Endogenous Wage-Bargaining Institutions in Oligopolistic Sectors

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Abstract: This paper explores the endogenous emergence of wage bargaining institutions in sectors with market power. We show that asymmetries in firms' productivity and in unions' risk aversion and/or bargaining power may generate various degrees of centralization in wage bargaining, which are often observable in real life. In the presence of such asymmetries, a winning coalition of all the unions and (typically) the efficient firms has an incentive to establish wage bargaining centralization at the sectoral level. If productivity differences are high enough, wage bargaining may also occur at the firm level, but only regarding the efficient firms. Otherwise, a completely centralized structure prevails and the sectoral wage deal is simply confirmed by all firms and unions. However, if the sources of asymmetry "cancel out", decentralized wage bargaining is sustained in equilibrium.

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1. Introduction

Real-life labour market institutions display substantial variability, in particular regarding the level at which collective wage negotiations are conducted. In USA, Canada, and Japan, wage bargaining occurs at the firm level alone. In Europe, however, wage negotiations are often conducted at various levels: At the national and the sectoral level in Germany and the Scandinavian countries. They are typically centralized at the sectoral-level in Italy, the Netherlands, Spain, France and Portugal. Wage negotiations are carried out at all three levels (national, sectoral, and firm level) in Belgium and Greece, while they are mainly decentralized at the firm level in UK and Ireland (see e.g. Layard *et al*., 1991; Hartog and Theeuwes, 1992). Under this light, a two-fold question naturally arises: Why such a striking cross-country variety of wage-bargaining centralization exists, and how do these alternative institutional structures emerge? Economic theory has, up to date, hardly addressed such inquiries.

Recently, the literature has assigned a crucial role on the degree of wage bargaining centralization, because it has been shown to have a significant impact on the equilibrium outcomes in unionized labour markets (see e.g. Davidson, 1988; Dorwick, 1989; Corneo, 1996; Padilla *et al*., 1996). If, for instance, firm-union wage bargaining takes place independently at the firm level, wages may be lower and aggregate employment higher, than under wage-bargaining centralization at the sectoral level.[1] This literature, however, treats the degree of the wage-bargaining centralization as an exogenous institutional characteristic. Moreover, only the cases of *complete centralization*, or *complete decentralization*, are explicitly considered. There is no attempt so ever to

[1] This holds true whenever the scope of negotiations covers only wages (*Right-to-Manage*) and the product market is imperfectly competitive. This is so, because agents inside each firm/union bargaining unit do not fully internalize the market-wide effects of their decisions. Therefore, competitive wage cutting incentives drive wage bargains downwards.

explain under which circumstances each of these two polar cases emerges; or why collective wage agreements may be carried out at various levels, as it is evident from many labor markets.

In this paper we develop a framework of endogenous determination of wage-bargaining structures. Our analysis builds on the fundamental game-theoretic postulate that a collective arrangement could be established, only if a winning coalition among self-interested agents involved in the issue finds its establishment beneficial.[2] In the context of unionized labour markets, we argue that all the firms and unions in a specific sector, are those who are actively involved in the determination of the degree of wage bargaining centralization. Our analysis suggests that asymmetries in productive efficiency among firms and risk aversion/bargaining power asymmetries among unions may effectively be responsible for the emergence of various degrees of wage bargaining centralization across countries, or across sectors within a country.

In particular, we consider a homogeneous good sector where technologically asymmetric firms compete *a lá Cournot* in the product market. In the labour market, centralized firm-union wage bargains are conducted whenever a *"Minimum Sectoral Wage Institution"* (*MSWI*) has firstly been collectively agreed upon by the labour market participants. Wage negotiations at the firm level are subsequently conducted, during which a firm and its own employees' union may, or may not, decide to lift the firm-specific wage rate above the sectoral wage floor. If, however, a *MSWI* has not been established, the firm-specific wages are determined through completely decentralized wage

[2] In fact, this is only a necessary condition, since institutional resolutions authorizing those collective arrangements should also prove to be equilibrium outcomes of some well-defined political processes. However, since our focus is to explore the economic factors that could lead to interest-compatible institutional resolutions, we shall assume that the level of wage bargaining is decided upon by self-interested labour market participants, leaving the government the role of simply approving, or not, their decisions.

bargains. We argue that, during decentralized negotiations, unions may differ in their members' risk aversion and may, therefore, exhibit different bargaining behavior (see e.g. Svejnar, 1986).[3]

Our main result is that, asymmetries in the firms' productive efficiency and the unions' risk aversion and/or bargaining power are the driving forces that may potentially lead to the emergence of alternative centralized wage-bargaining systems. The key reasoning is as follows. Under completely decentralized wage negotiations, technologically advanced firms will pay higher wages than their inefficient rivals (unless their unions are much weaker than their rivals' unions in the negotiation table). As a result, the efficient firms' relative technological advantage is partially dissipated due to their higher relative wage costs. A sectoral minimum wage deal (with mandatory extension) could then play a strategic role in the rivalry among efficient and inefficient firms. Once established, the less productive firms are obliged to pay a wage rate at least equal to the sectoral wage floor. Efficient firms have an incentive to opt for a high enough minimum wage in order to reduce their relative wage cost disadvantage, "stealing" thus market share from their inefficient rivals and increasing their profits. This is in line with the "Raising Rivals' Costs" literature (Salop and Scheffman, 1983, 1987; Williamson, 1968).

Clearly, the efficient firms' unions share the same interest with their employers, since the establishment of a sectoral wage floor would imply both higher wages and more jobs for their members. More interestingly, the inefficient firms' unions could also benefit from a minimum wage, provided that the wage floor is not too high to drastically reduce their employers' market shares. In this case, the higher rents that these unions enjoy over-compensate for the ensuing losses in jobs. Therefore, since inefficient firms are the only labor market participants suffering from the

[3] Technological and bargaining power asymmetries have also been considered in Padilla *et al.* (1996). The authors analyze the ensuing vertical spillovers between labor and product markets, taking however the institutional setup as given (decentralized bargaining).

establishment of a sectoral wage floor, firm-union centralized wage negotiations are expected to lead to a binding, albeit not too high, minimum wage deal. Clearly then, efficient firms have an incentive to search for partnership with all the unions in order to form a "winning" coalition that could effectively establish a Minimum Sectoral Wage Institution.

Our analysis entails two variations of the wage bargaining centralization structure. If the firms' productivity differences are *ceteris paribus* high enough, the inefficient firms' unions are expected to "resist" high sectoral wage floors in order to avoid the marginalization of their employers and the ensuing drastic employment cuts for their members. Wage negotiations will then be conducted at the firm level too, but only regarding the efficient firms, with the inefficient firms and their unions simply confirming the minimum sectoral wage as their firm-specific wage rate. This will, in turn, lead to a *partially decentralized wage bargaining structure*, which is in fact quite often observed in real-life. In contrast, if the firms' productivity differences are not too high, the efficient firms are expected to "resist" the unions' demands for high sectoral wage floors. The established minimum wage will then be binding for all firm/union pairs, implying that wage bargains never take place at the firm level. This case is equivalent to a *completely centralized wage bargaining structure.*

Similar results are, quite interestingly, obtained if the efficient firms' unions' bargaining strength is too low (relatively to that of their rivals' unions) so that the wage cost of the inefficient employers turns out to be higher under completely decentralized wage bargains. Surprisingly in this case, the inefficient firms are the partners of unions in the winning coalition that has an incentive to promote sectoral wage bargaining centralization. Finally, if technological and risk aversion/bargaining power asymmetries "cancel out" (or they are absent at first place), leading thus to wage cost equalization under decentralized bargains, the strategic incentives for wage bargaining arrangements beyond the status quo firm-level wage negotiations are absent. A *complete wage bargaining decentralization structure* is then expected to prevail.

The rest of the paper is organized as follows. In Section 2, our basic model with risk-averse monopoly unions is presented and the decentralized wage setting case is analyzed. Section 3 highlights the strategic role that minimum sectoral wage deals could play in the rivalry among technologically asymmetric firms. Moreover, the preferences over alternative minimum wage rates of all the firms and the unions in the sector are derived and the interest of a winning coalition among the labor market participants to establish a binding wage floor is demonstrated. In Section 4, the sectoral minimum wage deal is determined. It also includes a brief discussion of alternative political processes via which the preferred by the majority of labour market participants wage centralization structure could be institutionalized by a self-interested government. Section 5 generalizes our results in the case where the status quo institution is decentralized firm-union wage negotiations. In Section 6, we analyze the implications of endogenous wage bargaining centralization for wage differentials, production patterns, aggregate employment and consumer welfare. Finally, Section 7 concludes.

2. The Basic Model

We consider a homogeneous good sector where two firms, on principle endowed with different technologies, compete *a lá Cournot* in the product market. For simplicity, we assume that production technologies exhibit constant returns to scale and require only labour input to produce the good.[4] Firm i's production function is $y_i=k_iN_i$, where y_i denotes the output, N_i the labor input and k_i the productivity of labor in firm i. Firm 2 possesses a superior technology than firm 1, i.e. $k_2\geq k_1$.

[4] This is equivalent to a two-factor Leontief technology where the amount of capital is fixed in the short run and is large enough not to induce zero marginal product of labor.

Normalizing $k_1=1$ and setting $k_2=k$, k measures the relative efficiency of technologies. We call firm 1 "inefficient" and firm 2 "efficient". We further assume that $k<5/3$, i.e. technological asymmetries are not so excessive that only the efficient firm can survive in the market. We also assume, for tractability, that market demand is linear and is given by $P(Y)=a-Y$, where Y is the aggregate output ($Y=y_1+y_2$).

The labour market is unionized. Workers are organized into two firm-specific unions that act as "closed shops". This is reasonable, since different technologies may require workers of distinct skills and this often creates conflicting interests among employees in different firms. Let union i be the firm i's union. Abusing terminology, we refer to the (in-) efficient firm's union as the (in-) efficient union. Each union is of the utilitarian type, maximizing the sum of the individual workers' utilities, i.e. union i's objective is to maximize

$$U_i = (w_i - w_0)^{\varphi_i} N_i \tag{1}$$

where w_i is the firm i's wage rate and w_0 the workers' outside option.[5] We shall assume that $w_0 / a < k(5k-3)/2(2k-1)$, a sufficient condition guaranteeing positive output and profits for both firms for all the relevant values of the minimum wage (see below). Finally, $0 \leq \varphi_i \leq 1$ can be thought of as the relative rate of risk aversion of the representative member of union i, provided that union membership is fixed and all members are identical (see e.g. Oswald, 1982; Booth, 1995; Pencavel, 1991). Alternatively, φ_i may denote the representative union i's member elasticity of substitution between wages and employment. Unions, on principle, differ in their representative members' wage-employment elasticity of substitution. In the basic model we assume that each union possesses all the power to set its firm-specific wage rate, while employment decisions are left

[5] Assuming that the sector is small relative to the aggregate economy, the impact of the unions' actions on the aggregate price index is negligible and thus unions care only about nominal wage rates.

to the firms' discretion (*Monopoly Union*). In section 5 we show that our results can easily be extended in the case where firms and unions negotiate over the firm-specific wage rates.

In the basic model, the *status quo* labour market institution is *completely decentralized* union wage setting. Nevertheless, it is at the labour market participants' discretion to collectively decide upon the establishment of sectoral level minimum wage contracting, provided that a "winning" coalition among those agents finds its establishment to their own benefit. Further, as long as the amendment of the existing institution gains substantial support by the involved agents, it is expected that a self-interested government should authorize the amendment by institutionalizing *wage bargaining centralization* with *mandatory extension.* The sequence of events is as follows.

In the first stage, the labour market participants (firms and unions) collectively decide in favor, or against, an amendment of the existing institution that establishes collective negotiations about a Minimum Sectoral Wage with a mandatory extension clause (i.e. a *MSWI*). Assigning the same number of votes (for simplicity, one vote) to the representatives of each firm's shareholders and each union's members, a Minimum Sectoral Wage Institution emerges whenever the amendment obtains a (simple) majority of votes.[6] Otherwise, the status quo decentralized wage setting institution prevails.

Once the Minimum Sectoral Wage Institution (*MSWI*) has been established, firms and unions collectively settle a minimum wage rate for the sector, in the second stage. To simplify the analysis, we shall assume that a mediator (e.g. a committee of experts) proposes a sectoral wage floor and the firms' and unions' representatives may then accept, or reject, the proposal via simple majority voting. Moreover, to resolve for the multiplicity of outcomes, we shall assume that a

[6] In fact, the procedure by which a new labor market institution is established is along these lines in a number of countries. In Spain, for example, a group of firms and unions, representing a majority of shareholders and workers, have the power to establish a new institution (see e.g. Jimeno, 1992; Petrakis and Vlassis, 1999).

committee, who knows the preferences of the involved parties over alternative minimum wages, will make a proposal equal to the median voter's (or alternatively, the pivotal voter's) most-preferred wage floor. Note, however, that those are simplifying assumptions that do not qualitatively alter our main results.[7]

In the third stage, each union sets its firm-specific wage rate, which cannot be lower than the sectoral minimum wage deal. If, on the other hand, the *status quo* institution prevails, the game directly proceeds to the firm-specific wage setting stage where, however, a wage floor is absent. In the last stage, firms make their employment and output plans. Thus, since employment decisions are at the firms' discretion, this is a *Right-to-Manage* model (Nickell and Andrews, 1983). We assume that all parties take into account the consequences of their decisions on the subsequent stages of the game. That is, we restrict attention to subgame perfect equilibria.

Consider first the employment-output stage of this game. Firm *i* chooses its output (hence, employment) to maximize profits, $\pi_i = (a - y_i - y_j)y_i - w_i N_i = (a - y_i - y_j)y_i - \omega_i y_i$, given its rival's output and the wage deal of the previous stage, where $\omega_i = w_i / k_i$ is firm *i*'s wage per efficiency unit of labour. The equilibrium outcome of this standard *Cournot* game is given by,

$$y_i^*(\omega_i, \omega_j) = (a - 2\omega_i + \omega_j)/3 \tag{2}$$

With $\pi_i^* = (y_i^*)^2$ and $N_i^* = y_i^*/k_i$, $i,j=1,2$. Substituting N_i^* into the union *i*'s objective (given in (1)), it can be checked that $\partial^2 U_i/\partial w_i \partial w_j > 0$, i.e. wages are strategic complements from the unions' point of view. An increase in the rival's wage rate improves firm *i*'s competitiveness in the market and it

[7] As the focus of this paper is on the emergence of the Minimum Sectoral Wage Institution, and *not* on the establishment of a specific minimum sectoral wage rate, we have chosen to model the industry-level collective negotiations in the simplest possible way. Note that our main results remain intact, if one, alternatively, assumes that the outcome of those negotiations is a weighed average, with strictly positive weights, of the involved parties' most-preferred minimum wage rates.

is thus more profitable for union i to opt for an increase in its firm-specific wage, since it will not lose as much in terms of employment.

Consider next the unions' wage setting game. Monopoly union i sets its firm-specific wage rate w_i to maximize (1), given the wage rate set by the rival firm's union and that w_i cannot be lower than the minimum sectoral wage rate w_m agreed upon in the previous stage (if any). The case of completely decentralized wage setting can then be treated by setting $w_m= w_0,$ a wage rate that is never binding for the unions. Taking the logarithm of (1) and using (2), the foc of the union i's unrestricted problem is,

$$\frac{\varphi_i}{(\omega_i - \frac{w_0}{k_i})} = \frac{2}{(a - 2\omega_i + \omega_j)} \tag{3}$$

Then, union i's reaction function, expressed in terms of wage per efficiency unit of labor, is,

$$\omega_i(\omega_j) = Max[\frac{w_m}{k_i}, \frac{a\varphi_i + \varphi_i\omega_j + 2w_0 / k_i}{2(1+\varphi_i)}] \tag{4}$$

Suppose, for the moment, that wage setting is completely decentralized. From (4), the equilibrium wages per efficiency unit of labor are,

$$\omega_i^d = \frac{a\varphi_i(2+3\varphi_j) + [2\varphi_i / k_j + 4(1+\varphi_j)/k_i]w_0}{3\varphi_i\varphi_j + 4(1+\varphi_i + \varphi_j)} \tag{5}$$

and the equilibrium wage rates are, $w_1^d = \omega_1^d$ and $w_2^d = k\omega_2^d$. As expected, w_i^d increases with the workers' outside option w_0.

It can be seen from (5) that, if both unions' members are equally risk-averse ($\varphi_1 = \varphi_2$), the efficient firm's wage is higher than its inefficient rival's. Hence, due to the decentralized wage setting institution, the efficient firm's relative technological advantage is dissipated, either partially if $w_0>0$ or thoroughly if $w_0=0$ (in which case both firms face the same marginal cost).

<Insert Figure 1 here>

Clearly, the efficient firm enjoys its full technological advantage only if $w_1^d=w_2^d$. From (5), this occurs if $k=\Gamma(\varphi_1,\varphi_2)\equiv\varphi_1(2+3\varphi_2)/\varphi_2(2+3\varphi_1)$, provided that $w_0=0$. In addition, it can be seen that, for given k and φ_1, the critical value of φ_2 equalizing the firms' wages is negatively related to w_0. These are shown in Figure 1, where the locus $k=\Gamma(\varphi_1,\varphi_2)$ lies below the 45-degree line for all $k>1$ (and it shifts down, as k increases). If $w_0=0$, the inefficient firm's wage rate is higher than the efficient firm's wage below the locus $k=\Gamma(\varphi_1,\varphi_2)$. Nevertheless, as the workers' outside option w_0 increases, the locus where the firms' wages are equal shifts down, making thus the parameter space under which the inefficient firm pays a higher wage rate to shrink.

An inefficient firm's union, whose members are sufficiently less risk-averse than the efficient union's counterparts, could set an equally high (or even higher) wage rate, despite the technological disadvantage of its employer. Further, as its members' outside option improves, a union cares less about wage increases as compared to employment cuts (since from (1) $-dw_i/dN_i=\dfrac{(w_i-w_0)}{\varphi_i N_i}$, which is negatively related to w_0). Hence, the higher w_0 is, the weaker are the inefficient union's incentives to set a high wage rate, because such a wage will induce significant job losses due to the marginalization of its employer. Proposition 1 summarizes all the above:

Proposition 1: *Under decentralized wage setting, for any given φ_1, there exists a critical value $\hat{\varphi}_2(k,w_0)<\varphi_1$ such that for all $\varphi_2>\hat{\varphi}_2$, $w_1^d<w_2^d$, and for all $\varphi_2<\hat{\varphi}_2$, $w_1^d>w_2^d$. Moreover, $\partial\varphi_2^*/\partial k<0$ and $\partial\varphi_2^*/\partial w_0<0$.*

Proof: From (5) we have $w_2^d - w_1^d = k\omega_2^d - \omega_1^d = a[C(k) + D(k)(w_0 / a)]/[3\varphi_1\varphi_2 + 4(1+\varphi_1 + \varphi_2)]$, where $C(k) = \varphi_2(2+3\varphi_1)k - \varphi_1(2+3\varphi_2)$ and $D(k) = 2[2(\varphi_1 - \varphi_2) - \varphi_1 / k + \varphi_2 k]$. Note that *C(.)* and *D(.)* are increasing in *k* and $C(1) = 2(\varphi_2 - \varphi_1) = -D(1)$. Since $w_0<a$, we see that if $\varphi_2 > \varphi_1$, then $w_2^d>w_1^d$ for $k=1$, and thus for all $1 \le k \le 5/3$. If, on the other hand, $\varphi_2 < \varphi_1$, then $D(k)>0$ for all $1 \le k \le 5/3$. Thus, $G(k, w_0 / a) \equiv C(k) + D(k)(w_0 / a)$ is increasing in both *k* and w_0/a in this case. Now by setting w_0/a equal to its maximum permissible value, $k(5-3k)/2(2k-1)$, and plotting the zero contour line of the *G* function in the (φ_1, φ_2)- unit square for different values of *k,* $1<k<5/3$, we observe the following. For any given φ_1, there is a $\hat{\varphi}_2 < \varphi_1$, such that for all $\varphi_2 > \hat{\varphi}_2$, $w_2^d > w_1^d$ and for all $\varphi_2 < \hat{\varphi}_2$, $w_2^d < w_1^d$. Moreover, since *G* increases with w_0/a (given *k*) and is positive for all $\varphi_2 \ge \varphi_1$, we can conclude that, for any other value of w_0/a, the zero contour line of the *G* function lies between the diagonal and the line corresponding to the maximum permissible w_0/a. Therefore, $\hat{\varphi}_2$ decreases with w_0/a. Finally, for given w_0/a, the zero contour line shifts down with *k*; hence, $\hat{\varphi}_2$ decreases with *k*. Q.E.D.

Furthermore, by substituting (5) into (2) we get the equilibrium outputs y_i^d, employment levels $N_i^d= y_i^d/k_i$ and firms' profits $\pi_i^d=(y_i^d)^2$. In addition, using the f.o.c. (3), the unions' welfare is given by, $U_i^d = (3\varphi_i / 2)^{\varphi_i} k_i^{-1+\varphi_i} (y_i^d)^{1+\varphi_i}$, where

$$y_i^d = \frac{2\{a(2+3\varphi_j) - [(4+3\varphi_j)/k_i - 2/k_j]w_0\}}{3\{3\varphi_i\varphi_j + 4(1+\varphi_i + \varphi_j)\}} \tag{6}$$

It can be checked that $y_i^d > 0, i = 1,2$ for all $1<k<5/3$ and $w_0 / a < k(5-3k)/2(2k-1)$.

3. The Strategic Role of Minimum Sectoral Wages

Suppose that a minimum wage w_m (with mandatory extension) has been established in the industry. In this section we determine the impact of the minimum wage on the firms' profits and the unions' welfare. We particularly emphasize situations in which the minimum wage turns out to benefit a group of firms by raising their rivals' costs, creating thus incentives for those firms to strategically opt for the establishment of a Minimum Sectoral Wage Institution.

We intentionally start our analysis with the case where such strategic incentives are absent. This occurs whenever the unions' decentralized wage setting leads to equal wage rates for the efficient and the inefficient firm. As we saw above, the equilibrium wage rates are equal whenever the firms' technological asymmetries and the unions' risk-aversion differentials cancel out (or, they are absent at first place i.e. if *k=1* and $\varphi_1 = \varphi_2$). If $w_1^d = w_2^d \equiv \hat{w}$, from (4) it is then easy to see that the equilibrium wage rates are $w_1^* = w_2^* = w_m$ for all $w_m \geq \hat{w}$ (and $w_1^* = w_2^* = \hat{w}$ otherwise). A sufficiently high wage floor becomes binding for both firms' unions. Hence, from (2)

$$y_1^* = [a - (2 - 1/k)w_m]/3 \qquad\qquad y_2^* = [a - (2/k - 1)w_m]/3 \tag{7}$$

Since $k < 5/3$ and $\pi_i^* = (y_i^*)^2$, it is clear that both firms' profits decrease with a binding wage floor. Obviously, no firm would ever vote in favor of a binding minimum wage proposed by a mediator, and furthermore, no firm would have an incentive to opt for the establishment of a *MSWI*.[8] In contrast, both unions benefit from a binding wage floor, provided that w_m is close enough to $\hat{w}$. To see this, note that $U_i = (w_i - w_0)^{\varphi_i} y_i^*(w_i / k_i, w_j / k_j) / k_i$ and thus,

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[7] A similar reasoning applies if the *MSWI* establishes sectoral wage negotiations between firms and unions. Since firms and unions have opposing interests over the issue, no minimum wage would ever be established, unless a mediator imposes a specific sectoral wage floor. In this case too, no firm would have an incentive to opt for the establishment of the *MSWI*, as wage bargaining centralization could never benefit, and may sometimes hurt the firm.

$$\frac{d\ln U_i}{dw_m} = \frac{\partial \ln U_i}{\partial w_i}\frac{dw_i}{dw_m} + \frac{\partial \ln U_i}{\partial w_j}\frac{dw_j}{dw_m} \tag{8}$$

where $dw_i / dw_m = dw_j / dw_m = 1$ and from (2), $\partial \ln U_i / \partial w_j = (\partial y_i^* / \partial \omega_j) / y_i^* k_j > 0$ for all $w_m \geq \hat{w}$ (a first-order effect); while from the f.o.c. (3), $\partial \ln U_i / \partial w_i = 0$ for $w_m = \hat{w}$ and negative, but arbitrarily close to zero, for all w_m close enough to $\hat{w}$ (a second-order effect). The minimum wage, by removing the unions' wage undercutting incentives, acts as a facilitating collusion device, leading thus to a higher welfare level for both unions. As expected, unions prefer centralized wage negotiations. Nonetheless, unions would be unable to establish a *MSWI* in order to promote their interests, unless they could form a strategic alliance with one of the firms. This is nevertheless impossible in this case where the various sources of asymmetries cancel out, and therefore the *status quo* institution of decentralized wage setting is sustained. Proposition 2 summarizes.

Proposition 2: *Whenever the firms' technological asymmetries and the unions' risk-aversion differentials cancel out (or, they are absent at first place), the prevailing institution in the industry will be the status quo completely decentralized wage setting.*

We now turn to the more interesting case where the firms' technological asymmetries and the unions' risk aversion differentials imply that, under decentralized wage setting, the firms' wage rates are *not equal* in equilibrium. We will treat both, the "common" case where the efficient firm wage rate is higher (NW region in Figure 1) and the less frequent case where the efficient union's members are so risk-averse that their firm, despite its technological advantage, turns out to pay a lower wage (SE region).

Let $w_i^d > w_j^d, i, j = 1,2$. From (4) we get,

$$w_j^* = w_m \quad w_i^* = \frac{a\varphi_i k_i + \varphi_i (k_i / k_j) w_m + 2w_0}{2(1+\varphi_i)} \quad \text{if } \underline{w} \leq w_m \leq \overline{w} \tag{9}$$

and $w_i^* = w_j^* = w_m$ if $w_m \geq \overline{w}$, where $\underline{w} = w_j^d$ and $\overline{w} = \frac{a\varphi_i k_i + 2w_0}{2(1+\varphi_i) - \varphi_i (k_i / k_j)}$ (Obviously, if $w_m < \underline{w}$, then $w_i^* = w_i^d, i = 1,2$). As the minimum wage increases, it initially becomes binding only for the union of the low wage firm under the decentralized regime, while later it becomes binding for both firms' unions. Interestingly, the initial wage differential, $w_i^d - w_j^d$, shrinks as the minimum wage increases, vanishing altogether for high enough values of w_m (see Figure 2). This can be seen from Eq. (9), as $0 < dw_i^* / dw_m = \varphi_i k_i / 2k_j (1+\varphi_i) < k_i / 4k_j < 5/12$ for all $0 < \varphi_i \leq 1$ and k<5/3; hence, the positively-sloped straight line $w_i^*(w_m)$, which starts above the 45^0-line at $w_m = \underline{w}$, necessarily intersects with the 45^0-line at a sufficiently high w_m.

<Insert Figure 2 here>

A low enough minimum wage has no impact on the unions' wage setting behavior. On the other hand, if the minimum wage is sufficiently high, both unions prefer to simply confirm the wage floor for their employed members. While, for intermediate values of w_m, the union that would have set the low wage under the decentralized regime, simply confirms the wage floor for its employed members, while the rival union optimally sets a higher wage rate. Nonetheless, the higher the minimum wage is, the weaker is the latter union's incentive to impose a wage drift (see Figure 2). This implies that the relative cost disadvantage of the high wage-under the decentralized regime-firm becomes less severe as w_m increases, vanishing thoroughly for a sufficiently high w_m. By means of a high enough wage floor, the high wage firm can "steal" market share from its rival and increase its revenues, paying however at the same time a higher wage to its own employees. The positive business stealing effect always dominates the negative increase in its own-costs effect. Clearly then, the high wage firm has an incentive to strategically opt for a high enough minimum wage during the sectoral wage settlement stage (see below). Furthermore, for sectoral wage negotiations to become effective, the firm should also vote in favor of the establishment of a *MSWI.*

The following Proposition summarizes the impact of the minimum wage on the firms' profits.

Proposition 3: *If* $w_i^d > w_j^d$*, then:*

(i) Firm i's profits increase with w_m *for* $\underline{w} \le w_m \le \overline{w}$ *and decrease all for* $w_m > \overline{w}$*. Thus, firm i's most-preferred minimum wage is* $m_{Fi} = \overline{w}$*.*

(ii) The firm j's profits decrease with w_m *for all* $w_m \ge \underline{w}$*. Thus, the firm j's most-preferred minimum wage is w.l.o.g* $m_{Fj} = \underline{w}$*.*

Proof: Substituting the equilibrium wage rates (9) into (2) yields:

$$y_j^* = \frac{a(2+3\varphi_i) + 2(w_0/k_i) - (4+3\varphi_i)(w_m/k_j)}{6(1+\varphi_i)} \tag{10a}$$

$$y_i^* = \frac{a - 2(w_0/k_i) + w_m/k_j}{3(1+\varphi_i)} \tag{10b}$$

Thus $\partial y_j^*/\partial w_m < 0$ and $\partial y_i^*/\partial w_m > 0$. Now since $\pi_i^* = (y_i^*)^2$, firm *j*'s profits decrease, while firm *i*'s profits increase with w_m, for all $\underline{w} \le w_m \le \overline{w}$. Moreover, since for all $w_m > \overline{w}$, $\partial y_i^*/\partial w_m < 0, i = 1,2$, the firm with the relative wage cost disadvantage under decentralized wage setting benefits from the existence of a high enough wage floor, with its most-preferred minimum wage, m_{Fi}, being the one that nullifies the wage differential with its rival, i.e. $m_{Fi} = \overline{w}$. On the other hand, the firm with the initial wage cost advantage will be hurt from the existence of any wage floor. It thus prefers a non-binding minimum wage and we can set w.l.o.g. $m_{Fj} = \underline{w}$. Q.E.D.

Whenever, for instance, the efficient firm is the high wage employer under the decentralized regime (the common case), its technological advantage will partially be dissipated due to its higher wage costs. The efficient firm could then recover (part of) its initial advantage by imposing a wage floor on its inefficient rival, at the expenses however of paying a higher wage to its own employees. Since, nonetheless, there is a substantial market share increase from recovering its technological advantage, the efficient firm's profits will increase. On the other hand, as the effect of the minimum wage is to drastically reduce the market share of the inefficient firm, the latter will oppose the existence of any sectoral wage floor.

Consider next how the unions' welfare is affected by the existence of a wage floor w_m. Union i, who sets the high wage under the decentralized regime, clearly benefits from a minimum wage which is binding only for its rival union's workers. Not only more of the union i's members can now find jobs, but they also receive higher wages. Also, union j benefits from the wage floor, provided that the minimum wage is not too high. A sufficiently low wage floor, by weakening the union i's wage-undercutting incentives, results in only few job losses for the union j' s members. This low magnitude (negative) effect is over-compensated by the first-order positive effect due to the wage increase, leading thus to a higher level of welfare for union j. Therefore, both unions have a clear incentive for the establishment of a not too high, albeit binding for the inefficient union's members, minimum wage rate. The following Proposition summarizes:

Proposition 4: *If $w_i^d > w_j^d$, then:*

(i) Union i's welfare is either increasing in w_m for all w_m or it reaches its maximum at some $w_m > \overline{w}$. Thus, union i's most-preferred minimum wage is $m_{Ui} > \overline{w}$.

(ii) Union j's welfare is increasing in w_m for all w_m above, but close enough to, $\underline{w}$. Depending on the parameter values, it may reach its (global) maximum at some w_m smaller, equal, or greater than $\overline{w}$. Thus, union j's most-preferred minimum wage is $m_{Uj} > \underline{w}$.

Proof: First, $dU_i / dw_m > 0$ for $\underline{w} \leq w_m \leq \overline{w}$, since from (9) and (10b), w_i^*, y_i^* and thus N_i^* increase with w_m in this range. In addition, U_i increases with w_m for wage floors above, but close enough to, $\overline{w}$, because from Eqs. (1) and (2), for $w_m \geq \overline{w}$, we have:

$$\frac{d \ln U_i}{dw_m} = \frac{\varphi_i}{w_m - w_0} + \frac{-(2/k_i - 1/k_j)}{a - (2/k_i - 1/k_j)w_m} \tag{11}$$

Hence, $d \ln U_i / dw_m > 0$ if and only if $a\varphi_i k_i k_j - (2k_j - k_i)[w_m(1+\varphi_i) - w_0] > 0$. Further, it can be checked that this slope evaluated at $w_m = \overline{w}$ is proportional to $a - (2/k_i - 1/k_j)w_0$, which is always positive for all k<5/3. Finally, since the slope is decreasing in w_m, the most-preferred minimum wage for union i is, $m_{Ui} = \max[w_u, \frac{a\varphi_i k_i k_j + (2k_j - k_i)w_0}{(1+\varphi_i)(2k_j - k_i)}] > \overline{w}$, where w_u is the highest w_m such that the inefficient firm's output is still non-negative, i.e. $w_u = ka/(2k-1)$ (from Eq. (7)).

Obviously, $m_{Ui} < w_u$ if the inefficient union sets the high wage under the decentralized regime. This is so, because $N_1^* = y_1^* = 0$ at $w_m = w_u$, and thus the inefficient union's welfare equals zero for $w_m = w_u$. Interestingly, $m_{Ui} > \overline{w}$ i.e. the inefficient union's welfare increases even for values of w_m above, but close enough to, the minimum wage that becomes binding for both firms' unions. The reason is that the decrease in employment due to the higher labor costs is more than compensated by the wage increase for values of w_m above, but close enough to, $\overline{w}$. On the other hand, if the efficient union sets the high wage under the decentralized regime and the technological advantage of its firm is, *ceteris paribus*, high enough, the efficient union's most-preferred w_m is, in fact, the minimum wage w_u that shuts down the inefficient firm. This completes the proof of part (i).

Union j that sets the low wage rate under the decentralized regime also benefits from a not too high w_m, since we have that

$$\frac{d\ln U_j}{dw_m} = \frac{\partial \ln U_j}{\partial w_j}\frac{dw_j^*}{dw_m} + \frac{\partial \ln U_j}{\partial w_i}\frac{dw_i^*}{dw_m} \qquad (12)$$

where $dw_j^* / dw_m = 1$ and $dw_i^* / dw_m = \varphi_i k_i / 2k_j (1+\varphi_i) > 0$ (from Eq. (9)); moreover, from Eqs. (1) and (2), $\partial \ln U_j / \partial w_i = (\partial y_j / \partial w_i) / y_j^* = 1/(3k_i y_j^*) > 0$. If we evaluate this slope at $w_m = \underline{w}$, $\partial \ln U_j / \partial w_j = 0$; hence, $d\ln U_j / dw_m$ is positive for w_m close enough to $\underline{w}$. Finally, to determine union j's most-preferred minimum wage rate, m_{Uj}, turns out to be a complicated task and it is relegated to Appendix A. Q.E.D.

Propositions 3 and 4 imply that three (out of the four) involved labor market parties, each acting for its own interest, have an incentive to establish a wage floor high enough to become binding for at least one of the unions, during the firm-level union wage setting game. While it is not surprising that both unions are better off with the guarantee of a minimum wage for their members, it is the strategic pursuit of the firm that pays the high wage under the decentralized regime that may enable the establishment of a sectoral wage floor.

4. Endogenous Wage-Bargaining Institutions

Let us now proceed in the second stage of the game where a mediator (e.g. a committee of experts) proposes a minimum wage rate and the representatives of the involved labor market parties vote in favor, or against, the proposal. It is reasonable to assume here that if the proposed w_m receives the (simple) majority of votes, it will be established as the sectoral wage floor. Obviously, a minimum wage $w_m^{\#}$ above, but close enough to, $\underline{w}$ proposed by the mediator will receive the votes of the three (out of the four) representatives and $w_m^{\#}$ will then be established as the sectoral minimum wage. This is so, because by Propositions 3 and 4, firm i's profits and both unions' welfare increase with w_m for w_m close enough to $\underline{w}$. Thus the representatives of all these parties will vote in favor of the mediator's proposal, while firm j's representative will vote against. Yet, there is an infinite number of proposals that lead to higher utility for both unions and higher profits for firm i than under the decentralized regime and any of those will receive the majority of votes.

One possible way to resolve this multiplicity issue which could also make the outcome of this stage resembling more to that of real-life collective wage negotiations among firms' and unions' representatives is as follows.[9] Assume that the mediator, who knows the preferences of all the involved parties over alternative minimum wages, makes a proposal equal to the pivotal voter's most-preferred w_m. This could be justified on the grounds that it is the pivotal voter who delivers the decisive power of the coalition of parties supporting the proposal. This is, of course, one of a few possible assumptions. Alternatively, the proposed minimum wage could be equal to the most-preferred w_m of the median voter.[10] Propositions 3 and 4 imply that the supporting coalition

[9] Negotiations among four parties at the sectoral level for the determination of the minimum wage is a complicated issue and there is still no satisfactory theory providing unique solution to the problem.
[10] In this case, however, the multiplicity issue remains, since there is an even number of voters in our case and the mediator's proposal could be any w_m between the second and third voter's most-preferred

consists of both unions and firm i and moreover that, depending on the parameter constellation, the pivotal voter is either firm i or union j.

In particular, in the common case, the pivotal voter is the efficient firm when the firms' technological asymmetry is small (low k). In this case both unions prefer a minimum wage greater than $\overline{w}$ and hence the pivot is the efficient firm with its most-preferred w_m being equal to $\overline{w}$. The latter will then be established as the minimum sectoral wage, i.e. $w_m^* = \overline{w}$.[11] As the wage floor is binding for both unions, unions will simply confirm w_m^* as their firm-specific wage rate. Hence, there will be no firm-level wage setting and this case corresponds to a *completely centralized* wage bargaining structure. On the other hand, if the firms' technological asymmetry is large (high k), the pivotal voter is the inefficient union. To avoid the marginilization of its firm and the ensuing drastic job losses for its members, the inefficient union will "oppose" a high wage floor. The established wage floor will be then $w_m^* = m_{U1} < \overline{w}$. The inefficient union will simply confirm w_m^* as its firm-specific wage, while the efficient union will set a wage rate higher than the sectoral wage floor. This case corresponds to a *partially decentralized* wage bargaining structure.

A similar analysis applies in the less frequent case where the inefficient union sets the high wage under the decentralized regime. It is now the inefficient firm and both unions who will vote in favor of a binding wage floor. In particular, if k is sufficiently low, the pivotal voter is the efficient

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minimum wage rate (with the only restriction that the second voter's utility be higher than when he votes against the proposal). It is easy though to check that this alternative assumption does not qualitatively alter our basic results.

[11] Of course, this requires that the inefficient union's utility is higher at $\overline{w}$ than at the non-binding wage floor $\underline{w}$. If this is not so, the mediator, to guarantee acceptance, could instead propose a (binding) minimum wage equal to the inefficient firm's most-preferred w_m in the range $[\underline{w}, \overline{w}]$. Alternatively, it could propose a w_m higher than $\overline{w}$ such that the inefficient union's utility and the efficient firm's profits are slightly higher than at $\underline{w}$.

union and the established minimum wage will be $w_m^* = m_{U2} < \overline{w}$. Whenever the firms' technologies are quite similar, the efficient firm's union prefers a low enough wage floor because it can thus diminish the negative consequences from the employment cuts for its members. This is, again, a partially decentralized wage bargaining structure, where at the firm level only the inefficient union will set a wage rate higher than the sectoral wage floor. On the other hand, if k is high enough, the inefficient firm turns out to be the pivot and the established wage floor is then, $w_m^* = m_{F1} = \overline{w}$.[12] In this completely centralized wage bargaining structure, both unions simply confirm w_m^* as their firm-specific wage rates. The following Proposition summarizes.

Proposition 5: *If the (in-)efficient union sets the high wage under decentralized wage setting i.e. if* $w_1^d < (>) w_2^d$, *then a winning coalition consisting of the two unions and the (in-) efficient firm will vote in favor of the binding minimum sectoral wage proposed by the mediator. Assuming that the mediator's proposal equals the pivotal voter's most-preferred* w_m, *a completely centralized wage bargaining structure will (typically) emerge in equilibrium, provided that* $w_1^d < w_2^d$ *and k is low enough or else,* $w_1^d > w_2^d$ *and k is large enough. In this case, both unions simply confirm the established* w_m^* *as their firm-specific wage. Otherwise, a partially decentralized wage bargaining structure emerges in equilibrium. If* $w_1^d > (<) w_2^d$, *the (in-)efficient union simply confirms the established* w_m^* *as its firm-specific wage.*

As suggested by Proposition 5, a majority coalition of the involved labor market parties benefits from the amendment of the status quo decentralized wage-setting regime and will thus collectively decide in favor of a sectoral minimum wage settlement with mandatory extension in the

[12] An analogous comment as that of the previous footnote is due here. If $\overline{w}$ does not satisfy the participation constraint of the efficient union, the mediator should make an alternative proposal in order to receive three out of the four votes in favor.

first stage. Nevertheless, it is at the government's discretion to institutionalize this amendment, or not. In the former case, the Minimum Sectoral Wage Institution is established. In the latter case, however, the status quo institution is, at least officially, sustained.

In the spirit of Political Economy, the government's decision to establish, or not, a *MSWI* should be the equilibrium outcome of a reasonably postulated political process, a task that is beyond the scope of the present paper. The government's decision should, nonetheless, depend on the support it expects to find from the involved labor market participants in the specific sector. For instance, if one evokes *Downsian competition* among office-seeking political parties (Downs, 1957), our findings suggest that, in economies with high union density, it is quite likely that an office-motivated government would include the *MSWI* issue in its political agenda. If not, the government would run the risk of losing a critical mass of prospective votes, i.e. the unions' members and e.g. the efficient firm's shareholders in the specific sector, which would turn instead to the rival party during the forthcoming elections. A similar argument applies if one appeals to *special interest politics*. Under this approach, the political equilibrium often depends on the way of interaction between lobbying groups and electoral competition. A reasonable principle that one can here evoke is that "office-seeking politicians use the lobbying revenues to influence voters" (see e.g. Persson and Tabellini, 1999). In our case, the lobbying group is obviously formed by the (in-) efficient firm's shareholders, who have a strategic incentive to establish a *MSWI* whenever the (in-) efficient union sets the high wage under the decentralized regime. In this case, even without receiving any funds from this lobbying group, the government may in fact favor its special interests. This is so, because the establishment of a *MSWI* also benefits both unions and this, in turn, is expected to "translate" to prospective votes during the forthcoming elections. In addition, the opposing group (i.e. the rival firms' shareholders) does not seem to "possess" adequate votes to counter-influence the government's choice. Proposition 6 summarizes:

Proposition 6: *Whenever firms' technological asymmetries and unions' risk-aversion differentials lead to unequal firm-specific wages under the decentralized wage setting regime (i.e. $w_1^d < w_2^d$ or $w_1^d > w_2^d$), a MSWI may endogenously emerge as the outcome of the collective decision among the involved labor market parties. The MSWI may also be the equilibrium outcome of the political process in which case the government will officially establish it. The driving force behind both arrangements is that, beyond a subset of employers, this institution proves to be on the best interest of all unions in the sector.*

5. Bargaining Power and Other Negotiation Process Asymmetries

In this section we show that other sorts of asymmetries could also generate strategic incentives for the establishment of a (binding) minimum sectoral wage and could thus lead to the emergence of a *MSWI*. We, firstly, consider asymmetries in bargaining power in a model similar to our basic model that differs only in the following aspects. First, unions are of the utilitarian type that maximize rents (Oswald, 1982), i.e. union *i*'s objective is,

$$U_i(w_i, N_i) = (w_i - w_0)N_i \tag{13}$$

That is, both unions' members are risk-neutral; or else, they have unitary elasticity of substitution between wages and employment. This is a simplification of our basic model where we have set $\varphi_1 = \varphi_2 = 1$. Unions, however, may differ in their bargaining power during the wage negotiations with their own firms. If β_i represents the union *i*'s bargaining power, then β_i can be greater, equal, or smaller than β_j. This is the new source of asymmetry that replaces the unions' risk-aversion differentials considered in the basic model. It is worth stressing that a (monopoly) union's risk-aversion and a union's bargaining power, have a similar impact on the union's wage bargaining behavior. The higher the union's power or the smaller its members' risk-aversion is, the higher is the firm-specific wage rate. In fact, an observed low wage rate could be due either to the wage setting behavior of a powerful (e.g. monopoly) union with fairly risk-averse members, or to the wage negotiations conducted between a weak union with risk-neutral members and its firm.

Second, the status quo institution is decentralized wage-bargaining where each firm negotiates with its own union over the firm-specific wage rate. Firm-level wage bargains are conducted *simultaneously* in "closed doors", in the sense that there is no information exchange between bargaining sessions before the negotiations are over. In other words, no firm/union pair, while negotiating, receives any information about the process of the negotiations in the rival pair.[13] As a result, each firm/union pair has to decide over its firm-specific wage rate taking the rival firm's wage as given. Under these circumstances, it is appropriate to employ Nash equilibrium to solve for the wage rivalry between the two bargaining sessions. In fact, this is the standard inter-sessions equilibrium concept used in the decentralized negotiations literature (see e.g. Dorwick, 1989; Padilla *et al*., 1996).

On the other hand, the solution concept used for the determination of the wage rate inside each bargaining session is more controversial. An extensive body of the literature follows the

[13] If, on the contrary, a firm/union pair is informed e.g. about the outcome of the negotiations in the rival session, one or both wage bargainers may have an incentive to strategically postpone the agreement in order to become Stackelberg leaders in the wage determination stage. In fact, when wages are strategic complements, this incentive is usually present and *sequential* bargaining may arise in equilibrium. We

axiomatic approach (mainly, the generalized Nash Bargaining Solution), while more recently the game-theoretic approach (the Alternating Offers model) is often employed. Under some conditions, these two approaches lead to the same outcome. It is well-known that in single (independent) two-party negotiations, the equilibrium outcome of the alternating offers model coincides with the outcome of the generalized Nash bargaining solution (see Binmore *et al.*, 1986). Unfortunately, there are still no equivalence results in the literature for multiple, interrelated two-party negotiations (as is the case in our model). In particular, in union-oligopoly models with simultaneous decentralized negotiations, the outcome of the alternating offers approach may crucially depend on a number of factors, such as: To which extent and what type of information is exchanged between the bargaining sessions during the negotiations. What happens in the product market if one session reaches an agreement while the other still negotiates and in particular, whether the firm of the former session becomes a monopolist, or not, in the market in the meantime, or production starts only after both negotiations are over. Due to all these complications that may arise in our framework, we are "coerced'' to consider alternative solution concepts. Interestingly, however, our main results seem to be robust under alternative assumptions about the wage bargaining process.

First, we employ the generalized Nash bargaining solution to determine the wage rate schedule inside each bargaining session. Given the wage bargain struck at the rival session, each firm/union pair chooses the wage rate to maximize the (weighed) Nash product, with the restriction that this wage cannot be lower than the minimum sectoral wage w_m. Equivalently, firm/union pair i selects its wage per efficiency unit of labor ω_i to solve,

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refrain from all these complications by focussing in cases where there is no information revelation before both negotiation sessions are over.

$$\max_{\omega_i} \{\pi_i^*(\omega_i,\omega_j)^{1-\beta_i}[(\omega_i - w_0/k_i)y_i^*(\omega_i,\omega_j)]^{\beta_i} \qquad s.t.\, \omega_i \geq w_m/k_i \tag{14}$$

where y_i^* and π_i^* are firm i's output and profits in the market competition stage (see Eq. (2)). From the first order condition of (14) we get the firm/union pair i's reaction function,

$$\omega_i(\omega_j) = \max[\frac{w_m}{k_i}, \frac{a\beta_i + \beta_i\omega_j + 2(2-\beta_i)w_0/k_i}{4}] \tag{15}$$

Let $\beta_i = 2\varphi_i/(1+\varphi_i)$, with $d\beta_i/d\varphi_i > 0$, $\beta_i = 0$ for $\varphi_i = 0$ and $\beta_i = 1$ for $\varphi_i = 1$. Interpreting φ_i as a (monopoly) union *i* members' risk-aversion, it is easy to see that with this transformation, the firm/union pair *i*'s reaction function coincides with that of the monopoly union *i* of our basic model (see Eq. (4)). The two problems are thus mathematically equivalent. Therefore, all the results of the basic model, with suitable interpretation, hold in the (simultaneous) decentralized firm-level wage bargaining model too.

For instance, whenever, due to technological and bargaining power asymmetries, decentralized firm-level negotiations lead to unequal wages, the firm facing the higher wage cost has a strategic incentive for a binding minimum sectoral wage. As both unions also benefit from the presence of a (not too high) wage floor, a committee's proposal to establish a minimum wage (e.g. equal to the most-preferred w_m of the median or the pivotal voter) will do receive the majority of votes of the involved parties. As a consequence, a two (sectoral and firm)-level wage bargaining institution will emerge in equilibrium.[14]

Second, consider the alternating offers model of bargaining. Let δ_{Ui} and δ_{Fi} be the discount factor of union *i* and firm *i*, respectively. The interpretation is that if $\delta_{Ui} < \delta_{Fi}$, union *i*'s members are more impatient than firm *i*'s managers to settle down to a wage agreement. Assume that the firm i makes the first offer (i.e. a wage schedule proposal) and the union i accepts or rejects. If the union accepts, both parties will adopt the firm's proposal. In case of rejection, the union i makes a counter-offer, which the firm can accept or reject. If this offer is accepted the negotiations are over. If it is rejected, the firm makes a second offer, which the union can accept or reject, and so on ad infinitum. Since there is no exchange of information between the two sessions during the negotiations, firm i and its union, while making their offers/counter-offers, take as given (or else, correctly anticipate) the wage bargain struck at the rival session. An additional complication, however, arises in this setting. If firm/union pair j has settled to a wage agreement, while firm/union i's negotiations are still in progress, does firm j become a monopolist in the market in the meantime? Or, production starts only after negotiations in both sessions have been concluded? The latter assumption seems to be more reasonable for our static, multi-stage model where product market competition follows clearly the labor market competition (i.e. wage rivalry) stage.[15] Under this assumption, the alternating offers model leads to the same outcome as the generalized Nash bargaining solution. In particular, the firm/union pair i's reaction function of the generalized Nash bargaining solution (see Eq. (15)) is the limit, as the time interval between two successive offers goes to zero, of the equilibrium firm/union i reaction functions in the alternating offers model (For a proof see Appendix B).

Finally, and more interestingly, let the negotiation process inside each bargaining session be a "black box". In general, the outcome of firm/union pair i negotiations will then be expected to be a weighed average (with non-negative weights) of the most-preferred wage rate of firm i

[14] For a detailed analysis and interpretation of the results for the decentralized firm-level negotiations case see Petrakis and Vlassis (1996).

[15] Note that the former assumption is fairly extreme. In a fully dynamic model, if firm/union pair i still negotiates when firm/union pair j has settled to an agreement, it would be reasonable to assume that firm i produces in the market with a wage cost equal to the wage agreed in the previous round of negotiations.

and union i. Note that, the firm's most-preferred wage is always equal to the workers' outside option w_0, *independently* of the wage bargain struck at the rival session. While the union's most-preferred wage is a function of the rival's unit anticipated wage deal (as it influences the relative productive efficiency of its firm and thus the union members' employment opportunities), as well as the workers' outside option, the demand conditions and other product market characteristics. Assuming that there is no wage floor in the industry, the firm/union i's bargained wage schedule, in terms of wages per efficiency unit of labor, can be expressed as,

$$\omega_i(\omega_j) = \lambda_i \omega_{Ui}(\omega_j;.) + (1-\lambda_i)(w_0 / k_i) \tag{16}$$

where ω_{Ui} is the union i's most-preferred wage rate and $0 \leq \lambda_i \leq 1$ can be interpreted as the union i's power. For instance, $\lambda_i = \beta_i$ if a fair representation of the negotiations is given by the generalized Nash bargaining solution, while $\lambda_i = r_{Fi} / (r_{Fi} + r_{Ui})$ if the negotiation process is conducted according to the *strict rules* of the alternating offers model described above. In a more general case, λ_i could reflect all the idiosyncratic features of the negotiation process between firm i and union i. Then, even if unions have the same bargaining power, the λ-weight of two bargaining sessions could be different simply because of existing asymmetries in the negotiation process between the sessions. On the other hand, $\omega_{Ui} = [a + \omega_j + 2(w_0 / k_i)]/4$ if union i's objective is as in Eq. (13), while it is given by (4) if it is as in Eq. (1). Moreover, differences in the unions' ω_{Ui} could be due to differences in their objectives, or due to the firms' technological asymmetries or to any other product market asymmetries. Note that Eq. (16) leads to the same structure as Eq. (15). Our theory then predicts that if the various sorts of asymmetries cancel-out, leading to equal wages for both bargaining sessions, there will be no incentive for the establishment of a sectoral wage floor and a *MSWI* will not emerge in equilibrium. In the opposite case, there will be circumstances under which wage-bargaining centralization will emerge in equilibrium.

6. Employment and Welfare Effects

Our analysis has a number of interesting implications for the wage structure and employment, as well as production patterns and consumers' welfare, in sectors with market power. First, if wage-bargaining centralization emerges endogenously, wage differentials between employees of efficient and inefficient firms are expected to substantially decrease, or even to be eliminated. In that narrow sense therefore, distribution of income is improved. Second, wages are always higher than under the completely decentralized wage bargaining institution. As a result, aggregate production is lower,[16] product price is higher, and hence consumers' welfare is lower. Despite that some of their members will be left unemployed under sectoral wage bargaining centralization, unions' total rents are always higher than under the decentralized regime. Further, the firm that has the initiative to establish wage bargaining centralization will benefit from the new institution, while the rival firm will always be hurt. In the common case where the efficient firm pays the higher wage under the *status quo* institution, its profits increase with the establishment of the Minimum Sectoral Wage Institution, while the inefficient firm's profits decrease. The opposite is true for the less frequent case where the inefficient firm faces a higher wage cost under the decentralized regime.

[16] This is so, since in a constant-returns-to-scale, Cournot competition market, aggregate output depends only on the sum of marginal costs.

Third, if the efficient firm pays a higher wage under the *status quo* decentralized regime (the common case), the equilibrium wage bargaining institution induces a production shift to the "right direction", i.e. the efficient firm's market share increases. In this case, sectoral wage bargaining centralization is an efficiency-enhancing institution. However, in the less frequent case where the inefficient firm pays the higher wage under the decentralized regime, there is a production shift towards the "wrong direction", augmenting thus the inefficiency due to the labor market imperfections. Finally, sectoral employment is always lower under wage bargaining centralization. It is clearly lower in the common case, because aggregate production decreases and the market share of the firm employing the labor-saving technology increases. It is also true in the less frequent case, since as it can be checked from (10a&b), aggregate employment $N^* = N_1^* + N_2^* = y_1^* + y_2^* / k$ decreases with w_m.

Regarding their distribution and employment effects, our results are, nonetheless, not novel in the literature. A minimum national/sectoral wage always acts as a redistributive tool (see e.g. Freeman, 1996). In particular, a sectoral minimum wage acts as a "sword of justice" (see Dolado *et al*., 1997), shifting the earnings distribution in favor of the low-paid workers. However, since some of those workers will be left unemployed, there may be adverse employment effects. Our theory suggests that distribution among high-paid and low-paid employees will be improved, at the cost of inefficient employers. Moreover, we provide a clear explanation for the predicted negative employment effects of sectoral wage bargaining centralization. The latter implies higher unit labour costs for all the firms in the industry. This, in conjunction with a labor-saving production shift, leads naturally to a lower sectoral employment. On the other hand, even if there is a production shift towards the labor-intensive firm, its magnitude does not compensate for the reduction of the labor demand due to the shrinkage of the aggregate output.

7. Conclusions

In this paper we have developed a theoretical framework for the endogenous determination of alternative wage-bargaining structures that are actually observed in unionized sectors. We have shown that economic factors, such as technological and risk aversion/bargaining power asymmetries, may effectively generate various degrees of sectoral wage-bargaining centralization. If the existing asymmetries do not “cancel out”, a winning coalition of all the unions and (typically) the efficient firms has an incentive to establish a Minimum Sectoral Wage Institution and will certainly lobby for it. Moreover, if firms’ productivity differences are *ceteris paribus* small enough, wage negotiations will be conducted at the sectoral level alone, i.e. complete centralization will emerge in equilibrium. Otherwise, wage negotiations will also be conducted at the firm level and thus a partially decentralized structure will emerge. On the other hand, if those asymmetries cancel out, complete wage-bargaining decentralization is sustained in equilibrium.

Productivity asymmetries have been shown to determine the extent of bargaining centralization also in a different context. Jun (1989) analyzes union formation decisions when a firm employs two groups of workers, a high- and a low-productivity group. Before entering in wage negotiations with the firm, workers decide to form a joint union or two separate unions. If productivity differences are small enough, a joint union is established, which then negotiates with the firm about wage(s). Otherwise, two separate unions are formed, which then simultaneously negotiate with the firm, each over its own wage.

Recently, there has been rising interest in studying the macroeconomic implications of various labour market institutions (see e.g. Calmfors and Driffil, 1988; Jackman *et al* 1990; Jimeno, 1992). This literature shows that the degree of wage-bargaining centralization significantly affects long-run unemployment and inflation rates. It thus becomes all the more important to understand and analyze, as our framework attempts, the conditions under which a certain degree of wage-bargaining centralization may endogenously emerge, as well as to study its consequences at the sectoral and macroeconomic level. Our analysis predicts that asymmetries across firms and unions could lead to the establishment of some degree of centralization. The latter will always lead to a lower sectoral level of employment due to the higher labor costs and (typically) the induced shift of production towards the efficient firms. Policy measures could then be carefully designed, targeted towards a group of labor market participants, who, acting for their own interest, could promote the establishment of socially desirable institutions.

Appendix A

Proof of Proposition 3 (continued):

The union j's most-preferred minimum wage, m_{Uj}, can be smaller, equal or greater than $\overline{w}$, depending not only on which union sets the high wage under the decentralized regime, but also on the whole array of the parameter values. To see this, one can check by Eqs. (1) and (10a) and after setting $d\ln U_j / dw_m = 0$ that, for values of w_m in the range $[\underline{w}, \overline{w}]$, the maximum of U_j is attained at

$$\mu_{Uj}^{I} = \max[\overline{w}, \frac{a\varphi_i(2+3\varphi_j)k_i + \{2\varphi_i(k_i/k_j)+4+3\varphi_j\}w_0}{(1+\varphi_i)(4+3\varphi_j)}]$$

Note further that, under some conditions, the slope of $U_j(w_m)$ evaluated at $\overline{w}^{+}$ is positive, i.e. union j's welfare is increasing in w_m for values of w_m above, but close enough to, $\overline{w}$. This occurs because, as the minimum wage increases, firm j's output (and employment) decreases more for intermediate values of w_m, $w \le w_m \le \overline{w}$, than for its higher values, $w_m > \overline{w}$. Indeed, for $w \le w_m \le \overline{w}$, $\left|dy_j^* / dw_m\right| = (4+3\varphi_i)/6(1+\varphi_i)k_j \ge 7/12k_j$ for all $0 < \varphi_i \le 1$ (from Eq. (10a)), while for $w_m \ge \overline{w}$, $\left|dy_j^* / dw_m\right| = [2-(k_j/k_i)]/3k_j \le 7/15k_j$ for all k_i, k_j <5/3 (from Eq. (2)). In the range of w_m where only union j faces a binding wage floor, union i can adjust upwards its wage by less than the full increase in the minimum wage that its rival union is obliged to confirm for its employed members. Due to the increase of its rival firm's relative cost advantage, firm j's market share and output is reduced, leading thus to additional losses of jobs for union j's members. The latter effect is clearly absent when both unions face a binding wage floor, since both unions can only confirm a given increase in the minimum wage. As a result, firm j's output reduction and union j's job losses are smaller as w_m increases in the upper range of values of w_m. This leads, under some parameter values, to an increase of union j's welfare for w_m above, but close enough to, $\overline{w}$. In particular, the maximum of U_j is attained at $\mu_{Uj}^U = \max[\overline{w}, \frac{a\varphi_j k_i k_j + (2k_i - k_j)w_0}{(1+\varphi_j)(2k_i - k_j)}]$ for values of $w_m \geq \overline{w}$ (This is obtained in a similar way as m_{Ui} above; see Eq. (11)). Finally, if $U_j(\mu_{Uj}^I) > U_j(\mu_{Uj}^U)$ then $m_{Uj} = \mu_{Uj}^I$; otherwise, $m_{Uj} = \mu_{Uj}^U$. Even though the exact shape of union j's welfare as a function of w_m depends on all the parameters of the model, it can be fairly well described in terms of the relative efficiency parameter k alone.

In the common case where the efficient union sets the high wage under the decentralized regime, if the technological advantage of its firm is sufficiently high, the inefficient union's most-preferred w_m is smaller than $\overline{w}$. In order to avoid the marginilization of its firm and the ensuing drastic reduction in its members' jobs, the inefficient union prefers a moderate wage floor. In fact, for high values of k, the inefficient union's welfare reaches a unique maximum at some $w_m < \overline{w}$; while for lower values of k, it is doubled-peaked, with its highest value attained at some $w_m < \overline{w}$. In contrast, if technological asymmetries are not too strong, the inefficient union can opt for a high wage floor without jeopardizing too many jobs for its members. In this case, for small values of k, the inefficient union's welfare increases for all $w \leq w_m \leq \overline{w}$ and reaches its maximum at some $w_m > \overline{w}$; while for higher values of k, it is double-peaked, with its highest value attained at some $w_m > \overline{w}$.

On the other hand, in the less frequent case where the inefficient union sets the high wage under the decentralized regime, we have the following. For high values of k, the efficient union's welfare is single-peaked with the most-preferred w_m being higher than $\overline{w}$. For intermediate values of k, it is doubled-peaked with its maximum attained at some $w_m > \overline{w}$. While for low values of k, it is doubled-peaked with $m_{U2} < \overline{w}$. If the technological asymmetries are not too strong, the efficient union faces significant employment cuts due to an increase of the minimum wage and hence prefers a moderate sectoral wage floor. Otherwise, it will opt for a minimum wage that becomes binding for both unions.

Appendix B

Proof of the statement on page 31: Let production and market interaction start only after negotiations in both sessions are over. We are looking for the subgame perfect equilibrium firm/union pair i's wage proposals, taking as given (or else, correctly anticipating) the wage bargain struck at firm/union pair j, w_j. Let $w_{it}^F(w_j)[w_{it}^U(w_j)]$ be firm i's [union i's] wage proposal in period t. Assuming that a minimum sectoral wage w_m, with mandatory extension, has been established in the previous stage, these wage proposals are legally restricted to be at least equal to w_m. Now it is well-known that a vector $\{w_i^{F*}, w_i^{U*}\}$ constitutes a subgame perfect equilibrium of the infinite horizon bargaining model if and only if,

$$\pi_i^*(w_i^{U*}, w_j) = \delta_{Fi}\pi_i^*(w_i^{F*}, w_j) \quad \text{and} \quad U_i(w_i^{F*}, w_j) = \delta_{Ui}U_i(w_i^{U*}, w_j) \qquad \text{(A1)}$$

That is, the equilibrium wage proposals are such that the firm (union) is indifferent between accepting now the union's (firm's) offer or waiting for one period and making its counter-offer. If we work, for convenience, with wages per efficiency unit of labor, we get from Eq. (2) and (13) the following system of equations:

$$(a - 2\omega_i^{U*} + \omega_j)^2 = \delta_{Fi}(a - 2\omega_i^{F*} + \omega_j)^2 \qquad \text{(A2)}$$

$$(\omega_i^{F*} - w_0 / k_i)(a - 2\omega_i^{F*} + \omega_j) = \delta_{Ui}(\omega_i^{U*} - w_0 / k_i)(a - 2\omega_i^{U*} + \omega_j) \tag{A3}$$

Solving the above system we obtain $(\omega_i^{F*}, \omega_i^{U*})$ as functions of the wage bargain struck at the rival session, as well as the firm *i*'s and the union *i*'s discount factors δ_{Fi} and δ_{Ui}, respectively. Set $\delta_{Fi} = e^{-r_{Fi}\Delta t}$ and $\delta_{Ui} = e^{-r_{Ui}\Delta t}$, with $r_{Fi}(r_{Ui})$ the (instantaneous) discount rate of firm *i* (union *i*). Taking the limit as $\Delta t \to 0$, i.e. when the time interval between two successive offers goes to zero, we get

$$\omega_i^{F*} = \omega_i^{U*} = \max[\frac{w_m}{k_i}, \frac{ar_{Fi} + \omega_j r_{Fi} + 2(r_{Fi} + 2r_{Ui})w_0 / k_i}{4(r_{Fi} + r_{Ui})}] \tag{A4}$$

Letting $\beta_i = r_{Fi} / (r_{Fi} + r_{Ui})$, then $\partial\beta_i / \partial r_{Fi} > 0$, $\partial\beta_i / \partial r_{Ui} < 0$, $\beta_i = 0$ for $r_{Fi} = 0$ (if $r_{Ui} > 0$) and $\beta_i = 1$ for $r_{Ui} = 0$. Note that, as union *i*'s discount rate r_{Ui} decreases, its members become more patient (δ_{Ui} increases) and thus the union's bargaining power β_i increases. Also, as firm *i*'s discount rate r_{Fi} increases, its managers become more impatient (δ_{Fi} decreases) and thus the firm's power, $1 - \beta_i$, decreases. It is easy to see that, with this transformation, firm/union bargaining unit *i*'s reaction function is the same as the one stemming from the generalized Nash bargaining solution (see Eq. (15)). Q.E.D.

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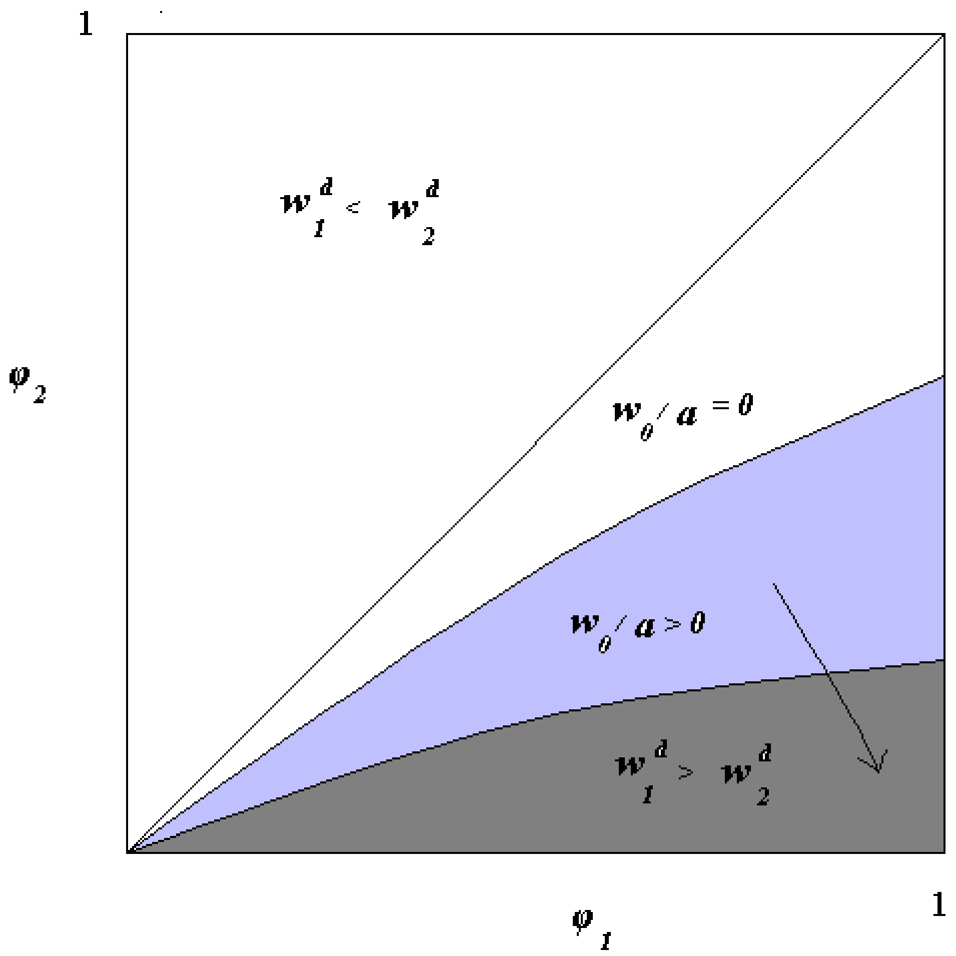

Figure 1

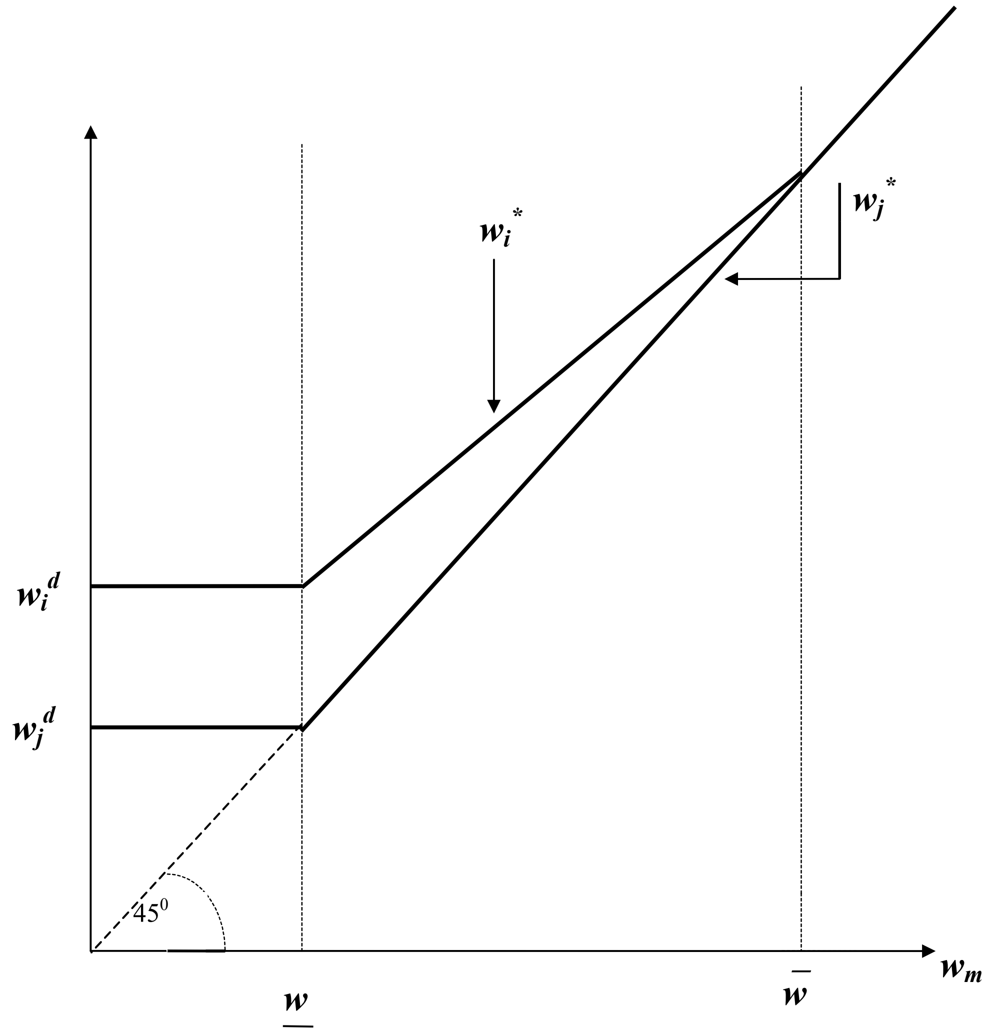

Figure 2