section 4 considers decentralized country-specific negotiations and examines wage externalities between countries belonging to the single market. Section 5 discusses the case of a heterogeneous degree of centralization as a source of international wage differentials. The case of national industry-level negotiations is analyzed in Section 6, with special focus on the issue of endogenous timing of wage negotiations. In Section 7 the model is extended to profit sharing. Section 8 provides concluding remarks.

2. The model

Consider a market for a homogeneous commodity, in which demand is given by the function $D(p)$. The demand function is assumed to be strictly decreasing and concave; its inverse is written as $p(Q)$. On the supply side of the product market there are n

identical profit-maximizing firms, denoted $j = 1, \dots, n$. Firm's output q_j is a strictly increasing, concave function of labor l_j , the only variable input, and fixed costs per firm are C . There are two countries: firms indexed by $j = 1, \dots, m$ are located in country A, whereas firms indexed by $j = m+1, \dots, n$ belong to the industry of country B.

In both countries each worker supplies labor to one of the firms and to each firm is allocated a continuum of workers of equal size. Workers have one unit of labor which they supply with no disutility. Their identical von Neumann-Morgenstern preferences are represented by the following (indirect) utility function:

$$U_j = s_j u(w_j) + (1-s_j) u(\bar{w}_j) \quad j=1, \dots, n$$

where $u(\cdot)$ is a strictly increasing and concave function. The general price level is normalized to unity, so that w denotes both the real and the nominal wage⁴. The endogenous variable s_j is the probability of being employed in the firm to which the worker is initially allocated (the "survival" probability). The parameter $\bar{w}_j$ denotes expected real income of a worker who loses his job in the firm; in general, it will depend positively on the expected outside real wage, the unemployment benefit and the turnover rate, and negatively on the unemployment rate, all of which are allowed to be country-specific (Layard *et al.*, 1991).

The workforce is represented in the wage bargaining process by a utilitarian union. Union bargaining power, union utility during a dispute, as well as the degree of centralization of bargaining (at firm level or industry level) are allowed to differ between countries. Furthermore, wage negotiations may occur simultaneously or sequentially. Interactions between the single product market and national bargaining systems are analyzed according to the following move structure. First, wages are bargained over in each country: inside each firm or at the industry level, either simultaneously or sequentially. Second, Cournot competition occurs: firms simultaneously choose their level of employment, which determines industry output and the market clearing price. The equilibrium notion adopted throughout the paper is that of subgame perfection.

3. The benchmark

If the hypothesis of country-specific labor institutions is dropped, the model collapses into a variant of Dowrick's (1989) model⁵. Results emerging from this context are therefore useful as a benchmark to highlight the impact of a single market with different national labor institutions. Obtaining these results is the task of this section; as a byproduct, the solution of the Cournot competition stage game is derived for later use.

For the sake of calculus and without significant loss of generality, it is assumed throughout the rest of the paper that fixed costs are nil, production and demand functions are linear, and workers are risk neutral, i.e. $C = 0$,

$$q_j = l_j \quad j=1,..n$$

$$p(Q) = a - bQ \quad a>0; b>0$$

$$U_j = s_j w_j + (1-s_j) \bar{w} \quad j=1,..n; \quad (1)$$

Furthermore, I normalize to unity the continuum of workers who supply labor to each firm, so that $s_j = l_j$. Hence, union utility can be written more compactly as

$$U_j = U_j(q_j, w_j).$$

The equilibrium of the model is found by backward induction. In the last stage of the game, firms play Cournot competition taking wage levels as fixed. Firm's profits are given by:

$$\pi_j(q_1,..q_n) = q_j (a - w_j - bQ) \quad j=1,..n \quad (2)$$

where $Q = \sum_{j=1}^n q_j$ is total industry output. Assuming an interior solution to the Cournot competition game, the unique Nash equilibrium of this stage game yields:

$$Q(w_1, \dots, w_n) = \frac{na - W}{b(n+1)} \quad (3)$$

and

$$q_j(w_1, \dots, w_n) = \frac{a - nw_j + W_{-j}}{b(n+1)} \quad j=1, \dots, n \quad (4)$$

where $W = \sum_{j=1}^n w_j$ and $W_{-j} = W - w_j$. A firm's equilibrium output (and employment) is a decreasing function of both the own wage and the number of firms in the industry. Conversely, it is an increasing function of wage levels paid elsewhere and of total industry demand.

In the stage of the game before oligopolistic competition, employers and employees negotiate the wage level with perfect foresight of the effect of wages on firms' decisions concerning employment. The outcome of negotiations is taken to be the generalized Nash solution⁶. Using equations (1) and (2), for each union/firm pair the Nash solution maximizes the following function:

$$V_j = (U_j(q_j, w_j) - \bar{U})^\gamma (\pi_j(q_1, \dots, q_n) - \bar{\pi})^{1-\gamma}$$

where $\bar{U}$ and $\bar{\pi}$ are the relevant "fallbacks" of the two parties and $\gamma \in (0,1)$ is referred to as the union bargaining power. Fallbacks depend on agents' payoffs during a dispute. If disagreement translates into a strike, $\bar{U}$ would equal strike pay, provided that it is paid from a fund including mainly workers from outside the bargaining unit. Otherwise, the main relevant incomes are earnings from other temporary jobs which strikers pick up during the strike, plus unemployment benefits in so far as these are payable (Layard *et al.*, 1991). The harm inflicted to a firm during a strike depends on the ability of the union to persuade workers to adhere to the strike, which is dependent on trade union membership. This variable is sometimes thought to influence also the union bargaining power. Actually, this parameter should merely capture asymmetries in the bargaining

procedure and different discount factors (Binmore *et al.*, 1986). I assume for simplicity $\bar{\pi} = 0$ and $\bar{U} = \bar{w}$, which is referred to as the reservation wage; the logic of the paper is unaltered when there are different fallback values.

Since bargainers correctly anticipate the effect of wages on subsequent Cournot competition (i.e. equations (3) and (4)), the Nash maximand can be rewritten as $V_j = V_j(w_1, \dots, w_n; \bar{w}, \gamma)$. When bargaining is centralized, a uniform wage is set by industrial associations for all firms. Therefore, the outcome of bargaining can be formalized as the solution of the following program:

$$\max_{w_j} V_j(w_1, \dots, w_n; \bar{w}, \gamma) \quad (5)$$

It is straightforward to prove that under equations (1)-(4) and $s_j = l_j = q_j$, the solution of (5) implies the following industry wage⁷:

$$w^{I*} = \bar{w} + \frac{\gamma(a - \bar{w})}{2} \quad (6)$$

The difference between the equilibrium wage and the reservation wage might be interpreted as the union wage mark-up. This is, as expected, an increasing function of the union bargaining power and the level of industry demand, parametrized by the intercept of the linear demand function.

Now, consider a situation of decentralized bargaining. Inside each firm, the union and the management negotiate the wage level and all negotiations take place simultaneously. When setting the wage level, each union/firm pair takes all other wage settlements as given and correctly anticipates their effects on the subsequent Cournot competition in the product market. This can be formalized as follows:

$$w_j^{F*} = \arg \max_{w_j} V_j(w_1, \dots, w_n; \bar{w}, \gamma) \quad j=1, \dots, n \quad (7)$$

where w_{-j} is the vector which has as its elements the wage levels in all firms except firm j . The (symmetric) solution to (7) - as shown in the Appendix - is:

$$w^{F*} = \bar{w} + \frac{\gamma(a - \bar{w})}{2n - \gamma(n - 1)} \quad (8)$$

Comparing (6) with (8) provides us with the quite general result that the wage level in a decentralized bargaining system is lower than in a system of industry-level bargaining⁸. As Dowrick (1989) puts it: "If each union/firm pair expects to be able to alter its relative wage position in the industry, both unions and employers have some incentive to cut wages in order to gain a larger share of employment/output or to increase profit margins". As shown by equation (8), this incentives increases with the number of firms operating in the industry, so that in the limit, for $n \rightarrow \infty$, the bargained wage equals the reservation wage and the perfectly competitive outcome results. When wage bargaining takes place at the industry level this competitive mechanism disappears and "wage bargaining affects employment and profits only through the overall level of industry demand"⁹. A further point to be noticed is that both profits and employment are higher under firm-level bargaining, whereas workers' expected utility is higher under industry-level bargaining. The goal of the following sections is to show how results obtained here are affected when one allows for the coexistence of idiosyncratic bargaining systems.

4. Decentralized bargaining

In this section the model is studied under the assumption that firm-level negotiations take place simultaneously in the two countries. Union/firm pairs can now be divided into two national groups, differing with respect to the bargaining environment that they face. The location of firms matters since reservation wage, union bargaining power and number of firms in the industry change across countries.

Consider wage bargaining in a firm $j \leq m$, located in country A. Applying the same

reasoning as above, the agreed outcome must be a solution of the following program:

$$w_j^{FF*} = \arg \max_{w_j} V_j(w_j, w_{-j}^{FF*}; \bar{w}_A, \gamma_A) \quad (9)$$

An analogous optimization program describes the outcome of wage bargaining for country B's firms. Solving for all bargainings simultaneously yields the following equilibrium wage:

$$w_A^{FF*} = \bar{w}_A + \frac{\gamma_A[(a - \bar{w}_A)(2n + \gamma_B) - (\bar{w}_A - \bar{w}_B)(n - m)(2n - \gamma_B n)]}{(2n + \gamma_A)[2n - \gamma_B(n - 1)] - 2nm(\gamma_A - \gamma_B)} \quad (10)$$

(see Appendix). A symmetric expression holds for the equilibrium wage in country B. Notice that if $\gamma_A = \gamma_B = \gamma$ and $\bar{w}_A = \bar{w}_B = \bar{w}$, equation (10) reduces to equation (8) of the benchmark. Further inspection of (10) provides us with the following fact.

Proposition 1. The wage level in one country is an increasing function of union bargaining power and reservation wage in both countries.

The mechanism at work here is that of a positive externality between wage levels in the two countries. When the bargaining strength of unions increases in one country (because of increasing γ_i or $\bar{w}_i$), national wages rise as a consequence. With a single product market, this wage increase has the effect of lowering the competitive pressure on the firms abroad. This implies that, even if bargaining systems are separated between countries, the bargaining position of employers and employees in the other country is affected. Since firms in that country face less tough foreign competition, their negotiated wage turns out to rise. This transmission mechanism is very general and independent of the degree of centralization in national bargaining. It shows that national managements and unions are forced to "transfer abroad" part of their bargaining strength when they operate in a single product market. Hence, product market integration has the remarkable effect of dampening diverging wage movements that may arise out of

country-specific shocks hitting the relative bargaining strength of unions and firms. However, product market integration is not in general sufficient to induce wage equality across national bargaining systems.

From (10), also the impact of the international distribution of firms can easily be deduced. As expected, its role is to "weight" the effect of union bargaining strength in the two countries. Thus, if $\bar{w}_A >(<) \bar{w}_B$ and $\gamma_A >(<) \gamma_B$, the wage level in country A is an increasing (decreasing) function of the portion of firms belonging to this country. Symmetrically for the wage negotiated in country B.

In order to avoid repetitions on the same theme and simplify notation, I shall assume in what follows that $\gamma_A = \gamma_B = \gamma$ and $\bar{w}_A = \bar{w}_B = \bar{w}$ and simply focus on differences in the level at which bargaining occurs in each country as well as on the timing of negotiations.

5. Heterogeneous degree of centralization

5.1 Synchronized bargaining

I now consider the case in which the wage level in one of the countries (say country A) is negotiated at industry level, whereas in the other country wage negotiations are decentralized. As before, all wages are negotiated simultaneously. The primary interest for studying this case lies in the possibility that a heterogeneous degree of centralization might be an important source of wage differentials within a single market.

Wage settlements at industry level in country A can be computed as the solution of the following program, for $j \leq m$:

$$\max_{w_j} V_j(w_p \dots w_p, w_{m+1}^{IF^*}, \dots, w_n^{IF^*}) \quad (11)$$

Whereas firm-level negotiations in country B solve, for $j \geq m+1$:

$$\max_{w_j} V_j(w_j, w_{-j}^{IF*}) \quad (12)$$

Solving (11) and (12) yields a system of $n-m+1$ equations that determine equilibrium wages in the two countries:

$$w_A^{IF*} = \bar{w} + \frac{\gamma(2n + \gamma)(a - \bar{w})}{Z} \quad (13)$$

$$w_B^{IF*} = \bar{w} + \frac{\gamma[Z + \gamma m(2n + \gamma)](a - \bar{w})}{[2n - \gamma(n - m - 1)]Z} \quad (14)$$

where Z is a positive constant (see Appendix). Comparison of equations (6) and (8) with (13) and (14) establishes the following important proposition.

Proposition 2. Under synchronized wage setting, wages in the country with industry-level bargaining are higher than in the country with firm-level bargaining. This holds irrespectively of the relative size of the country¹⁰. The wage level is lower in the former than under overall industry-level bargaining. Symmetrically, the wage level is higher in the latter than under overall firm-level bargaining.

This result makes economic good sense. On the one hand, setting a nationally uniform wage in country A prevents national union/firm pairs to engage in competitive wage cutting, so that the national wage is higher than in the country where bargaining is decentralized. On the other hand, since some union/firm pairs in the industry (those in country B) negotiate independently of employers' and employees' associations, the latters reply to wage cutting by the formers setting a wage that is lower than in the case in which all union/firm pairs are covered by the same wage agreement. Conversely, decentralized wage setters in country B anticipate that agents abroad are "less aggressive" than in a completely decentralized common market, which allows them to fix higher wages.

Thus, the existence of a single product market, *ceteris paribus*, mitigates international

wage differentials that arise from different degrees of centralization in wage bargaining. Note again that it does not induce a complete convergence in wage levels: real wages are higher in the country with industry-level bargaining and therefore employment per firm is lower in that country.

5.2 Sequential bargaining

The hypothesis that in one country there is one national bargaining, whereas in the other there may be a myriad of decentralized negotiations, suggests to examine an alternative move structure, namely such that the first country exerts an international leadership in wage setting for the industry under examination. Thus, I shall consider the following variant of the basic model: first, wages are bargained over at industry level in country A (the leader); next, wages are simultaneously negotiated inside firms of country B (the follower); finally, Cournot competition is played in the single product market.

Proceeding by backward induction, the outcome of the last stage of the game is, as before, given by equations (3) and (4). In the stage immediately before, bargainers in country B take the industry wage in country A as a parameter and correctly anticipate the product market equilibrium. Hence, the generalized Nash solution of their bargaining problem is given by an equivalent program to (12). As it is shown in the Appendix, this generates best reply functions of union/firm pairs, from which the (uniform) reaction of wage bargainers in country B to any wage level in country A can be deduced:

$$w_B(w_A) = \bar{w} + \frac{\gamma[a - \bar{w} + m(w_A - \bar{w})]}{2n - \gamma(n - m - 1)} \quad (15)$$

This function is strictly increasing, which can be interpreted in terms of the previously discussed positive wage externality between countries.

In the first stage of the game, industrial associations involved in the bargaining process in country A take into account the wage reaction of bargainers in country B and the subsequent oligopolistic competition in the product market. Whence, the outcome of bargaining can be written, for $j \leq m$, as:

$$w_{AI}^{IF*} = \arg \max_{w_A} V_j(w_A, \dots, w_A, w_B(w_A), \dots, w_B(w_A)) \quad (16)$$

with $w_j = w_A$ if $j \leq m$ and $w_j = w_B(w_A)$ if $j \geq m+1$. Subscript "I" denotes wage leadership. After some tedious but relatively straightforward manipulations one obtains the solution of this program, which yields the equilibrium wage in country A:

$$w_{AI}^{IF*} = \bar{w} + \frac{\gamma[(2n + \gamma)(a - \bar{w}) + \gamma\bar{w}(n - m)(n - 2)]}{2[(n + 1 - m)(2n - \gamma n + \gamma) + \gamma m]} \quad (17)$$

Although it looks intricate at first glance, this expression allows us to establish the following clear-cut result.

Proposition 3. Under heterogeneous degree of centralization, wages in both countries are higher, and industry employment is lower, when bargaining is sequential rather than synchronized.

Proof: see Appendix.

In the present framework, sequential bargaining implies that industrial associations of country A can commit themselves to a national wage *vis-à-vis* wage setters in country B. Since there exists a positive externality between wage levels prevailing in the two countries (recall that the reaction function (15) is positively sloped), industrial associations in country A negotiate a higher wage than under simultaneous bargaining, thereby inducing wage bargainers in country B to do likewise. As a consequence, industry employment and output are lower and the product price is higher when wage bargaining is sequential rather than synchronized. Total industry surplus, as a possible measure of social welfare, is therefore higher when wage settlements are synchronized¹¹. Sequential wage setting provides workers with the possibility to increase their aggregate surplus at expense of consumers' surplus and firms' profits.

The finding of proposition 3 is closely related to De Fraja's (1993) main result, which states that in a duopoly with monopoly unions, staggered wage setting leads to higher

steady state levels of wage and unemployment than synchronized wage setting¹². The common policy implication is therefore to exclude such a possibility, letting all wage negotiations occur at the same point in time¹³. With a single market this would require an international coordination of agents involved in wage bargaining. Furthermore, since for bargainers in a country it might be profitable to deviate from a previously announced timing of negotiations, a supranational agency should make this agreement enforceable. I will be more specific on this point in the following section, the focus of which is precisely on the order in which national negotiations occur as a factor determining the performance of labor markets.

6. Centralization

6.1 Synchronized national bargainings

Consider the case of national industry-level negotiations. Since this case is relatively simple to handle, it can conveniently be used to gain further insights on the role of the timing of wage negotiations. As before, I begin to study the case of simultaneous wage bargaining across countries. Applying the same method as before, the outcome of bargaining in country A must be the solution of the following program:

$$\max_{w_A} V_j(w_A, \dots, w_A, w_B^{II^*}, \dots, w_B^{II^*}) \quad (18)$$

where $w_j = w_A$ if $j \leq m$ and $w_j = w_B^{II^*}$ if $j \geq m+1$. The equilibrium wage in country A is shown in the Appendix to be:

$$w_A^{II^*} = \bar{w} + \frac{\gamma(a - \bar{w})[2(m+1) + \gamma(n-m)]}{4(n+1-m)(m+1) - \gamma^2 m(n-m)} \quad (19)$$

and identically for the wage in country B, except substituting m with $n-m$. Inspection of equations (19) and (6) provide us with the following finding.

Proposition 4. Under synchronized national negotiations at industry level, the wage level is higher in the larger country. Wages in both countries are lower than in the case of overall industry-level bargaining.

The intuition behind this finding is, first, simply that large industrial associations enjoy more independence in wage setting than small ones. A "very large" country can almost ignore wages prevailing in a "very small" country since the market share that it can lose is negligible. This pushes up wages in the large country. On the contrary, a small country is highly vulnerable from competitive wage setting abroad, which moderates wage pressure in the small country¹⁴. As a corollary, employment per firm is higher in the smaller country. Second, product market integration creates competition between previously isolated national bargaining systems, which, *ceteris paribus*, decreases wage pressure and enhances employment in both countries. Conversely, centralizing wage negotiations at industry level for the whole common market would induce lower employment, higher product price and a fall of total industry surplus.

6.2 Sequential national bargainings

Suppose that one country (say country A) is the international leader in wage setting and that negotiations occur in both countries at national industry level. Then, the wage level in country B (the follower) is determined according to a program which is symmetric to (11); this yields the following reaction function describing the bargain of industrial associations in country B:

$$w_B(w_A) = \bar{w} + \frac{\gamma[a - \bar{w} + m(w_A - \bar{w})]}{2(m + 1)} \quad (20)$$

Industrial associations in country A correctly anticipate the wage reaction in country B and the subsequent outcome of Cournot competition when setting the national wage. Thus, their wage setting program is equivalent to (16), except for the substitution of (15) with (20), a higher and steeper wage reaction function. After routine computations one obtains the following equilibrium wage for country A:

$$w_{AI}^{II*} = \bar{w} + \frac{\gamma(a - \bar{w})[2(m + 1) + \gamma(n - m)]}{2(n + 1 - m)(m + 1) - \gamma m(n - m)} \quad (21)$$

Together with equation (19) this expression allows us to establish the analogue of proposition 3.

Proposition 5. Under national bargainings at industry level, wages in both countries are higher, and industry employment is lower, when bargaining is sequential rather than synchronized.

Proof: see Appendix.

The economic interpretation of this proposition and its welfare implications are equivalent to those of proposition 3 and they will not be repeated here. Rather, I turn to the issue of timing, which is crucial for assessing the policy implications of these findings.

6.3 Endogenous timing

Especially when negotiations in both countries are conducted at industry level, it is not evident which country should be considered the international leader in wage setting. More generally, it is useful to consider the timing of wage settlements as an endogenous outcome of an augmented model. This can be done by letting the former game be preceded by a preliminary stage in which players simultaneously choose the time of their negotiation. Assuming that only two dates, $t_0 < t_1$, are available for bargaining, four outcomes of the timing game can a priori be obtained: synchronized negotiations at t_0 or at t_1 , and sequential negotiations beginning either in country A or in country B.

A preliminary step for analyzing this issue consists of identifying the players of the timing game; as before, I treat each bargaining pair as a single player, with payoff function given by the Nash maximand. The move structure is the following. In the first stage of the game, bargaining pairs simultaneously choose a bargaining date, which determines the actual timing. Depending on the outcome, the game precedes as before,

with either sequential or simultaneous wage negotiations.

In order to determine the equilibria of the augmented model, I have to establish the structure of the payoff matrix for the two bargaining pairs at the first stage of the game. This matrix must encompass the outcome of the game in terms of the Nash maximands for both cases of sequential and synchronized wage negotiations. The structure of the payoff matrix is established through three lemmas. To simplify the notation I shall suppress superscripts which indicated that bargaining occurs at industry level in both countries.

Lemma 1. $w_{ii}^* > w_{ij}^*$, $i=A,B$.

Proof: see Appendix.

Thus, under sequential bargainings a country's wage level is higher when it is the leader rather than the follower. The possibility of commitment induces a wage pressure in the country which adopts it, that is stronger than the pressure which might arise from following a larger country.

Denote the payoff function of a representative bargaining pair in country A as $V_A(w_A, w_B)$, by which it is meant that $w_j = w_A$ if $j \leq m$ and $w_j = w_B$ if $j \geq m+1$.

Next, define the following value function for players in country A:

$$F_A(w_B) = \max_{w_A} V_A(w_A, w_B) \quad (22)$$

and equivalently for country B. The following fact can be established:

Lemma 2. $\frac{dF_i(w_{-i})}{dw_{-i}} > 0$, $i=A,B$; $-i=A,B$; $i \neq -i$.

Proof: see Appendix.

This result is not very surprising since it merely reflects the positive wage externality

discussed above. It is useful in order to establish the following important fact.

Lemma 3. $V_i(w_{iN}^*, w_{-iN}^*) < V_i(w_{iI}^*, w_{-iI}^*) < V_i(w_{iF}^*, w_{-iI}^*)$.

Proof: see Appendix (subscript N denotes synchronized bargaining).

Whence, each bargaining pair prefers to follow rather than lead; however, it prefers to lead rather than negotiate simultaneously. The latter preference relation can be explained by the commitment effect previously discussed, which allows a bargaining pair to exploit the positive wage externality existing between countries. Interpreting the former preference relation is more subtle. Players like sequential bargaining since it makes competition less tough; however, each players prefers to be the follower precisely because of the possibility to undercut the rival, which is conferred by this role.

Using lemma 3 one can deduce the structure of the payoff matrix of the timing game; this characterization is sufficient to establish the Nash equilibria of this game.

Proposition 6. Sequential negotiations where either country A or country B acts as a leader are the only two Nash equilibria in pure strategies of the timing game¹⁵.

Whence, sequential wage negotiations emerge as a noncooperative equilibrium when the timing of bargaining is determined endogenously. Since industry employment is lower with sequential rather than synchronized bargaining, total surplus is also lower. If this is taken as a measure of social welfare, an improvement may be obtained by forcing the parties in the two countries to bargain simultaneously. This might be accomplished by a supranational agency, although it would be surely a difficult task. In particular, since each bargaining pair prefers deviating from synchronized wage settlements, the agency should be endowed with sufficient power to enforce the socially optimal timing.

Finally, notice that each bargaining pair prefers to coordinate on the Nash equilibrium in which it is the follower. Whence the conjecture that in a dynamic extension of the model wage negotiations would be alternating, i.e. staggered wage contracts according to nationality would emerge as the noncooperative equilibrium. Actually, De Fraja (1993) finds the following result in his duopoly model: if each union can choose when to set its

wage, provided that, once set, the wage is fixed for two periods, then, in the steady state they alternate their wage setting. When product markets are integrated, staggered wage contracts arise even if wage negotiations are centralized at national level and staggering becomes an international phenomenon. This suggests that in general product market integration may affect the timing of wage negotiations, inducing more staggering than under separated product markets.

7. Profit sharing

In a profit-sharing system, firms promise to pay each worker a base wage and a share of gross profits per capita (see e.g. Weitzman, 1987). When a profit-sharing system is considered, with the profit-sharing coefficient statutorily fixed by governments at some predetermined value and the base wage bargained by union and management, results are affected in the following way¹⁶.

First, the base wage in a decentralized bargaining system is, *ceteris paribus*, lower than in a system of industry-level bargaining. Since employment only depends on the base wage, a decentralized system with profit sharing turns out to have also higher employment and industry surplus. The mechanism at work is the same as that in a wage system, i.e. the presence of incentives to cut wages when each union/firm pair expects to be able to alter its relative wage position in the industry.

Second, within a single bargaining system, the base wage is a decreasing function of the profit-sharing coefficient. This happens because, with given union bargaining power, increasing the coefficient determines an increase in the union payoff which must be counterbalanced by a fall of the base wage. This implies that, *ceteris paribus*, a profit-sharing system induces larger employment and industry surplus than a wage system.

Third, transmission mechanisms across countries with profit-sharing systems are qualitatively the same as across countries with wage systems, as long as profit-sharing coefficients are "small". In that case, increasing the profit-sharing coefficient in one country turns out to decrease the base wage in both countries and increase industry employment. Otherwise, a country with a "large" coefficient tends to set the base wage equal to the wage minimum in order to increase gross profits, irrespective of wages in

the other country. In that case, increasing e.g. the union bargaining power in the latter country induces a rise of the base wage only in that country, and product market integration has merely unilateral effects.

8. Conclusion

Although the existence of country-specific systems of industrial relations is a well-known stylized fact, scholars have devoted scant attention to implications of different bargaining systems linked through common product markets. However, this issue is relevant for the European community, especially in light of its program for liberalizing goods markets throughout Europe. The simple model presented here aims precisely at featuring interactions between an international oligopoly competing on a single product market and wage negotiations occurring along national patterns. In this model, national labor institutions may differ with respect to the degree of centralization in wage bargaining and parameters affecting the relative bargaining strength of employers and employees. When a common product market links national pay bargaining systems together, the wage setting behavior is affected with relevant implications for employment and welfare.

First, product market integration creates competition between labor markets which are otherwise separated along country-specific bargaining systems. This competition effect lowers wage pressure with a positive impact on social welfare, as measured by total industry surplus. Conversely, centralizing wage negotiations at industry level for the whole common market reduces incentives for wage cutting and negatively affects total surplus.

Second, product market integration alone does not eliminate international wage differentials resulting from heterogeneous labor institutions. Wages in countries with industry-level bargaining are, *ceteris paribus*, higher than in countries with decentralized bargaining. However, the common product market induces a "leak" of the parties' bargaining strength abroad, thereby mitigating international wage differentials. E.g., an increase in union power in one country increases also the wage level abroad through competition in the single product market. This implies that idiosyncratic institutional

changes affecting one national bargaining system have the same qualitative impact in all countries of the single market¹⁷.

Third, the importance of coordinating wage negotiations within the single market must be stressed. Due to the existence of a positive wage externality between countries, sequential bargaining leads to higher wages and lower industry employment than synchronized bargaining. Quite surprisingly, this result holds for any relative size of the countries. Moreover, if bargainers are able to determine when labor contracts are signed, sequential wage setting emerges as the only noncooperative equilibrium. Since total industry surplus is higher with simultaneous bargaining, this may support the establishment of a supranational agency, whose task would be to synchronize wage negotiations across countries. Although this is surely a difficult task, it might be worthwhile to try it in light of international wage staggering induced by product market integration.

Appendix

Determination of equation (8)

Using equations (1)-(4), program (7) can be rewritten as:

$$\max_{w_j} \gamma \log \left[\frac{(a - nw_j + W_{-j}^{F*})(w_j - \bar{w})}{b(n+1)} \right] + (1 - \gamma) \log \left[\frac{(a - nw_j + W_{-j}^{F*})^2}{b(n+1)^2} \right]$$

with obvious notation. Computing the f.o.c. one obtains

$$\gamma(n\bar{w} - 2nw_j + a + W_{-j}^{F*}) = 2n(1 - \gamma)(w_j - \bar{w}) \quad (A.1)$$

Since this condition holds for all firms, which are identical, the symmetric equilibrium can be computed by setting $w_j = w^{F*}$, $j=1, \dots, n$, which gives equation (8). QED

Determination of equation (10)

Computing the f.o.c. of (9) yields equation (A.1) with subscripts for country A. Since it holds in a symmetric equilibrium for all firms, one can rewrite it as

$$\gamma_A[n\bar{w}_A - (2n - m + 1)w_A^{FF*} + a + (n - m)w_B^{FF*}] = 2n(1 - \gamma_A)(w_A^{FF*} - \bar{w}_A)$$

A symmetric equation is obtained for union/firm pairs in country B. Solving this two-equations system yields (10). QED

Determination of equations (13) and (14)

Computing the f.o.c. of (11) yields

$$\gamma[(n+1-m)(\bar{w} - 2w_A^{IF}) + a + W^F] = 2(n+1-m)(1-\gamma)(w_A^{IF} - \bar{w}) \quad (A.2)$$

which implicitly defines the best reply function for the union/firm pair in country A.

Computing the f.o.c. of (12) yields:

$$\gamma[n(\bar{w} - 2w_h^{IF}) + a + mw_A^{IF} + W_{-h}^F] = 2n(1-\gamma)(w_h^{IF} - \bar{w}) \quad h > m \quad (A.3)$$

which implicitly defines the best reply function for union/firm pairs in country B. Solving the system consisting of (A.2) and (A.3) for a symmetric equilibrium yields equations (13) and (14), where

$$Z \equiv 2(n + 1 - m)[2n - \gamma(n - m - 1)] - \gamma^2 m(n - m) > 0$$

QED

Determination of equation (15)

Take (A.3) and suppose a symmetric equilibrium in country B. Rearranging one obtains (15). QED

Proof of proposition 3

Consider country A: compare the mark-up on the reservation wage in (13) with that in (17). The numerator is unambiguously larger for the latter. Conversely, the denominator is unambiguously smaller for the latter, since this can be rewritten as

$$Z - \gamma m(n - m)(2 - \gamma)$$

This establishes $w_{Al}^{IF*} > w_A^{IF*}$. Consider country B: the best reply functions (A.3) are identical to (15) when a symmetric equilibrium is considered. Since the selected wage in country B is an increasing function of the wage in country A, it follows that $w_{Bf}^{IF*} > w_B^{IF*}$. Then, it follows immediately from (3) that industry employment is lower if bargaining is sequential. QED

Determination of equation (19)

From (18) one obtains the f.o.c. of the problem, which is equivalent to (A.2). This implicitly defines the best reply of industrial associations in country A as a function of the wage in country B. The best reply function for country B is obtained in a symmetric way. Putting them into system yields (19) and the equilibrium wage for country B. QED

Proof of proposition 5

Comparing (21) with (19) yields the result for the wage in country A. Recognizing that (20) is also country B's best reply function when bargaining is synchronized and that it is positively sloped yields the same result for country B. From (3), it follows that industry employment is higher if bargaining is synchronized. QED

Proof of lemma 1

Consider the equilibrium wage in country A. If it is the leader, its wage level is given by (21). If it is the follower, its wage level can be computed from (20) and (21) using symmetry, which yields:

$$w_{Af}^* = \bar{w} + \frac{\gamma Y(a - \bar{w})}{2(n - m + 1)} \quad (A.4)$$

where

$$Y \equiv 1 + \frac{\gamma(n - m)[2(n - m + 1) + \gamma m]}{2(n - m + 1)(m + 1) - \gamma m(n - m)}$$

Comparing (A.4) with (21) yields $w_{Al}^* > w_{Af}^*$, independently of the relative size of the country. By symmetry the same argument applies to the wage level in country B. QED

Proof of lemma 2

First, notice that definition (22) can be reformulated as $F_A(w_B) = V_A(w_A^*(w_B), w_B)$, where $w_A^*(.)$ is the reaction function of bargainers in country A. Second, define

$\Phi(w_A, w_B) \equiv b(n+1)^{2-\gamma} V_A(w_A, w_B)$. Then:

$$\frac{dF_A(w_B)}{dw_B} = \frac{1}{b(n+1)^{2-\gamma}} \left[\frac{\partial \Phi(w_A, w_B)}{\partial w_A} \frac{dw_A^*(w_B)}{dw_B} + \frac{\partial \Phi(w_A, w_B)}{\partial w_B} \right]$$

Using (3), (4) and the former definition one obtains:

$$\begin{aligned} \frac{\partial \Phi(w_A, w_B)}{\partial w_A} &= -(2-\gamma)(n-m+1)[a - (n-m+1)w_A + (n-m)w_B]^{1-\gamma} (w_A - \bar{w})^\gamma + \\ &\quad + \gamma[a - (n-m+1)w_A + (n-m)w_B]^{2-\gamma} (w_A - \bar{w})^{\gamma-1} \end{aligned}$$

$$\frac{\partial \Phi(w_A, w_B)}{\partial w_B} = (2-\gamma)(n-m)[a - (n-m+1)w_A + (n-m)w_B]^{1-\gamma} (w_A - \bar{w})^\gamma$$

And by equation (20):

$$\frac{dw_A^*(w_B)}{dw_B} = \frac{\gamma(n-m)}{2(n-m+1)}$$

Using these expressions the assert for country A is obtained. By an equivalent method the assert for country B is proven. QED

Proof of lemma 3

I prove the lemma for country A; the proof is equivalent for country B.

Proof of the first inequality:

$$V_A(w_{Af}^*, w_{Af}^*) = \max_{w_A} V_A(w_A, w_B^*(w_A)) \geq V_A(w', w_B^*(w'))$$

for all w' . Taking $w' = w_{AN}^*$ we have:

$$V_A(w_{Al}^*, w_{Bf}^*) \geq V_A(w_{AN}^*, w_B^*(w_{AN}^*)) = V_A(w_{AN}^*, w_{BN}^*)$$

Since the argmax above is unique and $w_{BN}^* < w_{Bf}^*$, this is actually a strict inequality.

Proof of the second inequality, in two steps.

Step 1: $V_A(w_{Af}^*, w_{Bl}^*) > V_A(w_A^*(w_{Bf}^*), w_{Bf}^*)$.

In fact, using the former definition one obtains:

$$V_A(w_{Af}^*, w_{Bl}^*) = V_A(w_A^*(w_{Bl}^*), w_{Bl}^*) = F_A(w_{Bl}^*)$$

and

$$V_A(w_A^*(w_{Bf}^*), w_{Bf}^*) = F_A(w_{Bf}^*)$$

Then, by lemma 1 and lemma 2, step 1 is proven.

Step 2: $V_A(w_A^*(w_{Bf}^*), w_{Bf}^*) \geq V_A(w_{Al}^*, w_{Bf}^*)$.

In fact, we have:

$$V_A(w_A^*(w_{Bf}^*), w_{Bf}^*) = \max_{w_A} V_A(w_A, w_{Bf}^*) \geq V_A(w', w_{Bf}^*)$$

for all w' . Taking $w' = w_{Al}^*$, step 2 is proven. Together, steps 1 and 2 proves the assert of the lemma. QED

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FOOTNOTES

1. Just to mention a few examples, wage bargaining mainly occurs at industry level in Germany and at firm level in the UK. Union density is more than 70% in Denmark, about 40% in Italy, but only 12% in France. Minimum wage is high in France but does not exist in the UK. The duration of the unemployment benefit in years is up to 3.5 in Spain but only 0.5 in Portugal. See Layard (1990) and OECD (1991).

2. From a different perspective, Driffill and van der Ploeg (1993) study the effects of cutting tariffs on trade unions and wage formation. They develop a two-country model of international trade where each country specializes in the production of a homogeneous commodity, and show that unions, in the face of increased international competition between firms, have an incentive to cooperate with unions abroad. In their model institutional arrangements are the same in the two countries and national trade unions ignore the effects of their behavior on foreign wage formation.

3. Dowrick (1989) considers also the efficient bargaining model, in which bargaining is over both wages and employment and these are simultaneously determined. For a discussion of evidence on the scope of bargaining see Layard *et al.* (1991) and references therein.

4. Implicit in this normalization is the assumption that the industry which is considered is small as compared to the aggregate economy, since the price of its output has a negligible impact on the aggregate price index.

5. Actually, Dowrick's (1989) study differs from the present one as he uses a model of parametric conjectural variation oligopoly, which should capture the full spectrum of industry behavior (from Bertrand competition to pure monopoly). He finds that the relationship between the wage and product market collusion crucially depends on product market demand. If demand is elastic, this relationship has the shape of an inverted U. If it is inelastic, the wage is monotonically increasing in the degree of product market collusion. As his results are likely to carry over in the present model, I do not introduce product market collusion explicitly in order to simplify the algebra.

6. The (generalized) Nash solution can be seen as a useful shortcut for a noncooperative bargaining process; see Binmore *et al.* (1986).

7. The superscript on the wage symbol denotes the level of bargaining ("I" for industry, "F" for firm). When necessary, I shall use a subscript to denote the country or firm that is considered.

8. There exists an extensive empirical and theoretical literature on the relationships between the degree of centralization in bargaining, wage pressure, and macroeconomic performance. See e.g. Brunetta and Dell'Aringa (1990) and references therein.

9. Another rationale for lower wages under decentralized bargaining states that such a system is less favorable to union organization, thereby lowering the actual bargaining strength of unions. This is argued by Corneo (1993) in a model with endogenous union

membership and management opposition to unionization.

10. Throughout the paper, the size of a country is identified with the number of firms of the industry which are located in it.

11. Total industry surplus is the sum of consumer surplus, profits, and workers' surplus. In the present model it can be written as $S = Q(a - \bar{w} - \frac{bQ}{2})$. This is a strictly concave function of industry output, which is maximized at $Q^o = \frac{a - \bar{w}}{b} > \frac{n(a - \bar{w})}{(n + 1)b} \geq Q(w_1, \dots, w_n)$, as defined by equation (3).

12. De Fraja's (1993) result is obtained in a dynamic variant of Dowrick's (1989) model, in which unions' behavior is restricted to Markov strategies and firms are assumed to choose their output level according to one-period conjectural variations. However, the force which drives his result is essentially the same as in the present framework, i.e. the possibility of commitment to a selected wage level for a bargaining pair coupled with a positive wage externality.

13. The "Spring offensive" (*Shunto*) of Japanese trade unions may provide an example of such a policy. A counterexample may be staggered collective bargaining in most EEC countries and the US.

14. The experience of unionized EEC countries seems broadly consistent with the result of more wage moderation in smaller countries.

15. There is also a mixed strategy equilibrium in which players randomize between the two bargaining dates. The probability of bargaining at t_0 in country -i is given by $\frac{V_u - V_{IN}}{V_y + V_u - 2V_{IN}}$, which is strictly less than one half.

16. Proofs of the following claims involve the same manipulatory methods used above; their derivation is available from the author upon request.

17. The property of reducing country-specific shocks is not a general one. The divergence in the national employment level that is induced by a country-specific productivity shock will be magnified by competition in the same product market.