

## The incentives of employers' associations to raise rivals' costs in the presence of collective bargaining

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**The Incentives of Employers' Associations  
to Raise Rivals' Costs in the Presence of  
Collective Bargaining**

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## ABSTRACT

### **The Incentives of Employers' Associations to Raise Rivals' Costs in the Presence of Collective Bargaining**

by Justus Haucap, Uwe Pauly and Christian Wey\*

This paper explores the role that employers' associations may play in centralized wage bargaining processes. It thereby adds to the literature on labor markets, in which the relationship between union behavior and unemployment has been explored quite extensively, while employers' associations have been almost escaped economic analysis so far. The paper shows that employers' associations may possibly foster a wage increase due to their potential incentives to raise rivals' costs. In a simple model, it is shown that employers' associations can use standard wages as a barrier to entry to product markets if producers differ in labor productivity. We identify conditions, under which unions will prefer entry deterring standard wages compared to a system of competitive wage determination, and the paper shows that there may be cases in which a centralized union acting in a wage revenue maximizing manner may actually prevent minimum wages from raising above certain levels. Depending on the exact parameter values unions may then offset the adverse effects employers' federations can have on the industry's employment rate. Starting from our formal model we argue that minimum wage legislation might actually be favored by employers' federations. Furthermore, we show that the German labor law provides for a mechanism to set minimum wages by the industry itself: Wage agreements between unions and employers' associations can be made legally binding for the entire industry through a so-called *Allgemeinverbindlicherklärung*. As a final example we analyze the incentives the West German employers' association had to implement high wages in Eastern Germany in order to avoid competition from labor-inefficient, but low-wage East German firms.

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## ZUSAMMENFASSUNG

### **Die Anreize von Arbeitgeberverbänden zur strategischen Kostenerhöhung bei kollektiven Lohnverhandlungen**

Diese Arbeit untersucht die Rolle von Arbeitgeberverbänden in zentralisierten Lohnverhandlungen. Der Beitrag ergänzt die existierende Literatur über Arbeitsmärkte, in der zwar die Beziehungen zwischen Gewerkschaftsverhalten und Arbeitslosigkeit ausgiebig analysiert werden, die Rolle der Arbeitgeberverbände jedoch fast durchweg im verborgenen bleibt. Die Arbeit zeigt, daß Arbeitgeberverbände unter Umständen bestrebt sind, Lohnerhöhungen durchzusetzen, um die Lohnkosten von nicht-organisierten Konkurrenzunternehmen überproportional zu erhöhen. In einem einfachen Modell wird bewiesen, daß ein Arbeitgeberverband Anreize hat, allgemein verbindliche Löhne als ein Instrument zur Errichtung von Markteintrittsbarrieren zu benutzen, wenn die nicht-organisierten Unternehmen eine niedrigere Arbeitsproduktivität aufweisen. Des weiteren wird die Rolle einer Gewerkschaft untersucht, die die Lohnsumme ihrer Mitglieder maximiert. Es werden die Parameterkonstellationen spezifiziert, so daß die Gewerkschaft einen Lohn präferiert, der unter dem marktzutrittsverhindernden Lohn liegt, den der Arbeitgeberverband durchsetzen möchte. Auf der Grundlage des Modells argumentieren wir, daß Arbeitgeberorganisationen unter Umständen für die Implementierung von Minimallöhnen eintreten. Als weitere Anwendungen des Modells diskutieren wir die Allgemeinverbindlicherklärung (AVE) von Tarifvereinbarungen in Deutschland und die Bereitschaft der westdeutschen Arbeitgeberverbände nach der Wiedervereinigung Deutschlands, die rasche Angleichung des ostdeutschen Lohnniveaus an das Westdeutschlands zu befürworten.

*“[...] in 1990 I still thought that West German firms would help East German firms to become competitive. Many of those (West German) firms’ only interest was, however, to eliminate competition.”* Former German Chancellor Helmut Kohl in a newspaper interview for “Die Zeit”, August 27, 1998, No. 36 (translated by the authors).

## 1 Introduction

In Germany wage bargaining occurs mainly at both, the national and the sectorial level.<sup>1</sup> One core institution of the German system of collective bargaining is the so-called “Tarifautonomie,” which empowers unions, employers and employers’ associations to bargain collectively.<sup>2</sup> Although only unions, employers and employers’ associations that are involved as bargaining parties are bound by the contract (§3 I TVG) the coverage of the agreement goes way beyond the bargaining parties themselves. In particular, according to Article 5 TVG collective wage settlements can be made generally binding for the entire industry by the so-called “Allgemeinverbindlichkeitserklärung” (AVE).

This paper develops a theoretical model to examine the effects of the AVE institution within the German system of bilateral wage bargaining, where wages are determined by an industry-wide union bargaining with a single employers’ association. The paper is concerned with the anticompetitive effects of generally binding wage rates when incumbent firms face potential entrants that are ready to enter the market in an oligopolistic industry. The paper illustrates now the incentives of employers’ association to use the AVE as a means to raise rivals’ costs, and thereby, to deter entry of potential entrants. Within the model we also examine the role a union plays in this setting. Depending on the exact parameter values, bilateral wage bargaining might either lead to standard wage agreements that even exceed the entry deterring level or might induce more efficient wage

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<sup>1</sup>For a cross-country comparison of the degree of centralization see Layard et al. 1991.

<sup>2</sup>The legal grounds for the “Tarifautonomie” can be found in Article 9 Paragraph 3 of the Grundgesetz (GG) and the Tarifvertragsgesetz (TVG).

agreements.

As a topical example, which nicely illustrates the incentives of employers' associations to raise rivals' costs through collective wage agreements, consider wage bargaining in East Germany after reunification. Clearly, East German firms had relatively low productivity levels compared to West German firms. However, by March 1991 the collective bargaining agreement in the metal producing industry specified that wages would be equal for East and West German by April 1994. This and other wage settlements have been so high that many East German firms had to shut down.

In their well-known study about the German reunification Sinn/Sinn 1992 argued that West German employers' associations had no interest in keeping East German wages low, because this would have devalued the existing capital stock in West Germany. According to Sinn/Sinn 1992 low wages would have enabled East German firms to compete, and thereby reduce profits of West German firms. While the employers' associations' representatives paid lip service for the necessity of low wages, union leaders praised them for their "cooperative behavior" during negotiations (Sinn/Sinn 1992).

Yet, despite the intuitive plausibility of anticompetitive abuse of the AVE and the obvious interests of incumbent firms to erect barriers to entry, those effects have not been incorporated explicitly into the theoretical literature dealing with labor market institutions.<sup>3</sup> Even political-economy based studies of labor market institutions tend to neglect employers' associations. While Saint-Paul (1996a, 1996b) focuses on labor market institutions such as employment protection laws, collective bargaining and minimum wages, the role of employers' associations is

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<sup>3</sup>It is also surprising that the numerous theories explaining unemployment (see Bean 1994 and Richter 1997 for surveys) do not consider the role of employers' associations. While the relationship between union behavior and unemployment has been explored quite extensively, employers' associations have hardly been subject to analysis so far. In this context it is also interesting to note that the "Handbook of Labor Economics" (see Ashenfelter/Layard 1986) does not even mention the term "employers' association".

almost completely neglected.

The present paper tries to take first steps to close this gap. Similar to insider-outsider theories of unemployment (see Lindbeck/Snower 1988, Romer 1996) we stress the idea that interest groups and social relations play a significant role in labor markets. Coherent with theories of monopolistic union behavior (see McDonald/Solow 1981) we assume that the labor market is not perfectly competitive, but that market participants have some degree of market power. However, in contrast to much of the existing literature the focus of our paper is not only on union behavior, but also on the incentives employers' associations face in the wage setting process. While theories of monopolistic union behavior usually assume that it is the unions that have some monopoly power, we emphasize the monopoly power of employers' associations. Contrary to conventional wisdom we now claim that employers' associations eventually have incentives to increase wages above the market-clearing level, when wages are generally binding for all active firms in the industry that is covered by the wage agreement.

The idea that firms might put up with cost increases to raise rivals' costs was first developed by Williamson (1963, 1968). While in the first paper Williamson 1963 examined the role of advertising expenses as a barrier to entry, in the latter Williamson explicitly focused on the use of uniform wage rates to induce labor intensive firms to exit a particular industry. More specifically, Williamson analyzed the *Pennington* case -an industrywide wage contract that raised the costs of relative labor-intensive competitors to a larger extent than the costs of relative capital-intensive firms. In his analysis Williamson uses a standard limit pricing model of the Bain-Sylos-Labini type. According to Williamson's analysis larger firms can operate at a more efficient scale and set limit prices which prevent entry into the industry.

Potential entrants are assumed to take the ex ante behavior of incumbent firms as given for the ex post situation when entry has occurred - an assumption that has been correctly criticized by Selten (1965, 1975). Not only are oligopolistic inter-



actions between firms neglected by Williamson 1968, but the behavior of unions -or workers in general- is also not subject to Williamson's analysis. Williamson 1968, 91 rather assumes that "an agreement exists between the principal large scale firms in the industry and the union to impose a uniform wage on all firms in the industry independent of ability to pay." In contrast, the present paper will also analyze the union's incentives to comply with high, non market-clearing wages and introduce oligopolistic interactions into Williamson's basic analysis.<sup>4</sup> In this respect, the paper is related to recent work by Michaelis 1994 who shows that firms which have relatively low costs of avoiding pollution might lobby for tight environmental standards to raise rivals' costs.

Our analysis of employers' associations also touches the labor market literature on the degree of wage bargaining centralization and its implications on macroeconomic variables (see, e.g., Calmfors/Driffill 1988, Freeman 1988, and Jackman et al. 1990). As Petrakis/Vlassis 1997 show, centralized bargaining might lead to wages above the market-clearing level.

Finally, our paper is also related to the analysis of Maloney et al. 1979 and Maloney/McCormick 1982. The former work focuses on strikes and the latter on certain quality standards as a means to restrict industry output and to raise prices above the competitive level. However, in Maloney et al. 1979 the number of firms is exogenously given, i.e., there are no potential entrants. Moreover, while Maloney et al. directly focus on quantity restrictions, we will analyze labor market institutions that raise costs, and thereby preventing firms from entering the market and keeping prices high that way.

The rest of the paper is organized as follows. In Section 2 we develop our model. To illustrate our model, Section 3 discusses German labor market institutions which are designed to extend settlements either by a legal instrument (*Allgemein-*

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<sup>4</sup>Williamson's idea that firms might put up with higher costs if they can raise rivals' costs to a larger degree has been picked up before by Salop/Scheffman (1983, 1987) and Krattenmaker/Salop 1986.

*verbindlicherklärung*) (Section 3.2) or by the German system of Pilot agreements (Section 3.3 and 3.4). Section 4 shows that wage settlements in Eastern Germany after reunification can be explained by our model. Finally, Section 5 gives some policy implications and concludes.

## 2 The Model

The model is kept as simple as possible in order to isolate the impact of the AVE within the German system of bilateral wage bargaining, which is characterized by two main features: First, the main negotiations occur at industry level, and second, there exists one central employers' association and one central union confederation which jointly determine the industrywide standard wage.<sup>5</sup> Therefore, we consider an industry with one union and one employers' association.

The model consists of a simple two-stage game. In the first stage of the game wages are set on the labor market. Then, in the second stage firms compete in Cournot fashion on the product market. Concerning the wage setting process, we will analyze two different regimes of wage determination.

1. *Monopolistic Employers' Association* (ME): The employers' association sets the generally binding standard wage in the first stage of the game without facing a union. At the second stage all firms take the standard wage as given and determine their output levels.
2. *Bilateral Monopoly* (BM): One union and one employers' association bargain about the standard wage. We assume that in the first stage the employers' association proposes a take-it or leave-it offer which the union can either accept or reject. If the union decides to accept the wage proposal of the

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<sup>5</sup>For a comparison of national wage bargaining systems see Bunn 1984 and Calmfors/Driffill 1988. In addition, see Berghahn/Karsten 1987 for a description of the historical roots and the organizational structure of the German employers' associations.

employers' association, this wage becomes the generally binding standard wage. If, however, the union rejects the offer, we assume the bargaining process ends and market clearing wages prevail as the industry's uniform wage. In the second stage, all firms take the standard wage as given and determine their output levels on the product market.

The first regime (ME) serves as a hypothetical benchmark case, to illustrate the incentives of an employers' association to raise rivals' costs by increasing standard wages. The second regime (BM) introduces an industrywide union which puts a restriction on the wage proposals the employers' association can push through. Hence, this regime examines the union's role in a setting where the employers' association has incentives for adopting a raising rivals' costs strategy.

Throughout our analysis we assume the wage rate is the only variable determined in the first stage of the game. This means, we restrict our analysis to *right-to-manage* bargaining, so that each individual firm retains its own management right over the level of employment.<sup>6</sup>

We now solve the game by backward induction. In Section 2.1 we calculate the noncooperative optimal strategies in the second stage of the game. In Section 2.2 we look at the optimal wage offers under the *monopolistic employers' association* regime and the *bilateral monopoly* regime, given the optimal strategies in the second stage of the game.

## 2.1 Second-Stage Equilibrium: Cournot Oligopoly

Suppose that there are  $N$  Cournot competitors in some particular industry producing a homogeneous product. Quantity will be denoted by  $q$ , price by  $p$ . We

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<sup>6</sup>In contrast to the *right-to-manage* model (see for example Nickell/Andrews 1983), the *efficient bargaining* model stipulates that the unions and the firms bargain over wages *and* firms' employment levels. For arguments in favor of the *right-to-manage* model see Layard et al. 1991.

suppose that labor is the only variable input factor, and that the production function is linear in labor.<sup>7</sup> Moreover, let us assume that there are two types of firms characterized by their production costs: Type-H firms with constant marginal cost of  $c_H = \alpha_H w$  and type-L firms with constant marginal cost of  $c_L = \alpha_L w$ , where  $w$  denotes the uniform standard wage for the entire industry. Type-H firms use labor less efficiently than type-L firms, so that the ratio of labor input to output is higher for type-H firms, i.e.  $\alpha_H > \alpha_L$ . Hence, it follows that  $c_H > c_L$ . Type-L firms are now indexed by  $i = (1, \dots, k)$  and type-H firms by  $j = (k + 1, \dots, N)$ . The number of type-L firms is  $k$ , while the number of type-H firms is  $n$  with  $k + n = N$ .

Let us denote aggregate output by  $Q$ , and assume that the linear inverse demand schedule is given by  $p = a - bQ$ , with  $a, b > 0$  and  $\frac{a}{b} > Q \geq 0$ . The aggregate output,  $Q$ , consists of the sum over all quantities produced by type-L firms,  $Q_L \equiv \sum_{i=1}^k q_i$ , and the aggregate output of type-H firms,  $Q_H \equiv \sum_{j=k+1}^N q_j$ ; i.e.,  $Q = Q_L + Q_H$ . Suppose firm  $t$  is of type L, then its maximization problem is given by

$$\max_{q_t} \Pi_t = \left( a - b \sum_{i=1}^k q_i - b \sum_{j=k+1}^N q_j - c_L \right) q_t, \text{ for } t = 1, \dots, k. \quad (1)$$

Solving for the first-order condition, one obtains firm  $t$ 's reaction function

$$q_t(Q_{-t}) = \frac{1}{2b} \left( a - b \sum_{i=1, i \neq t}^k q_i - b \sum_{j=k+1}^N q_j - c_L \right), \quad (2)$$

for  $t = 1, \dots, k$ , where  $Q_{-t}$  denotes the sum of quantities chosen by firm  $t$ 's competitors. Similarly, if firm  $t$  is of type H the maximization problem becomes

$$\max_{q_t} \Pi_t = \left( a - b \sum_{i=1}^k q_i - b \sum_{j=k+1}^N q_j - c_H \right) q_t, \quad (3)$$

for  $t = k + 1, \dots, N$ . Firm  $t$ 's reaction function is now given by

$$q_t(Q_{-t}) = \frac{1}{2b} \left( a - b \sum_{i=1}^k q_i - b \sum_{j=k+1, j \neq t}^N q_j - c_H \right), \quad (4)$$

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<sup>7</sup>As an implication of this assumption there is no optimal scale and production is determined by product market restrictions.

for  $t = k + 1, \dots, N$ . Solving (2) and (4) for  $q_t$ , we obtain the unique (and type-symmetric) Cournot-Nash equilibrium which is characterized by the following quantities for type-L firms,  $q_L$ , and type-H firms,  $q_H$ :<sup>8</sup>

$$q_L = \frac{a - c_L + n(c_H - c_L)}{b(k + n + 1)} = \frac{a + w(n\alpha_H - \alpha_L(n + 1))}{b(k + n + 1)}, \quad (5)$$

$$q_H = \frac{a - c_H - k(c_H - c_L)}{b(k + n + 1)} = \frac{a - w(\alpha_H(k + 1) - k\alpha_L)}{b(k + n + 1)}. \quad (6)$$

Industry output is

$$Q = kq_L + nq_H = \frac{Na - nc_H - kc_L}{b(n + k + 1)} = \frac{Na - w(n\alpha_H + k\alpha_L)}{b(n + k + 1)}. \quad (7)$$

Substituting the equilibrium quantities as given by (5) and (6) into (1) and (3) shows that the equilibrium profit for firm  $t$  is equal to  $bq_t^2$ .

We can now examine how a wage increase affects equilibrium quantities (and thus profits). Inspecting equations (5) and (6) we can immediately see that  $q_L$  is strictly larger than  $q_H$  if the wage level,  $w$ , is positive and the term in brackets in the numerator is strictly positive. In this particular case  $q_L$  increases with higher wages, since the sign in front of  $w$  is positive. On the other hand,  $q_H$  is strictly decreasing in  $w$ . This follows from the sign in front of  $w$  being negative and the term in brackets in the numerator being strictly positive. If, however, the type-H firms do not enter the market, with  $n = 0$  holding, equation (5) reduces to

$$\tilde{q}_L = \frac{a - \alpha_L w}{b(k + 1)}, \quad (8)$$

where the tilde indicates that  $N = k$  firms are active on the product market. In this case, type-L firms' production quantities are strictly decreasing in  $w$ , what can be immediately seen from inspecting equation (8). The following Lemma (1) summarizes the comparative static results of each firm-type's equilibrium quantity with respect to  $w$ .

**Lemma 1** (i) *Type-H firms' equilibrium quantities strictly decrease for increasing values of  $w$ . Equilibrium quantities are positive ( $q_H > 0$ ) for  $w \in [0, w_0[$*

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<sup>8</sup>Second-order conditions are satisfied:  $-b(k + 1) < 0$  for type-L firms and  $-b(n + 1) < 0$  for type-H firms. For expositional convenience we will not explicitly mark optimal values.

with  $w_0 \equiv \frac{a}{\alpha_H + k(\alpha_H - \alpha_L)}$ . For wages equal to or larger than  $w_0$  type-H firms do not enter the market. (ii) As long as all  $N$  firms are active, i.e.  $w \in [0, w_0[$ , type-L firms' equilibrium quantities are (weakly) increasing in  $w$  if and only if  $\frac{\alpha_H}{\alpha_L} \geq \frac{n+1}{n}$ . If, however,  $\frac{\alpha_H}{\alpha_L} < \frac{n+1}{n}$ , the equilibrium quantities of type-L firms are strictly decreasing in wages. (iii) For  $w \in [w_0, (a/\alpha_L)[$  only the  $k$  firms of type L are active; their equilibrium quantities are strictly decreasing in  $w$  over this range. For  $w > (a/\alpha_L)$  no firm produces. (iv) Type-L firms' profits reach a global maximum at  $w = w_0$  if and only if  $\frac{\alpha_H}{\alpha_L} \geq \frac{n+1}{n}$ . (v) Total industry output,  $Q$ , strictly decreases with increasing wage rates.

*Proof.* See Appendix. *Q.E.D.*

Part (i) and (iii) of Lemma (1) are standard results of any Cournot oligopoly model: Every firm's profit depends negatively on the industry's overall marginal production costs. However, as part (ii) reveals this result no longer holds if firms are sufficiently heterogeneous so that the following condition holds:<sup>9</sup>

$$\frac{\alpha_H}{\alpha_L} \geq \frac{n+1}{n}. \quad (\text{HETERO-1})$$

In this case, the more efficient firms (i.e. firms which have relatively low input-output ratios for labor) actually gain from an industrywide wage increase. As long as those firms that have a relatively low labor productivity (the type-H firms) do not exit, equilibrium output of firms that have a rather high labor productivity (type-L firms) strictly increase. As the number of type-H firms increases to infinity, one has

$$\lim_{n \rightarrow \infty} \frac{n+1}{n} = 1, \quad (9)$$

and hence, for sufficiently large  $n$  (HETERO-1) is always satisfied. Furthermore, according to part (iv) of Lemma (1) profits for type-L firms reach a maximum at the point at which type-H firms just decide not to enter or just exit the market. Finally, part (v) of Lemma (1) states that total industry output is strictly

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<sup>9</sup>HETERO is a mnemonics for 'heterogeneity'.

decreasing as  $w$  increases. Since we assume a linear production technology this implies that the level of total industry employment decreases for increasing wage rates.

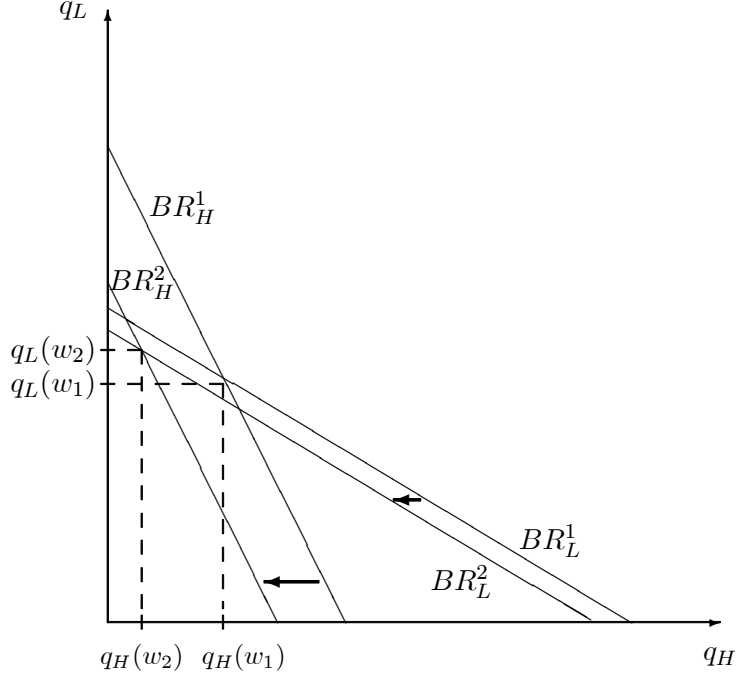
Figure (1) depicts the shift of the best response functions in the duopoly case (i.e.,  $k = n = 1$ ) when the standard wage increases and the (HETERO-1) condition holds. The best response function for the type-L firm,  $BR_L$ , as given by equation (2) is  $q_L = \frac{1}{2b}(a - bq_H - \alpha_L w)$ , and the best response function for the type-H firm,  $BR_H$ , as given by equation (4) is  $q_H = \frac{1}{2b}(a - bq_L - \alpha_H w)$ . According to equations (5) and (6) equilibrium quantities are  $q_L = \frac{a+w(\alpha_H-2\alpha_L)}{3b}$  for the type-L firm and  $q_H = \frac{a-w(2\alpha_H-\alpha_L)}{3b}$  for the type-H firm. Obviously, given that the (HETERO-1) condition is fulfilled an increase in the standard wage reduces the equilibrium quantity of the type-H firm and increases the equilibrium quantity of the type-L firm. Figure (1) illustrates these facts.  $BR_H^1$  and  $BR_L^2$  are the best response functions for the representative type-H and the representative type-L firm in the initial situation 1, in which  $w = w_1$ . Equilibrium quantities are given by  $q_L(w_1)$  and  $q_H(w_1)$ . In situation 2 the standard wage is increased to  $w_2 > w_1$ . Therefore, the two best response functions shift inwards and are represented by  $BR_H^2$  and  $BR_L^1$ . In the new equilibrium the quantity of the type-H firm decreases to  $q_H(w_2)$  while the quantity of the type-L firm increases to  $q_L(w_2)$ .

Figure 2 shows the equilibrium quantities for the type-H firm,  $q_H$ , and for the type-L firm,  $q_L$ , whenever the type-L firm gains from an increase in wages as long as all firms are active; i.e. (HETERO-1) holds. For any given positive wage level the type-L firm's market share is greater than the market share of its type-H rival and the type-L firm's production quantity is increasing until the limit wage,  $w_0$ , is reached. The thick curve in Figure 2 represents the type-L firm's equilibrium profits,  $\Pi_L$ , which are strictly convex in  $w$ .<sup>10</sup> Profits increase for wages below the

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<sup>10</sup>The strict convexity of  $\Pi_L$  can be easily checked by substituting the equilibrium quantities into type-L firm's profit function  $\Pi_L = bq_L^2$ , and differentiating with respect to  $w$  twice. For wages below  $w_0$  we obtain  $\frac{d^2 \Pi_L}{dw^2} = \frac{2}{b} \left( \frac{n\alpha_H - \alpha_L(n+1)}{k+n+1} \right)^2 > 0$ , and for wages  $w \in [w_0, \frac{a}{\alpha_L}[$  we get  $\frac{d^2 \Pi_L}{dw^2} = \frac{2}{b} \left( \frac{\alpha_L}{k+1} \right)^2 > 0$ .

Figure 1: Best Response Functions: Duopoly Case



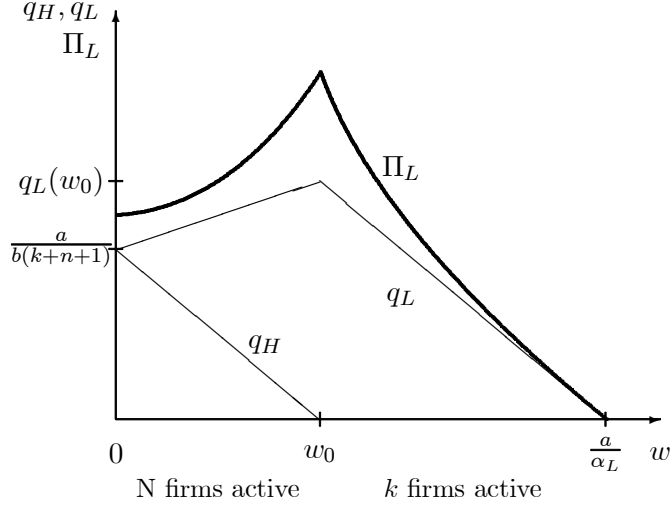
limit wage and decrease for higher wages.

## 2.2 First-Stage Equilibrium: Wage Setting

Next, we look for the subgame perfect equilibria of the game. We thus examine the Nash equilibria in the wage setting stage, taking the optimal strategies in every subgame as given. We define an employers' association as a group of firms with homogeneous interests in the wage setting process. This means, *every* firm within the employers' association must (weakly) prefer the wage proposal of the employers' association compared to the initial situation's wage. Since type-H firms would never agree to a higher wage than the existing one, we assume that type-L firms can coordinate to establish an employers' association by excluding the type-H firms. Alternatively, we may interpret the type-L firms as the incumbents and the type-H firms as the potential entrants, which are relatively less efficient.



Figure 2: Equilibrium Quantities and Type-L Firm's Profits



Furthermore, we assume that, in absence of any labor market institutions such as an employers' association or a union, the initial labor market wage,  $\hat{w}$ , is the efficient equilibrium wage realized in a perfectly competitive market. Therefore, the initial wage,  $\hat{w}$ , represents each worker's reservation utility, so that for any wage proposal below  $\hat{w}$  labor supply within the sector is zero.

In the following, we analyze the wage setting under the two regimes *monopolistic employers' association* (ME) and *bilateral monopoly* (BM).

### 2.2.1 Monopolistic Employers' Association (ME)

Given the initial labor market wage  $\hat{w}$ , the employers' association now chooses a wage  $w^{ME}$  (the superscript "ME" indicates the *monopolistic employers' association* regime) which solves the maximization problem

$$\max_w \quad \Pi_i = (a - bQ_L - c_L)q_i \text{ for all } i = 1, \dots, k \quad (10)$$

$$\text{s.t.} \quad \hat{w} \leq w^{ME} \quad (11)$$

$$q_i \geq 0, \text{ for all } i = 1, \dots, k. \quad (12)$$

Constraint (11) reflects the fact that the wage offer of the employers' association,  $W^{ME}$ , can not fall below workers' reservation wage, which prevails in the absence of any labor market institutions. For any sectorial wage proposal below the initial wage,  $\hat{w}$ , there would be no worker willing to work in this sector. Furthermore, every individual firm's profits within the employers' association must (weakly) increase when compared to a situation without an employers' association. Given the objective function (10) of the employers' association, this constraint is satisfied because all firms within the employers' association are identical.

Let  $\omega'$  denote the set of vectors  $\omega' = (\alpha_H, \alpha_L, k, n) \in R_+^4$  that satisfy (HETERO-1). This enables us to summarize the solution to the above maximization problem as follows.

**Proposition 1** *For  $\omega' \in \omega'$  wage setting by the employers' association is characterized by the following properties: (i) The employers' association maximizes members' profits by setting the standard wage equal to  $w_0$ , and hence deters type-H firms from entering the market. (ii) Wages increase if the initial wage level is below  $w_0$  with the consequence of less sectorial employment. (iii) Wages do not change if the initial wage is higher than  $w_0$ ; full employment is realized and wages remain at  $\hat{w}$ .*

*Proof.* Follows directly from Lemma 1. *Q.E.D.*

From Lemma 1 we know that type-L firms' profits are maximized at  $w_0$  if and only if the (HETERO-1) condition holds. Therefore, all type-L firms would like to increase the standard wage to  $w_0$  for initial wage levels below  $w_0$ . As a result total industry output and sectorial employment levels decrease. If the market-clearing wage,  $\hat{w}$ , is higher than the limit wage,  $w_0$ , the employers' association would like to reduce the wage rate below the initial wage,  $\hat{w}$ . However, as  $\hat{w}$  denotes the workers' reservation wage rate, they will not accept to work for less.

### 2.2.2 Bilateral Monopoly (BM)

Now let us consider the case where the employers' association has to bargain about the standard wage with a single union, but where the employers' association has all the bargaining power. That means, the employers' association makes a take-it-or-leave-it wage offer to the union. The union then either accepts or rejects the offer. If the union does not accept the offer, the initial wage rate of  $\hat{w}$  prevails.

We pose that the employers' association and union can only bargain about the standard wage rate of the industry. In contrast to efficient bargaining models, in which parties bargain about wages and employment levels, we adopt the right-to-manage assumption. According to the right-to-manage assumption all firms retain the right to decide about their employment levels individually. In our model, each firm's employment decision is determined by its optimal production strategy in the second stage of the game.

Given these circumstances we assume that the union will accept a wage offer if and only if overall wage revenues in the industry are at least as large as in the initial situation. This participation constraint of the union can be formulated as

$$W(w^{EA}) \geq W(\hat{w}), \quad (13)$$

where  $W$  indicates wage revenues and  $w^{EA}$  stands for the wage offer of the employers' association. The union will accept the wage offer,  $w^{EA}$ , if and only if wage revenues under the proposed wage,  $W(w^{EA})$ , are at least as high as in the initial situation, in which wage revenues are given by  $W(\hat{w})$ . This means, the employers' association is restricted to wage offers that satisfy the union's participation constraint (13).

Before we derive the wage offer function of the employers' association, we carefully analyze the wage revenue schedule which is identical to the union's objective

function. The wage revenue function,  $W$ , is given by

$$W \equiv \begin{cases} W_N = [k\alpha_L q_L(w) + n\alpha_H q_H(w)]w, & \text{for } 0 \leq w < w_0 \\ W_k = [k\alpha_L \tilde{q}_L(w)]w & , \text{for } w_0 \leq w < \frac{a}{\alpha_L} \\ 0 & , \text{for } \frac{a}{\alpha_L} \leq w, \end{cases} \quad (14)$$

where  $q_L$ ,  $q_H$ , and  $\tilde{q}_L$  are given by (5), (6), and (8). The union's revenue function (14) consists of three parts. For wage levels  $w \in [0, w_0[$  all firms are active, so that both type-H and type-L firms contribute to industry wage revenues. For wages above the limit wage,  $w_0$ , only the efficient type-L firms remain active on the product market, and wage revenues are given by  $W_k$ . Of course, for wages above  $\frac{a}{\alpha_L}$  even type-L firms do not enter the market, so that wage revenues are zero in this case.

Both wage revenue functions  $W_N$  and  $W_k$  are strictly concave with respect to  $w$ . Hence, there are in principle two candidate values of  $w$  at which the union's overall wage revenue function is maximized. Wage revenue might reach its absolute maximum at a wage below the limit wage,  $w_0$ , or at a wage above the limit wage. In the former case the union prefers all  $N = k + n$  firms being active on the product market. In the latter case, the union maximizes overall wage revenue when only the type-L firms produce and the type-H firms do not enter the market.

In order to derive the wage offer function of the employers' association, we now derive some properties of the wage revenue schedule. For this purpose let us take a closer look at the union's decision problem in absence of any employers' association, i.e., in the case in which the union acts as a wage setting monopolist. Presumably, the union now chooses  $w^U$  to maximize total wage revenue (the superscript "U" stands for union)<sup>11</sup>

$$\max_w W \quad (15)$$

$$\text{s.t. } q_t \geq 0, \text{ for all } t = 1, \dots, N. \quad (16)$$

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<sup>11</sup>For the sake of simplicity we assume that the industry is small such that the countries' price level is independent of the industry's wage agreement. However, the following results will not change qualitatively if the union were maximizing real wage revenues.

Substituting the firms' equilibrium quantities (5), (6), and (8) into the wage revenue function (14), we obtain the union's reduced objective function

$$W_N = \frac{w[a(k\alpha_L + n\alpha_H) - w(n\alpha_H^2 + nk(\alpha_H - \alpha_L)^2 + k\alpha_L^2)]}{b(k + n + 1)}, \quad (17)$$

for all  $w \in [0, w_0]$ , i.e., if all  $N$  firms are active, and

$$W_k = \frac{wk\alpha_L(a - w\alpha_L)}{b(k + 1)}, \quad \text{for } w \in [w_0, (a/\alpha_L)[, \quad (18)$$

if only the  $k$  type-L firms are active. Differentiation of  $W_N$  with respect to  $w$  yields the maximizer<sup>12</sup>

$$w_N^U = \frac{a(k\alpha_L + n\alpha_H)}{2(n\alpha_H^2 + nk(\alpha_H - \alpha_L)^2 + k\alpha_L^2)}. \quad (19)$$

Similarly, we get the maximizer for  $W_k$  as<sup>13</sup>

$$w_k^U = \frac{a}{2\alpha_L}. \quad (20)$$

As long as the wage revenue function is monotonically increasing up to  $w_0$  the union will accept the wage offer  $w_0$  for initial wage levels  $\hat{w} \in [0, w_0[$ . The union's wage revenue function for the interval  $[0, w_0[$  is  $W_N$ . This function is strictly concave in  $w$ .<sup>14</sup> Hence, wage revenues are monotonically increasing up to  $w_0$  if and only if the maximizer of  $W_N$ , which is given by equation (19), is larger than the entry deterring wage,  $w_0$ . In this case, parties interest match for all initial wage levels below the entry deterring wage  $w_0$ .

If, however,  $w_N^U$  is smaller than the limit wage  $w_0$  the picture becomes more complicated since  $w_0$  is not necessarily self-enforcing for any initial wage below  $w_0$  anymore. In this case  $W_N$  reaches its absolute maximum at a wage below the limit wage such that

$$w_N^U < w_0 \quad (21)$$

holds. The following Lemma 2 specifies the condition under which inequality (21) is satisfied.

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<sup>12</sup>The second-order condition is satisfied:  $-(n\alpha_H^2 + nk(\alpha_H - \alpha_L)^2 + k\alpha_L^2) < 0$ .

<sup>13</sup>The second order condition is globally satisfied, since  $-\frac{2k\alpha_L^2}{b(k+1)} < 0$ .

<sup>14</sup>See second derivative of  $W_N$  with respect to  $w$  is strictly negative (see Footnote 12).

**Lemma 2** *There exists a vector of parameters  $\omega \in R^4$  such that  $w_N^U < w_0$  is satisfied if and only if*

$$\frac{\alpha_H^2}{\alpha_L^2}n(k+1) - \frac{\alpha_H}{\alpha_L}k(3n+k+1) + k(2n+k+2) > 0. \quad (\text{HETERO-2})$$

*Proof.* See the Appendix. *Q.E.D.*

The left-hand side of (HETERO-2) is a U-shaped function in  $\frac{\alpha_H}{\alpha_L}$  which has two potential roots along the real axis.<sup>15</sup> Straight forward inspection of (HETERO-2) yields that the condition is the sooner fulfilled, the closer  $\frac{\alpha_H}{\alpha_L}$  is to one.<sup>16</sup> In the Appendix we also provide some numerical examples which illustrate that there are cases, where (HETERO-2) is not fulfilled, with wage revenues monotonically increasing in wages up to  $w_0$ .

In the case where only  $k$  type-L firms are active the following condition assures that the maximum of the wage revenue function  $W_k$  is at  $w = w_k^U$  to the right of  $w_0$ :

$$\begin{aligned} w_k^U = \frac{a}{2\alpha_L} &> \frac{a}{\alpha_H + k(\alpha_H - \alpha_L)} = w_0 \\ \Rightarrow \frac{\alpha_H}{\alpha_L} &> \frac{k+2}{k+1}. \quad (\text{HETERO-3}) \end{aligned}$$

Given that both the (HETERO-2) and (HETERO-3) condition hold the following condition (HETERO-4) assures that the absolute maximum of the union's wage revenues,  $W$ , is reached at  $w_N^U$  to the left of  $w_0$  with all firms active:

$$\begin{aligned} &W_N(w_N^U) > W_k(w_k^U) \\ \Leftrightarrow \frac{a^2(n\alpha_H + k\alpha_L)^2}{4b(n+k+1)[n\alpha_H^2 + nk(\alpha_H - \alpha_L)^2 + k\alpha_L^2]} &> \frac{a^2k}{4b(k+1)} \\ \Rightarrow \frac{\alpha_H}{\alpha_L} &< \frac{k^2 + nk + 2k}{k^2 + nk + k - n}. \quad (\text{HETERO-4}) \end{aligned}$$

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<sup>15</sup>In the Appendix we explicitly calculate the roots and derive the condition such that those solutions are real. If there exists no real root the condition holds for all parameter vectors  $\omega \in R^+$ .

<sup>16</sup>Indeed, (HETERO-2) is fulfilled for all  $\omega \in R^4$ , whenever the productivity difference between the L-firms and the H-firms vanishes.

It is easily checked that the left-hand side of (HETERO-4) is strictly greater than one. Based on these intermediate results concerning the wage revenue function, we can now formulate the following lemma.

**Lemma 3** *If  $\omega \in \Omega$  satisfies the conditions (HETERO-2), (HETERO-3), and (HETERO-4), then  $w_N^U < w_0 < w_k^U$  and  $W_N(w_N^U) > W(w_k^U)$ .*

*Proof.* Follows directly from conditions (HETERO-2), (HETERO-3), and (HETERO-4). *Q.E.D.*

To show the existence of a parameter range that satisfies the conditions of Lemma 3 and (HETERO-1), we state the following sufficient conditions:

**Lemma 4** *Let  $n > k + 1$  and  $k \geq 5$ . Then conditions (HETERO-1) to (HETERO-4) are satisfied for all  $\frac{\alpha_H}{\alpha_L} \in ]\frac{k+2}{k+1}, \frac{k^2+nk+2k}{k^2+nk+k-n}[$ .*

*Proof.* See Appendix. *Q.E.D.*

Lemma 4 states the conditions of an interval for  $\frac{\alpha_H}{\alpha_L}$  such that for the wage revenue function  $w_N^U < w_0 < w_k^U$  and  $W_N(w_N^U) > W(w_k^U)$  holds. In the following, we restrict attention to those parameter vectors  $\omega$  which are given by Lemma 4.<sup>17</sup> Therefore, let us now introduce the following parameter restrictions, which assure that those conditions are met: Let  $\omega = (\alpha_H, \alpha_L, k, n) \in R_+^4$  be the vector of parameters which characterizes the heterogeneity and the scale -in terms of the number of firms- of the two firm groups. Moreover, let  $\Omega$  denote the restricted domain of parameters that satisfies (HETERO-1) to (HETERO4),  $n > k + 1$  and  $k \geq 5$ .

This means, we assume that the union's wage revenue function has two relative maxima, one to the left of  $w_0$  with all firms being active, and one to the right

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<sup>17</sup>Restricting the parameter range in this fashion enables us to keep all strategic incentives while simplifying exposition considerably. See Haucap et al. 1999 for an analysis of wage setting when the union prefers a wage rate above the entry deterring wage,  $w_0$ .

of  $w_0$  with only the type-L firms producing. Moreover, we assume that the overall revenue maximum is reached at a wage, where all firms enter the market. Under these conditions, the employers' association and the union have conflicting interest, with respect to the optimal standard wage. The employers' association favors a wage close to the limit wage such that less efficient firms are deterred from entering the market. In contrast, the union wants to implement a standard wage at which all firms produce.

Now we can examine the wage offer function,  $\Phi = \Phi^{EA}(\hat{w})$ , that assigns the optimal wage offer of the employers' association to every initial wage level,  $\hat{w}$ ; i.e.,  $\Phi^{EA}(\hat{w}) = w^{EA}$ . For any given  $\hat{w}$  the employers' association chooses a wage offer  $w^{EA}$  which solves the following maximization problem:

$$\max_w \quad \Pi_L(w) \quad (22)$$

$$\text{s.t.} \quad \Pi_L(\hat{w}) \leq \Pi_L(w^{EA}) \quad (23)$$

$$W(\hat{w}) \leq W(w^{EA}) \quad (24)$$

$$\hat{w} \leq w^{EA}. \quad (25)$$

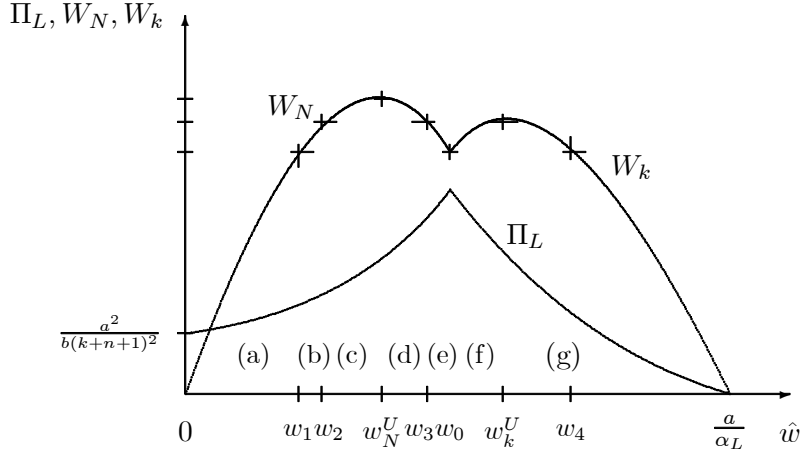
The wage offer of the employers' association,  $w^{EA}$ , has to meet the members' participation constraint (23), the union's participation constraint (24), and the condition (25) that wages cannot fall below the workers' reservation wage.

Figure (3) graphs the wage revenue functions,  $W_N$  and  $W_k$ , and the type-L firm's profit function,  $\Pi_L$  for  $\omega \in -$ . From (HETERO-1) we know that type-L firms' profits increase up to  $w_0$  and decrease for higher values of  $w$ . The (HETERO-2) condition implies that the maximum of  $W_N$  lies to the left of the limit wage  $w_0$  and (HETERO-3) guarantees that the maximum of  $W_k$  lies to the right of  $w_0$ . Furthermore, condition (HETERO-4) assures that the union's wage revenue function reaches its absolute maximum when all firms are active.

If the initial wage  $\hat{w}$  is below  $w_1$  (region (a)) the union's interest and interest of the employers' association match, and the employers' association can set the profit maximizing entry deterring wage  $w_0$  which is self-enforcing. At  $w_0$  wage revenue



Figure 3: Critical Wage Intervals:  $W_N(w_N^U) > W_k(w_k^U)$



$W_k(w_0)$  is larger than the initial wage revenue. The employers' association cannot put through the limit wage,  $w_0$ , if the wage is in region (b) because wage revenues are lower at that point. Holding initial wage revenues constant, the employers' association might propose a wage which lies between  $w_3$  and  $w_0$  or a wage that lies in the interval  $[w_0, w_k^U[$ .

In the former case the union acts as an imperfect countervailing power, because it prevents the employers' association from setting the entry deterring wage. In the latter case, the employers' association proposes a wage above the entry deterring wage in order to fulfill the union's participation constraint (24). For initial wages between  $w_2$  and  $w_3$  the employers' association cannot increase the wage rate to the entry deterring level because the wage revenue is always lower when only the  $k$  type-L firms remain active. As long as the initial wage is in region (c) the employers' association can increase profits by proposing a wage which is to the right of the maximum of the wage revenue function,  $W_N$ , while keeping wage revenues constant. Therefore, wages increase but not to the entry deterring level; the  $n$  type-H firms stay in the market with reduced equilibrium quantities.

If the initial wage is in region (d) the union and the employers' association have

opposite interests. Hence, the wage does not change, and the initially efficient wage prevails. To put it differently, the union is a perfect countervailing power which makes it impossible for the employers' association to enforce an increase of the standard wage.

If the initial wage is in region (e) this might be the case as well, but it is also possible that the same happens as in region (b): The employers' association proposes a wage increase above the entry deterring level while keeping the union's wage revenues constant. In regions (f) and (g) the employers' association would like to reduce the wage below the initial wage level. However, this is not possible since workers will not accept to work for less and firms compete for workers until  $w = \hat{w}$ . Therefore, for initial wage levels above the limit wage,  $w_0$ , there is no labor market distortion.

The following Proposition (2) summarizes the results and characterizes the optimal wage offer for any given initial wage  $\hat{w}$ .

**Proposition 2** *For all  $\omega \in -$  the wage offer function  $\Phi^{EA}(\hat{w})$  is characterized by the following six intervals for the initial wage,  $\hat{w}$ :*

- (a) for  $\hat{w} \in [0, w_1[$ , the employers' association chooses  $w_a^{EA} = w_0$ ,
- (b) for  $\hat{w} \in [w_1, w_2[$ , the employers' association chooses (i)  $w_{b1}^{EA} \in [w_0, w_k^U[$  s.t.  $W^N(\hat{w}) = W^k(w_{b1}^{EA})$  if  $\Pi_L(w_{b1}^{EA}) > \Pi_L(w_{b2}^{EA})$ , and (ii)  $w_{b2}^{EA} \in [w_3, w_0[$  s.t.  $W^N(\hat{w}) = W^N(w_{b2}^{EA})$  if  $\Pi_L(w_{b2}^{EA}) > \Pi_L(w_{b1}^{EA})$ ,
- (c) for  $\hat{w} \in [w_2, w_N^U[$ , the employers' association chooses  $w_c^{EA} \in [w_N^U, w_3[$  s.t.  $W^N(\hat{w}) = W^N(w_c^{EA})$ ,
- (d) for  $\hat{w} \in [w_N^U, w_3[$ , the employers' association chooses  $w_d^{EA} = \hat{w}$ ,
- (e) for  $\hat{w} \in [w_3, w_0[$ , the employers' association chooses (i)  $w_{e1}^{EA} \in [w_0, w_k^U[$  s.t.  $W_N(\hat{w}) = W^k(w_{e1}^{EA})$  if  $\Pi_L(w_{e1}^{EA}) \geq \Pi_L(\hat{w})$ , and (ii)  $w_{e2}^{EA} = \hat{w}$  otherwise,
- (f) and (g) for  $\hat{w} \in [w_0, (a/\alpha_L)[$ , the employers' association does not propose a change of the initial wage level.

*Proof.* Follows directly from inspection of Figure 3. *Q.E.D.*

Figure (4) depicts the wage offer function when the employers' association proposes a take-it or leave-it offer to the union and all four (HETERO) conditions hold.<sup>18</sup> The 45° line reflects all efficient wage agreements, since we assume an efficient labor market equilibrium to persist in the absence of any labor market institutions. First, notice that the employers' association would always set the entry deterring wage  $w_0$  if there were no union. This would reduce sectorial employment levels for initial wage levels below  $w_0$ . Next, we introduced a union which has the power to make sure that wage revenues cannot decrease. As Figure 4 reveals the union's power to oppose wage revenue reductions may have five effects:

1. *Neutralization:* The initial efficient wage prevails for  $\hat{w} \in [w_N^U, w_3[$ . The employers' association and the union neutralize each other. This means that the very existence of unions might deter the employers' association from setting the limit wage, and therefore induces labor market efficiency.
2. *Impotency:* For initial wage levels  $\hat{w} \in [0, w_1[$  the employers' association can set its profit maximizing wage level  $w_0$  as if there were no union. In this case the limit wage  $w_0$  is self-enforcing.
3. *Over-deterrence:* The wage rate might increase above the entry deterring level  $w_0$  if  $\hat{w} \in [w_1, w_2[ \cup [w_3, w_0[$ . In those cases, the employers' association has to propose a wage level *higher* than  $w_0$  to meet the union's participation constraint. Thus, sectorial employment is lower with, than without, an industrywide union.
4. *Relief:* For initial wage levels  $\hat{w} \in [w_2, w_N^U[$  unions induce a move towards the efficient wage level, compared to a situation without unions (regime I). The employers' association can reduce type-H firms' output but they cannot induce them to exit the market.

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<sup>18</sup>In addition, we assume that the optimal wage offer of the employers' association for initial wages in regions (b) and (e) is to propose a wage above the entry deterring wage. This means, the optimal wage offer is for region (b)  $w_{b1}^{EA}$  and for region (e)  $w_{e1}^{EA}$ .

5. *Efficient markets*: The efficient wage  $\hat{w}$  is sustainable for initial wage levels  $\hat{w} \in [w_0, (a/\alpha_L)]$ .

Therefore, in contrast to conventional wisdom, it might be the case that the existence of a centralized union in the bargaining process is efficiency enhancing. Given that wage agreements are expected to be generally binding, the union might act as a countervailing power, which prevents the employers' association from setting the entry deterring wage. In our model, this result depends on the fact that the union might strictly prefer a wage below the limit wage. The conditions for such a situation are stated in Lemma 3. However, if at least one of the conditions (HETERO-2) and (HETERO-4) is violated, the union strictly prefers a wage above the limit wage. Under these circumstances it could be the case that the union's and the employers' association interests perfectly match, so that both parties strictly prefer to increase the standard wage up to the limit wage.

It is also possible that the union prefers a wage higher than the limit wage. If the union would have all the bargaining power, it would then push the standard wage to higher levels than the employers' association would do. While many people appear to believe that this is always the case, our analysis has identified the conditions under which the contrary is true.

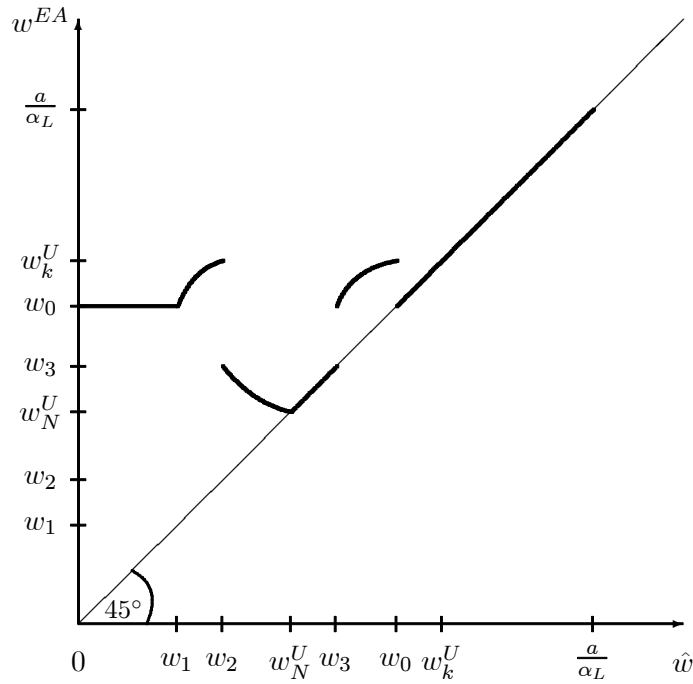
Having analyzed the model, let us now examine German labor market institutions in greater detail to give support to the cost raising strategies described above.

## **3 The German Collective Bargaining System**

### **3.1 The Legal Basis of Collective Bargaining**

In contrast to the USA, Canada, and Japan where wage bargaining occurs at firm-level alone, wage negotiations in Germany are mainly at both, the natio-

Figure 4: Employers' Association's Wage-Offer Curve



nal and the sectorial level.<sup>19</sup> As mentioned above, one core institution of the German labor market, the so-called *Tarifautonomie*, empowers unions, employers and employers' associations to bargain and negotiate collectively and almost without state intervention. This right is based on Article 9 III of the German constitution (*Grundgesetz*, GG), which guarantees the freedom to establish and join associations in order to maintain and promote working conditions.

Furthermore, the legal nature of the collective bargaining process is specified in the *Tarifvertragsgesetz* (TVG). §1 TVG defines unions, employers and employers' associations as exclusive bargaining parties. §3 TVG makes clear that in general only members of the bargaining parties are actually bound to obey the regulations of the contract. In §4 TVG the normative character of the bargaining agreements is emphasized. All bargaining parties have to comply with the agreement and, in general, deviations are only possible if the agreement explicitly allows them or if

<sup>19</sup>For a cross-nation comparison of wage bargaining systems see Bunn 1984 and Layard et al. 1991.

they are in favor of the employee (TVG §4 III (*Günstigkeitsprinzip*)).

Although only those unions, employers and employers' associations that are involved as bargaining parties are bound by the contract (§3 I TVG) the coverage of the agreement goes way beyond the bargaining parties themselves.

Interestingly, collective bargaining contracts can be made compulsory for unorganized employers by a legal authority. §5 TVG provides the bargaining partners with such a device, the so-called *Allgemeinverbindlicherklärung* (AVE).

## **3.2 The Allgemeinverbindlicherklärung (AVE)**

### **3.2.1 The AVE's Prerequisites**

The first prerequisite to declare an employment contract to be generally binding is the existence of a legal collective bargaining agreement. At least 50 per cent of employees in the tariff area for which an AVE is initiated have to be employed in firms of contract-bound employers (§5 I1. TVG). As Lindena/Höhmann 1988a, 466 argue that this condition prevents a prospective majority of unorganized employers from being forced to obey a contract they never signed.

Secondly, the AVE must be "in the public interest" (§5 I 2. TVG).<sup>20</sup> However, an AVE can even be put into force if the two conditions are not met, but there exists some social emergency (*sozialer Notstand*) according to §5 I TVG.

### **3.2.2 Implementation of the AVE**

In order to initiate an AVE one of the bargaining parties has to apply for it at the Ministry of Labor. Unorganized employees and employers concerned, as well as employers' associations, unions and the Ministry of Labor of the state affected by the AVE are given the right to express their opinion. Afterwards a public

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<sup>20</sup>For some critical remarks concerning this precondition see below.

hearing of a council consisting of three representatives of umbrella organizations of unions and employers respectively (*Tarifausschuß*) is initiated (§12 TVG).<sup>21</sup> The council decides with the majority of votes whether or not to recommend the use of an AVE to the Ministry of Labor. While the Ministry of Labor is not bound to put an AVE into force if the council recommends one, it may only put an AVE into force if the council recommends it. However, in the latter case the Ministry is not forced to follow the council's opinion (Meyer 1992, 366).<sup>22</sup>

Once an AVE has been put into force it remains effective until the collective bargaining contract expires or the Ministry of Labor puts the AVE out of force (§5 V TVG).

### 3.2.3 The Scope of AVEs

Between 1968 and 1991 the total number of AVEs effective has increased from 158 (1968) to 622 (1991). Since 1980 the average number of AVEs effective has varied between 500 and 600 per year. About one million workers are additionally affected by these orders (Meyer 1992, 366).<sup>23</sup>

Most sectors affected by AVEs are characterized by many small firms, low skilled workers, low capital labor ratios, a slow expansion of domestic demand and a comparatively low extent of organized employers and employees (Deregulierungskommission 1991, 151). Thus, AVEs appear to set minimum wage standards because of their concentration in low wage sectors (Sachverständigenrat 1995,

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<sup>21</sup>For the employers' side the representatives are appointed by the top organization, the *Bund Deutscher Arbeitgeberverbände*, while for the union's side there are two representatives of the *Deutscher Gewerkschaftsbund* and one of the *Deutsche Angestellten Gewerkschaft* (Kreimer-de Fries 1995, 211). It is important to note that the bargaining partners themselves are not members of the council. Theoretically, an AVE can be put into force notwithstanding the interest of one bargaining partner.

<sup>22</sup>In practice, the Ministry of Labor generally follows the council's recommendation as Lindena/Höhmann 1989, 5 report.

<sup>23</sup>Kreimer-de Fries 1995, 212 estimate that even 1.5 to 1.7 million workers or 5 to 6 per cent of the working force is additionally affected.

228). The requirement, that the Ministry of Labor can only put AVEs into force if this is justified by the public interest, is a very weak and imprecise constraint (Deregulierungskommission 1991, 151). To give an example, AVEs are argued to serve the public interest if they are intended to abolish low-wage competition (*Schmutzkonkurrenz*) (see Lindena/Höhmnn 1988a, 466) or to induce equal working conditions across firms in a particular industry (see Clasen 1988, 27). Hence, the political agent has some considerable leeway that might lead to an extension of collective bargaining agreements well beyond today's scope.<sup>24</sup>

The social-emergency-clause (§5 I TVG) can be considered to be a further loophole to extend AVEs since it waives the requirements that the public interest is served and that at least 50 per cent of the employees of the tariff area concerned have to be employed by contract-bound firms. This provision is used in cases where most employers are not organized as, for example, in agriculture and where the working conditions are "inadequate" (see Meyer 1992, 365). There is no clear-cut definition as to what establishes a social-emergency-case.<sup>25</sup> So the discretionary leeway of the Ministry of Labor is expanded once more (Löwisch/Rieble 1992, 318).

However, as long as the organizational density of employers is high, it is not very surprising that the direct impact of AVEs is low.<sup>26</sup> But the declining number of firms that are members of employers' associations in East Germany might lead to further requests to use AVEs (Sachverständigenrat 1995, 231). And organizational problems do not only exist in East Germany, but in West Germany as

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<sup>24</sup>Moreover, as Ring 1994, 356 reports it is extremely difficult to examine in court whether the public interest is really served.

<sup>25</sup>Most authors claim that considerable wage differentials ("social distortions") between sectors already establish a social emergency (see Däubler/Hege 1981, 222) or Hegemeier 1990, 587).

<sup>26</sup>In this context it is interesting to note that both employers' associations and unions heavily oppose any criticism concerning AVEs although they claim that the scope of AVEs is minor. (For the employers' association see Lindena/Höhmnn (1988a, 1988b, 1989) and for the union side Kreimer-de Fries 1995).



well; a growing number of firms have cancelled their organizational membership (Keller 1997, 16 and OECD 1994, 176). There are some indicators that the growing problems for employers' associations to maintain their membership enhance the importance of AVEs. Despite of lip service of representatives of employers' associations concerning the minor importance of AVEs, the regional East German wage agreements in retail trade were extended using this instrument (Kreimer-de Fries 1995, 224). Moreover, on the employers' side it was even considered to apply AVEs in the metal producing sector in East Germany (Kreimer-de Fries 1995, 222).

Although direct effects of the AVE regulation are of minor importance today, its threat-point character and the indirect effects might be enormous.<sup>27</sup> The threat-point character of the AVEs has also been recognized by the German Monopolies Commission as it writes: "The cartel effect of collective agreements is increased by the possibility to declare them generally binding. It is misleading to play down the importance of this legal institution by pointing at the low number of collective bargaining agreements declared generally binding. In January 1994, 544 of 41700 collective bargaining agreements have been declared generally binding. However, these contracts aim just at those industries in which the eroding effects on collective bargaining agreements through outside competition would be extremely strong . . . Moreover, this legal institution contains a normative threat-point potential which aims at stabilizing the system." (Monopolkommission 1994, 380)

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<sup>27</sup>In international comparison of such extension rules, France is a quite vivid example. There "around half of all sectorial agreements are usually extended by government decree" (OECD 1994, 171). It is not surprising that in spite of a very low union density rate of 10 per cent (the lowest rate of all OECD countries) the collective bargaining coverage rate is extremely high (at a level of 90 per cent) (OECD 1994, 173).

### 3.3 Institutional Settings and Collective Bargaining Coverage Rate

Aside from AVEs, additional institutional arrangements help to establish high wage standards under the German wage setting system, which is characterized by a relatively high (although declining) coverage rate of collective bargaining agreements.<sup>28</sup>

The organization rate of employers is already high in Germany. In spite of differences in empirical concepts, there is broad consensus that around 80 per cent of the workforce are employed by firms which are members of employers' associations (Keller 1997, 16 and Franz 1996, 250).

Although contract-bound employers are not forced to pay the same wages to non-union members this seems rational because they are interested in industrial peace, but also because they would force their unorganized workers to join the union otherwise. However, even the small number of employers not bound by contract often offer employment conditions comparable to those agreed upon in collective bargaining contracts. This is often done to forestall a unionization of their firms or to avoid the costs of increasing turnovers if, for example, workers are attracted by supposedly higher paying schemes in organized firms.

A key feature of the German wage setting process is the major importance of pilot agreements (*Pilotabschlüsse*). Collective bargaining agreements are made on a sectorial basis for each region (wage tariff area). The regions in which the pilot agreements are made are mostly characterized by high union density as well as large firms which can be struck easily (Molitor 1997, 158, fn. 178). In the metal producing sector pilot agreements are usually signed in the wage tariff area of *Nordwürttemberg-Nordbaden* - a region where the most profitable and dynamic metal manufacturers in Germany are located. This might easily lead to wage

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<sup>28</sup>The collective bargaining coverage rate amounts to about 90 per cent while the union density rate is about 32 per cent (OECD 1994, 173 and Halbach et al. 1991, 181).

agreements which are above the market-clearing level if these agreements are simply adopted for economically weaker regions.

Once a sectorial agreement in a specific region is signed this agreement sets a standard and is followed by almost all other regions of this sector. What is even more important is that there is not only a coordination between regions of the same sector but also between the sectors as a whole. Especially pilot agreements in the metalworking sector (and sometimes the public sector) are almost completely adopted by other sectors with respect to issues such as wage increases and working time regulations (OECD 1994, 175).

Because of the minimum standard character of collective bargaining agreements described above these contracts are generally binding for almost the entire workforce.<sup>29</sup> Up to now we have only described that there are voluntary extensions of collective bargaining agreements. The key question concerning our model, however, is why employers or employers' associations in other regions with a weaker economic performance do not try to achieve competitive advantages by signing low wage agreements. Even without any legal extension rule as the AVE, internal policies of employers' associations already seem to stabilize the cartel. Hence, we now want to examine the associations' and the unions' incentive structure.

### **3.4 Employers' Associations from a Public Choice Perspective**

Let us now take a closer look at the incentives regional and sectorial employers' associations face when a collective bargaining agreement with high wage standards has been reached.<sup>30</sup> In the context of our model, the association is not

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<sup>29</sup>Of course, there is no stringent and perfect coordination between the different sectorial agreements. It is important to note, however, that in general all wage increases and working time regulations once agreed upon in one sector are adopted by other sectors within a fairly short period of time.

<sup>30</sup>This analysis follows Molitor 1997, 216 ff.

interested in lower wage agreements anywhere else in the industry while the regional union section is not interested in lower wages in other regions.<sup>31</sup> What kind of instruments are now available for these regional players to pursue their interests? First, the union will most likely try to expand the collective agreement reached in the high-standard region. Only excessive unemployment problems can be expected to induce lower wage demands or concession bargaining.

Empirically, however, such regional differences in wage trends are hard to find (see Paqué 1991, 35). Hence, it is quite likely that the regional union will fight to get its favored agreement. It is also important that the regional union can rely on the solidarity of the nationwide union which has a large strike fund at its disposal. Thus, the incentives of the union as a whole as well as the regional union sections go hand in hand. The union side cannot be expected to suffer from solidarity problems. The regional employers' associations on the other side can try to influence members in other regions to follow the agreement with the assistance of the nationwide top association. Whether this kind of moral suasion is effective, however, is rather unclear.

If employers' associations in other regions now want to follow a low wage strategy and thereby provokes a strike, problems will arise.<sup>32</sup> In general employers' associations are not only pressure groups, but they can rather be characterized as anti-strike insurance agencies.<sup>33</sup> All bargaining employers' associations have built up relief funds to support members confronted with strikes.

Particularly in the metalworking sector there are regional employers' relief funds and a coordination agreement that provides regional employers' associations with an interregional support system (*Gefahrgemeinschaft*).

Concerning the incentives of the employers' association that signed the pilot

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<sup>31</sup>This can be expected not only for organizational purposes, but also for ideological reasons expressed by slogans such as "equal pay for equal work".

<sup>32</sup>For the following reasoning see also Molitor 1997, 223 ff.

<sup>33</sup>It is important to note that historically this insurance function was a key factor for the formation of employers' associations (see Erdmann 1966, 53).

agreement mentioned above it is very unlikely that this association is willing to support industrial warfare for lower wage agreements in other regions. The employers' association for metal workers *Gesamtmittel*, even has established guidelines according to which resources of the interregional support system can only be used in labor disputes of more than just regional importance (Gesamtmittel 1993, 2).

When a single regional employers' association is following a low-wage strategy its bargaining power is considerably reduced. Only the few resources of the regional relief fund are available whereas the regional union section is supported by the whole nationwide strike fund. Hence, it is not surprising that perceptible withdrawals from pilot agreements are unlikely. Even without the threat of an AVE or other extension rules members of employers' associations are forced to sign agreements they would not subscribe to otherwise.

Employers which are not members of employers' associations face similar problems. If they make efforts to pay lower wages they are also confronted by a nationwide union strike fund and, even worse, they can not resort to any relief fund. In summary, the institutional framework and the incentive structures of employers' associations as well as unions create a self-enforcing mechanism for rigid wage standards above the market-clearing level.

## **4 The Deep-Freeze of the East German Economy**

The economic union between East and West Germany came in mid-1990. Compared to other ex-communist states of Eastern Europe, it was widely believed that the prospects for success were much brighter in East Germany with its well-educated and skilled work force and its rich brother generously helping with infusions of capital, and technological and organizational know-how. However, as

has been painfully experienced in the last seven years, with economic reunification of Germany “one of the worst and sharpest depressions in European history had begun” (Akerlof et al. 1991, 1); this was especially true for the employment situation: Manufacturing employment declined by 74 per cent from the second quarter of 1990 to the fourth quarter of 1993 (Deutsche Bundesbank, June 1994, p. 84).

From fall 1989 to 1992, one out of three workers -some 3 million people- had lost their jobs. The largest decline took place in the industrial sector, where more than 1.7 million jobs were lost.<sup>34</sup> As early as 1992 Dornbusch 1992 found that “Eastern German wages in many sectors now exceed 50 percent of Western German wage levels.” At this time labor productivity in East Germany (based of GDP per worker) was estimated to be only one third of the West German figure.

Several explanations have been proposed for the large drop in East Germany’s manufacturing employment after unification. In their outstanding assessment of the collapse of East Germany’s economy Akerlof et al. 1991 identify the price-cost squeeze due to the shift in demand away from East German goods and the sharp rise in costs relative to prices as the major problem. While playing down the impact of the conversion rate which was 1:1, they blame the unions for recklessly pushing wage parity between East and West Germany. “Their analysis clearly singles out West German unions as the villains in the collapse” (Dornbusch 1991, 89).

Moreover, according to the endgame hypothesis managers and employers had incentives to engage in massive overstaffing just prior to expected decapitalization and privatization programs (see Aghion et al. 1994). On this line Neumann et al. 1991, von Hagen 1992, and von Furstenberg 1995 argue that the prospect of unemployment in a social welfare and insurance system caused pressure for high wages. While all these theories certainly help to explain the dramatic collapse in

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<sup>34</sup>For the situation of the German labor market after reunification see Franz 1991, Scheremet 1992, and Scheremet/Schupp 1992.

East Germany we want to demonstrate that employers' associations are not as innocent as these theories implicitly suggest.

After the German reunification the West German collective bargaining system was immediately adopted by East Germany. Wages increased tremendously.<sup>35</sup>

Therefore, let us briefly analyze the situation.<sup>36</sup> Immediately after reunification West German employers' associations joined the collective bargaining table.<sup>37</sup> As exemplified in our model, West German employers did not have any interest in low wages in the East. Such a strategy would have devaluated their existing capital in the West, and introduced competition from the less efficient East German firms.

Although planned investment in the East would become unprofitable as a result of high Eastern wage standards this strategy was useful to hedge the profits in the West. On the other hand East German unions were assisted by West German union representatives because the East German unionists were simply too unexperienced in matters concerning collective bargaining. The West German agents, however, were not interested in low wage standards in the East in order to avoid a competitive disadvantage for their West German members. Following the implications of our model a collective bargaining agreement was concluded in March 1991 which aimed at an equalization of wages in East and West until 1994.

As demonstrated in our model both bargaining parties were quite successful in

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<sup>35</sup>Although the productivity in East Germany is quite below the West German level, workers in the East were paid 69 per cent of their western colleagues' wage per hour in 1996 (Institut der Deutschen Wirtschaft 1997, chart 137). The resulting increase of unit labor costs seems to be the major factor for the excessive employment problems in East Germany.

<sup>36</sup>Our analysis follows Sinn/Sinn 1993, 165 ff.

<sup>37</sup>Even before reunification, unions with large memberships were well established in East Germany. On the other hand, the largest employer was the *Treuhand*, a state agency. The labor-managers of these firms were in a conflicting situation. On the one hand they were employers at the bargaining table. On the other hand they were simply employees of the *Treuhand* in the end. Therefore, it was not surprising that these "employers" did not show strong resistance to wage increases that devaluated the existing capital (not owned by themselves).

pushing through their members' interests by raising wages and avoiding outside competition. The contrary nature of unions and employers' associations was set aside in order to stabilize the wage setting cartel.

## 5 Policy Implications and Conclusions

Standard reasoning emphasizes the efficiency aspects of employers' associations in the bargaining process. As, for example, Nickell 1997, 68 concludes: "To summarize, . . . unions are bad for jobs, but these bad effects can be nullified if both the unions and the employers can coordinate their wage bargaining activities." In contrast to this position our model has shown that employers' associations might even worsen wage bargaining outcomes in terms of the employment level of the industry.<sup>38</sup> Furthermore, in contrast to conventional wisdom, our paper also demonstrates that unions might improve the wage bargaining outcome. A wage revenue maximizing union may favor a heterogeneous supply structure on the product market with efficient and less efficient firms competing for market shares. Under such conditions the union might prevent the employers' association from setting an entry deterring standard wage for the entire industry. In this case the union acts as an effective countervailing power, and therefore, prevents the employers' association from monopolizing the industry.

In general, the macroeconomic implications of centralized wage bargaining on employment levels call for an extension of antitrust measures to the labor market.<sup>39</sup> Extension rules as the AVE, which make wage settlements generally binding for the entire industry, therefore, are alleged to be anticompetitive.

Referring to the German case analyzed above, we propose a reform of the AVE. In particular, the requirements of "public interest" and "social emergency" should be

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<sup>38</sup>A similar result is obtained by Petrakis/Vlassis 1997 who analyze how the centralization of the wage bargaining process affects intra-sectorial wage differentials.

<sup>39</sup>Macroeconomic effects of labor market institutions have also been studied by Calmfors/Driffill 1988 and Jackman et al. 1990.



formulated as precisely as possible to avoid any misuse of the AVE as a barrier to entry. Moreover, the application of an AVE should be restricted to matured firms so that potential new entrants are not affected by this instrument for a couple of years. In this case new firms would have a chance to establish themselves on the market, and most likely to improve their labor productivity over time.<sup>40</sup>

While there might be other ways than the AVE system that can make wage agreements generally binding as, for example, informal norms (Lindbeck/Snowder 1988, Lindbeck 1997), these informal governances of enforcing minimum wages can be expected to work only to a much lesser extent. Therefore, we think that formal legal means to make standard wage agreements generally binding should be abolished. If there should be a case for generally binding wage contracts, these measures should be at least applied in a very careful manner and only under clear-cut circumstances which have to be formulated as precisely as possible. Based on the analysis presented here, a substantial reform of the German labor law as specified in the TVG seems highly desirable.

Finally, our analysis might also apply to outright minimum wage legislation as, for example, introduced in Puerto Rico prior to the late 1960s -the devastating effects of which have been well described by Katz 1991. We think a worthwhile future undertaking is to explore the interests employers have in minimum wage legislation.

## Appendix

### Proof of Lemma 1

*Part (i).* Equilibrium quantity of a type-H firms is given by equation (6). Thus,  $\frac{\partial q_H}{\partial w} = -\frac{\alpha_H(1+k)+\alpha_L}{b(k+n+1)} < 0$ . By definition of  $w_0$ ,  $q_H(w_0) = 0$ . Thus,  $\frac{a-w(\alpha_H+k(\alpha_H-\alpha_L))}{b(k+n+1)} = 0$ , and hence  $w_0 = \frac{a}{\alpha_H+k(\alpha_H-\alpha_L)}$ .

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<sup>40</sup>Petrakis/Vlassis 1997, 22 suggest to target the centralized bargaining system by simply subsidizing the adoption of the more efficient technology.

*Part (ii).* If all firms are active equations (5) and (6) imply that type-L firms' equilibrium quantity is given by  $q_L(w) = \frac{a+w(n\alpha_H-\alpha_L(n+1))}{b(k+n+1)}$ . Differentiation yields  $\frac{\partial q_L}{\partial w} = \frac{n\alpha_H-(n+1)\alpha_L}{b(k+n+1)}$ , which is nonnegative if and only if  $\frac{\alpha_L}{\alpha_H} \geq \frac{n+1}{n}$ .

*Part (iii).* If only the  $k$  type-L firms are active each firm  $i$  chooses a quantity  $q_i$  which solves:  $\max_{q_i} \Pi_i = (a - bQ_L - c_L)q_i$ . Solving the  $k$  first-order conditions for the equilibrium quantity  $q_L$  gives  $\tilde{q}_L(w) = \frac{a-\alpha_L w}{b(k+1)}$ . Hence, equilibrium quantity (and thus profits) are strictly decreasing in wages. Setting the expression for the equilibrium quantity equal to zero, we obtain  $w = (a/\alpha_L)$ . Thus, by definition of  $w_0$ , the interval of  $w$  for which only type-L firms are active is given by  $w \in [w_0, (a/\alpha_L)[$ .

*Part (iv).* From (ii) we already know that  $q_L$  is (weakly) increasing in the interval  $[0, w_0[$  if and only if  $\frac{\alpha_H}{\alpha_L} \geq \frac{n+1}{n}$ . Thus, because  $q_L(w_0)$  is continuous in  $w_0$ , one has  $q_L(w_0) \geq q_L(w)$ , for all  $w \in [0, w_0[$ . For  $w \in [w_0, (a/\alpha_L)[$ , part (iii) implies that only firms  $i = 1, \dots, k$  are active and that type-L firm's quantity,  $\tilde{q}_L$ , is strictly decreasing in  $w$ . Therefore,  $\tilde{q}_L$  reaches a maximum at the point  $w = w_0$  with  $q_L(w_0) = \frac{a(\alpha_H-\alpha_L)}{b(\alpha_H+k(\alpha_H-\alpha_L))}$ . Note that the equilibrium quantity schedule of type-L firms is continuous at  $w = w_0$ . This can be easily checked by equating  $q_L(w_0)$  with  $\tilde{q}_L(w_0)$ . This establishes part (iv) of Lemma 1.

*Part (v).* Follows directly from equation (7). *Q.E.D.*

### Proof of Lemma 2

We have to specify the range of parameters for which  $w_N^U < w_0$  holds. Comparison of  $w_N^U$  and  $w_0$  yields

$$w_N^U = \frac{a(k\alpha_L + n\alpha_H)}{2(n\alpha_H^2 + nk(\alpha_H - \alpha_L)^2 + k\alpha_L^2)} < \frac{a}{\alpha_H + k(\alpha_H - \alpha_L)} = w_0.$$

This is equivalent to

$$\frac{1}{2}a \frac{\alpha_L^2(2kn + 2k + k^2) + \alpha_H^2(nk + n) - \alpha_H\alpha_L(3kn + k^2 + k)}{(\alpha_H + k(\alpha_H - \alpha_L))[kn(\alpha_H - \alpha_L)^2 + k\alpha_L^2 + n\alpha_H^2]} > 0.$$

Since the denominator of the inequality's left-hand side is strictly positive, rewriting yields

$$\frac{\alpha_H^2}{\alpha_L^2}n(k+1) - \frac{\alpha_H}{\alpha_L}k(3n+k+1) + k(2n+k+2) > 0,$$

which is the (HETERO-2) condition stated in Lemma 2. *Q.E.D.*

Table 1: Values of  $\bar{n}$ 

$k$	1	2	3	4	5	6	7	$k \geq 8$
$\bar{n}$	$\emptyset$	$\emptyset$	2	5	10	21	56	$\infty$

Calculating the roots of the left-hand side of (HETERO-2) with respect to  $\frac{\alpha_H}{\alpha_L}$ , one obtains two solutions

$$\begin{aligned} \left(\frac{\alpha_H}{\alpha_L}\right)_1 &< \frac{k(3n+k+1) - \sqrt{\rho}}{2n(k+1)}, \\ \left(\frac{\alpha_H}{\alpha_L}\right)_2 &> \frac{k(3n+k+1) + \sqrt{\rho}}{2n(k+1)}, \end{aligned}$$

where  $\rho \equiv n^2k(k-8) + 2nk(k^2 - 3k - 4) + k^2(k^2 + 2k + 1)$ . For those solutions being real  $\rho$  has to be non-negative. Obviously,  $\rho$  can only be negative if  $k < 8$ . Table 1 gives the maximum value of type-H firms,  $\bar{n}$ , for all values of  $k$ , such that  $\rho$  is non-negative.

From the table we observe that, e.g., for  $k = 3$  the maximum number of type-H firms is 2, in order to get a real solution. Hence, for  $k = 3$  and  $n = 2$  there exists a parameter vector  $\omega \in R^4$  such that the wage revenue function is increasing for all  $w \in [0, w_0]$ . The wage revenue function,  $W_N$ , always reaches its maximum at a wage below  $w_0$ , if no real solution to (HETERO-2) exists, since in this case (HETERO-2) is always satisfied. As can be seen from Table 1, this situation might only occur if  $k \leq 7$ .

#### Proof of Lemma 4

Since,  $\frac{k+2}{k+1} < \frac{k^2+nk+2k}{k^2+nk+k-n}$ , for  $k, n > 0$ , (HETERO-3) and (HETERO-4) are satisfied if and only if  $\frac{k+2}{k+1} < \frac{\alpha_H}{\alpha_L} < \frac{k^2+nk+2k}{k^2+nk+k-n}$ . The condition  $n > k + 1$  assures that  $\frac{n+1}{n} < \frac{k+2}{k+1}$ , so that (HETERO-1) is never binding. Finally, we have to show that for all  $\frac{\alpha_H}{\alpha_L} \in ]\frac{k+2}{k+1}, \frac{k^2+nk+2k}{k^2+nk+k-n}[$  (HETERO-2) is also satisfied. For this purpose let us define the left-hand side of (HETERO-2) by

$$G \equiv \frac{\alpha_H^2}{\alpha_L^2}n(k+1) - \frac{\alpha_H}{\alpha_L}k(3n+k+1) + k(2n+k+2).$$

This is a U-shaped function in  $\frac{\alpha_H}{\alpha_L}$ . Therefore, in order for (HETERO-2) to be fulfilled it suffices to show that three conditions are met: (i)  $G$  is positive at  $\frac{\alpha_H}{\alpha_L} = \frac{k+2}{k+1}$ , (ii)  $G$  is positive at  $\frac{\alpha_H}{\alpha_L} = \frac{k^2+nk+2k}{k^2+nk+k-n}$ , and (iii) the unique minimum of  $G$  with respect to  $\frac{\alpha_H}{\alpha_L}$  lies to the right of  $\frac{k^2+nk+2k}{k^2+nk+k-n}$ .

*Part (i).* By substituting  $\frac{k+2}{k+1}$  into  $G$  we obtain  $\frac{4n}{k+1} > 0$ .

*Part (ii).* Substituting  $\frac{k^2+nk+2k}{k^2+nk+k-n}$  into  $G$  gives  $2kn\frac{k^2+n^2+2nk+k+n}{(k^2+nk+k-n)^2} > 0$ .

*Part (iii).* Taking the derivative of  $G$  with respect to  $\frac{\alpha_H}{\alpha_L}$  and setting it equal to zero gives  $\frac{\alpha_H}{\alpha_L} = \frac{k^2+3nk+k}{2nk+2n}$ . This value is strictly larger than  $\frac{k^2+nk+2k}{k^2+nk+k-n}$  if and only if

$$n^2(k-5) + n(2k^2 - 3k - 5) + k^3 + 2k^2 + k > 0,$$

which holds for  $k \geq 5$ . This establishes Lemma 4. *Q.E.D.*

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