

Is Wage-Leadership an Instrument to Coordinate Unions'  
Wage-Policy?  
The Case of Imperfect Product Markets

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### **Abstract**

Given an oligopolistic product market, trade unions organized at firm level want to coordinate their wage bargaining activities, even if they are self interested. In this paper a situation is analysed, where for some exogenous reasons a complete centralization is not possible. Unions could try to coordinate wage-setting by "wage leadership". The outcome of such "wage leadership" is compared with the outcome of an uncoordinated bargaining and results in higher utilities for all unions. But the resulting wages and employment levels are not symmetrically neither for the unions nor for firms. Employment levels will change in different directions. In the "wage leader" firm employment falls and in the "follower" firm employment rises compared to an uncoordinated wage bargaining. This may cause problems with the implementation of "wage leadership".

# 1 Introduction

The institutional setting of the wage bargaining process matters. The empirical evidence seems to be clear. The paper of Calmfors and Driffill (1988) is a prominent contribution to that issue. Their thesis: highly centralized and highly decentralized wage bargaining systems perform best. This means that there is a hump-shaped relationship between the degree of centralization and the macroeconomic performance of a country. The hump-shaped form of this relationship can be explained by externalities. Wage setting in one firm or one industry or one country - depending on the degree of centralization - influences to some extent the wage setting process of other firms, industries or countries. Calmfors (1993) describes several externalities that may occur. A detailed theoretical contribution, based on utility and profit maximization, was published by Moene, Wallerstein and Hoel (1993). Hargreaves Heap (1994) gives a game theoretic interpretation of bargaining institutions. At the beginning of the nineties these insights have become components of several textbooks (see Carlin, Soskice (1990) or Layard, Nickell, Jackman (1991)).

An imperfection of the product market leads to a situation where, in a decentralized bargaining setting, each decision is influenced by each other.<sup>1</sup> Oligopoly theory is one way to describe an imperfect product market. Wage bargaining with oligopolistic product markets is analysed, for example, by Dowrick (1989). He uses a conjectural variation model, but does not incorporate a time structure of the bargaining process. Another example is Dobson (1994), who analysed a Cournot duopoly with one union for both firms and wage bargaining at firm level. He deals with the time structure of the two bargainings and investigates if the union is interested in pattern bargaining.

A similar structure is used in this paper. But contrary to Dobson's model, two unions are active (one in each firm) in the product market duopoly<sup>2</sup>. If wage rates are not identical for all firms, the firm who has to pay less gets higher profits and increases its employment level. So a union that bargains over wages at the firm level has to bear in mind relative wages, the own wage rate in relation to wage paid in the competing firm, because both wages determine the employment level. So the bargaining in one firm has an external effect on the bargaining situation in the competing firm. For the union it is a positive externality, because goods are substitutes, increasing wages in one firm increases the labour demand in the other. It would be a negative one, if the products were complements. In a centralized bargaining this externality would be internalized and resulted in a "better" outcome, so unions would prefer centralized bargaining. Assume that the bargaining partners, caused by some exogenous facts, are not able to organize the bargaining process in a centralized way. Can they internalize the externalities with the help of pattern bargaining? Is "wage leadership" an instrument to coordinate unions wage-policy?

The paper is organized in the following way. In section 2 the two-stage structure of the model - the wage setting stage and the employment setting stage - is described. An uncoordinated setting and a system coordinated by "wage leadership" is analysed. In subsection 2.1 the employment setting is modeled. The firms have to decide about output in an oligopolistic framework where the goods of different firms are substitutes. This is the starting-point for the analysis of the wage bargaining (subsection 2.2). Two alternative scenarios of wage bargaining (uncoordinated bargaining (2.2.1)) and "wage leadership" (2.2.2)) are formulated. In section 3 two examples of imperfect good markets are presented. In 3.1 a Cournot duopoly is analysed with linear demand and linear production functions, and in 3.2 the "linear city" framework is used. For both examples I derive the solution of collective bargaining in the two bargaining settings. The results are discussed in section 4. Pattern bargaining is not unusual in modern economies, but mostly used to "coordinate" firms or sectors with complementary products. So the model does not fit these situations. But I will argue that increasing international competition makes the coordination of collective bargaining in different countries

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<sup>1</sup>De la Croix (1994) gives a survey of possible channels of the mutual influence.

<sup>2</sup>The conclusions of the model also hold for an oligopoly with more than two firms.

necessary. For example the deeper integration of european countries within the European Union will change the labour market institutions in all countries, and this means a need of coordination of the bargaining processes in sectors producing substitutes. (For a discussion of the effects of European integration on unions see Reder, Ulman (1993)).

## 2 The Model

The model is characterized by the following points: (a) product market is imperfect, organized as an duopoly. Firms produce substitutes, (b) wages are set at the firm level, (c) in each firm one distinct union is active, and (d) there are two time periods.

**Period 1** is the wage setting stage. There is bargaining over wages (a so called "right to manage" model) where the union and the employer are the bargaining partners. If in different firms the wages are fixed at the same time, there is no information about the wages in other firms during the bargaining process. Such a situation will be called an "**uncoordinated wage setting**" system. If there is a sequence of wage setting in different firms, one union knows the wage rate payed in the competing firm; this system will be called "**wage leadership**".

**Period 2** is the employment setting stage. When wages are fixed each firm calculates its profit and hires workers. Profits depend on the costs of production and are therefore a function of firm's wage rate. But profits also depend on the degree of competition and therefore on the relative wage. The labour demand function is derived from the profit function and therefore depends also on all wages. This dependency is crucial to the model.

uncoordinated system		
stage 1		stage 2
decentralized		employment decision
wage setting		in an imperfect market
<i>Table 1</i>		

Table 1 describes the time structure of an uncoordinated wage setting system. It will be compared with a system where the wage setting stage is splitted once more. In this alternative system (table 2) bargaining takes place first in a "wage leader" firm. The bargaining partners of the "follower" firm react on the wage paid in the "wage leader" firm. Note that the employment setting stage is not altered by this change and succeeds the wage setting stage. Hence I will compare the outcome of simultaneous and sequential wage setting and not a simultaneous with a sequential employment decision (something similar to a Stackelberg game).

"wage leadership" system		
stage 1a	stage 1b	stage 2
wage setting in the	wage setting in the	employment decision
"wage leader" firm	"wage follower" firm	in an imperfect market
<i>Table 2</i>		

As usual I solve the employment setting stage for all possible wage rates first. These solutions give all the information I need to solve the first stage, the wage setting stage.

## 2.1 Employment Decision

The equilibrium of the duopolistic product market yields product prices, quantities and profits and gives me the labour demand functions. Each firm's cost function depends on the bargained wage rate (the wage rate will be set in the second stage). So one has to solve the product market equilibrium for all possible wages. I will examine two different models of imperfect product markets in section 3 and show that in both models labour demand is not only a function of the own wage, but depends also on the wage rate paid by the competing firm.

$$L_i = L_i(w_i, w_j) \quad (1)$$

where  $i$  and  $j$  are the index for the firms. Labour demand is decreasing in the firm's own wage and increasing in the wage rate of the competitor. An increase of the own wage shifts up the cost function. An increase of the wage in the competing firm shifts the residual demand for the firm's product outwards. Thus profit function and labour demand depend on the wages of both firms. Profit and labour demand fall with an increasing wage paid in the own firm and with a decreasing wage paid by the competitor.

## 2.2 Wage-Setting

Given labour demand, we can analyse stage 1. The bargaining solution will be described by a generalized Nash bargaining<sup>3</sup>. The solution can be found by maximizing the following Nash- product:

$$\max (U(w) - \bar{U})^\beta (\pi(w) - \bar{\pi})^{1-\beta} \quad (2)$$

$U(w)$  : is union's utility function and  $w$  is the decision variable.

$\pi(w)$  : is firm's profit.

$\bar{U}, \bar{\pi}$  : are the disagreement pay-offs (i.e. the utility levels reached by agents without an agreement).

$\beta$  : is the measure of bargaining power of the party with utility  $U$  (the union) and lies in the interval  $[0, 1]$ .  $\beta = 1$  describes the "monopoly union".

Let us assume, in correspondence with the modern literature of trade union behavior, that unions are interested in wages and employment<sup>4</sup>. In this paper, union behavior is modelled by maximizing a weighted wage bill<sup>5</sup>. The utility function is given by equation (3).

$$U_i = w_i^{\alpha_i} L_i^{1-\alpha_i} \quad (3)$$

Unions can differ by the weight they attach to the wage rate in the utility function ( $\alpha_i$ ) and by bargaining power ( $\beta_i$ ).

The behavior of firms is described by profit maximization. Each firm sets the level of employment autonomously in stage 2. Substituting labour demand (equation 1) and profit into the Nash bargaining problem (equation 2) and solving it - remember the wage is the decision variable - one obtains the optimal wage depending on the wage paid by the competitor.

$$w_i = w_i(w_j) \quad (4)$$

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<sup>3</sup>For a description of the cooperative concept of Nash see Faber (1986). The link between non-cooperative bargaining games and the Nash bargaining is described in Binmore and Dasgupta (1987). In the light of non-cooperative bargaining games of the sort proposed by Rubinstein (1982) one should interpret disagreement points as the utility level actors obtain during bargaining. Bargaining power can be derived from discount-rates of the actors. (See Sutton (1986)).

<sup>4</sup>There exist several surveys on that topic. See Oswald (1985), Farber (1986) or Ulph and Ulph (1990).

<sup>5</sup>In the recent literature usually unions maximize the expected utility of the representative member. For my purpose the introduction of an alternative income, for example unemployment benefits, would make the analysis more complicated, but would not add any more insights.

This is a reaction function and describes the optimal wage depending on the competitor's wage. The main result of the analysis is that the optimal reaction is described by an increasing function, with positive slope smaller than one. Wage in firm  $i$  increases with the wage paid by the competitor, because profit is increasing with the competitor's wage. So the distributable pie expands and the union as well as the employer benefit from that.

Moreover, there is a second channel by which employer and union can win: the slope of the reaction function is less than one. This means that the best the bargaining partners can do - as a reaction to a wage increase in the competing firm - is to increase their own wage but by less than the competitor. As a result they get a higher wage and more employment, caused by improved relative costs. The exact position of the reaction function depends on the bargaining power, weight of wages in union's utility and on production and demand function parameters.

### 2.2.1 Uncoordinated Wage Bargaining

If wages are fixed simultaneously, neither firm can react directly. Thus the wage in the competing firm is exogenously given for all agents.

The solution of wage setting can be described by the intersection of the reaction functions (see the solid lines in figure 1).

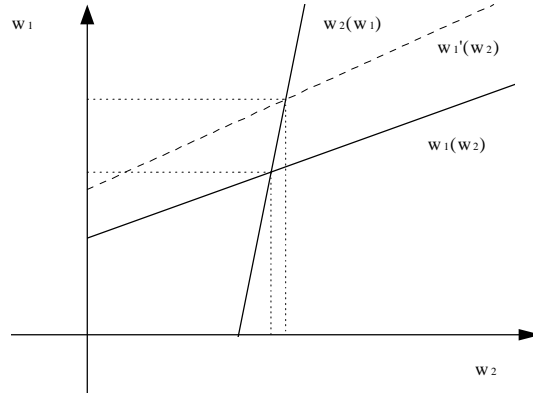


Figure 1:

Note that equilibrium wages - like the reaction functions - are functions of the parameters of the demand and production functions, of bargaining power and of the relative weights of the wage in the utility function of both unions. In symmetric situations (the same production functions, unions' utility and bargaining power in both firms) wages are equal. If bargaining power differs, the stronger union will achieve a higher equilibrium wage.

$$\begin{aligned} w_i^* &= w_j^* & \text{if} & \quad \beta_i = \beta_j \\ w_i^* &> w_j^* & \text{if} & \quad \beta_i > \beta_j \end{aligned} \quad (5)$$

The next points follow from a comparative static analysis.

- Equilibrium wages increase, when the bargaining power of one union is rising. In figure 1 bargaining power of the union 1 increases and shifts the reaction function upwards (dashed

line). In firm 2, the bargaining power of the union is kept constant. But the equilibrium wages increase in both firms, with:

$$\frac{dw_1^*}{d\beta_1} > \frac{dw_2^*}{d\beta_1} > 0 \quad (6)$$

The wage rise following an increase of bargaining power of the firm's own union is obvious. The distribution of the pie changes and the stronger union can successfully increase wages. The wage increase caused by additional bargaining power of the competitor's union follows from an improvement of the competitive situation. The cost function of the competitor (firm 1) has shifted up. The profit of firm 2 increases and the union is able to extract more.

- It follows that equilibrium employment is reduced in the firm, where union bargaining power increases. From the union's perspective this reduction is overcompensated by the increasing wage. The reduction of employment is weakened by the competitor's wage increase. In the firm with constant union bargaining power employment increases, because the wage rate paid by the competitor increases more than the own wage rate.

$$\begin{aligned} \frac{dL_1^*}{d\beta_1} < 0 & \quad \frac{dU_1^*}{d\beta_1} > 0 \\ \frac{dL_2^*}{d\beta_1} > 0 & \quad \frac{dU_2^*}{d\beta_1} > 0 \end{aligned} \quad (7)$$

- Profit decreases with rising bargaining power of the firm's union and increases with rising union power in the competing firm (profits are correlated with employment).

$$\frac{d\pi_1^*}{d\beta_1} < 0 \quad \frac{d\pi_2^*}{d\beta_1} > 0 \quad (8)$$

### 2.2.2 Wage Leadership

The uncoordinated setting differs from a bargaining coordinated by "wage leadership" by the information the bargaining partners have. In the "wage leader" firm they have to come to terms before bargaining takes place in the competing firm. Wage bargaining partners know that their rivals in the competing firm will react in a way that is optimal for them. On the other side the bargaining partners of the "follower" firm have full information about the wage paid by the leading firm.

Without loss of generality let me assume that bargaining takes place in firm 1 first. Using the equilibrium solution of the employment setting stage the bargaining partners in the leading firm have all informations to calculate the reaction function of the bargaining partners in the "follower" firm. The optimal wage is located on the reaction function of the "follower" firm, to the right of the equilibrium point of the simultaneous case.<sup>6</sup> Figure 2 shows the highest indifference curve possible for the bargaining partners of firm 1. The indifference curves for firm 1 show combinations of wages paid in the two firms with the same value of the Nash-product for firm 1. These indifference maps are ordered in uprising fashion from left to right, because for each  $w_1$  a higher wage in firm 2 is better for the bargaining partners of firm 1, because employment and profits are higher.

If we compare a simultaneous setting with a sequential one, we see that equilibrium wages in the sequential scenario are higher for both firms. This is a consequence of the positive slopes of the reaction functions. The slope of the reaction functions is smaller than one therefore the wages of the two systems differ more for the "leader" firm. As a result: employment is higher in the "follower" firm.

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<sup>6</sup>That means I am looking for a subgame perfect equilibrium. Further I assume that this equilibrium is unique. This is a restriction on the reaction functions and is met in the examples of section 3.

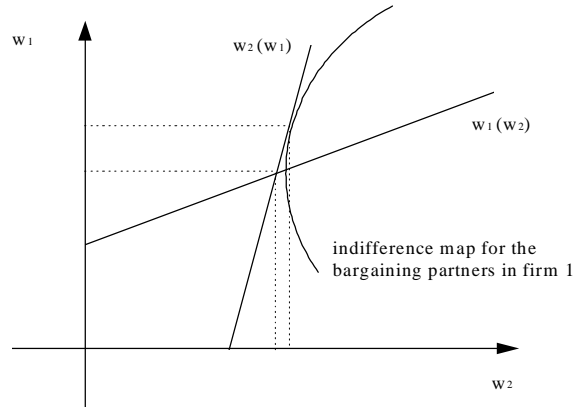


Figure 2:

There is a problem in interpreting a sequence of bargainings as "wage leadership" if these wage rounds are repeated every year. Who is "leader" and who is "follower"? Repeated wage bargaining is necessary because shocks change demand and supply conditions in a unpredictable way. "Wage leadership" can be an instrument for coordinating wage policy only if the time interval between the bargainings of the "leader" and "follower" is short enough, so the probability that a significant shock occurs in that time interval is small and most likely the two bargainings take place in the same state of the world. Inspection of figure 2 shows that without an additional shock wages would converge to the equilibrium of the uncoordinated bargaining situation along the reaction functions (in the  $w_1, w_2$  diagram of figure 2 the reaction function of firm 2 is "steeper" than the reaction function of firm 1).

The comparative static analysis gives qualitatively the same answers as in the uncoordinated system.

### 3 Examples

#### 3.1 Cournot Duopoly

In this subsection a Cournot duopoly is analysed as an example of an imperfect product market. The solution of that model can be described by the reaction functions of the two firms. Firms can decide about the quantity they produce. Given the demand and cost function, each firm can calculate its best response to all possible production plans of its competitor. The output price is a function of the quantities of the homogeneous good produced by both firms ( $P = P(q_1 + q_2)$ ) and the cost function is a function of each firm's own output ( $C_i = C_i(q_i)$ ).

Each firm chooses the output level that maximizes its profit, given the own cost function and the output level of the competitor. The solution of this maximization problem gives the reaction function of firm  $i$ .

$$q_i = q_i(q_j) \tag{9}$$

The non-cooperative Nash-equilibrium of this game is determined by the intersection of these reaction functions (given by the solid lines in figure 3). The position of the reaction function of firm  $i$  depends on firm's  $i$  own cost function which depends on the outcome of the wage bargaining. A



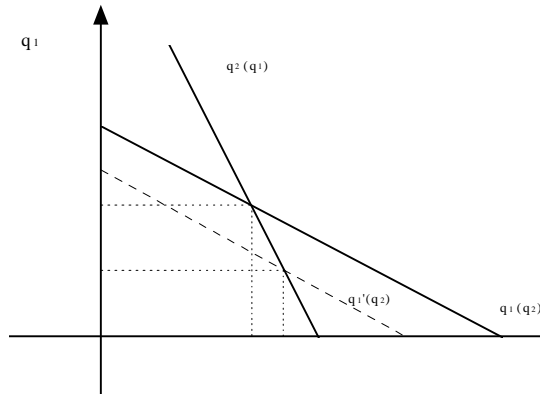


Figure 3:

wage increase shifts the reaction function to the left. As an example in figure 3 the wage rate of firm 1 increases (dashed line). So equilibrium output of firm 1 decreases and that of firm 2 increases.

Knowing the level of production, one can calculate the employment level. Equilibrium employment depends therefore on the wage rates of both firms. (See equation 1). Employment in firm 1 increases with increasing wages in firm 2 and decreases with an increase of the own wage rate. As can be seen in figure 3, this result is guaranteed by reaction functions with negative slopes<sup>7</sup>. Equilibrium employment levels can be interpreted as the relevant labour demand functions of the wage bargaining of our model. Given output levels, profits and the product price can be calculated. They are functions of both wages ( $P = P(w_i, w_j)$  and  $\pi_i = \pi_i(w_i, w_j)$ ).

Let me illustrate this by a simple example with linear demand and a primitive production function. It should be clear that the result extends to more general models. Assume a linear inverse demand function

$$P = k - a(q_i + q_j) \quad (10)$$

and a production technology

$$q_i = cL_i \quad (11)$$

( $L_i$  is employment in firm  $i$ , and the only variable factor).

The production plans of the firms are given by the solution of the profit maximization problem, where quantity is the decision variable:

$$\max \pi_i = (k - a(q_i + q_j)) q_i - \frac{w_i q_i}{c} \quad (12)$$

The reaction functions are linear functions with negative slopes:

$$q_i = \frac{ck - acq_j - w_i}{2ac} \quad (13)$$

The Cournot equilibrium and therefore employment is given by:

$$q_i = \frac{ck + w_j - 2w_i}{3ac} \Rightarrow L_i(w_i, w_j) = \frac{ck + w_j - 2w_i}{3ac^2} \quad (14)$$

<sup>7</sup>The condition for a reaction function with negative slope is:  $\frac{\partial \pi_i}{\partial q_i \partial q_j} = P'(\cdot) + q_i P''(\cdot) < 0$   
See Shapiro (1989).

Substituting production (11) in the inverse demand and profit function, we get:

$$\begin{aligned} P &= k - a(q_1 + q_2) = \frac{ck + w_1 + w_2}{3c} \\ \pi_1 &= Pq_1 - w_1L_1 = \frac{(ck + w_j - 2w_i)^2}{9ac^2} \end{aligned} \quad (15)$$

Note that in equilibrium firm's profits and employment are positively correlated.

### 3.1.1 Wage Setting in an Uncoordinated System

The next step is to formulate wage bargaining. First an uncoordinated situation is analysed. To simplify the model disagreement pay-offs of unions and firms are set to zero.<sup>8</sup> Then the Nash function to maximize is:

$$\max_{w_i} \left( w_i^{\alpha_i} \left( \frac{ck + w_j - 2w_i}{3ac^2} \right)^{1-\alpha_i} \right)^{\beta_i} \left( \frac{(ck + w_j - 2w_i)^2}{9ac^2} \right)^{1-\beta_i} \quad (16)$$

leading to the following reaction function:

$$w_i = \frac{\alpha_i \beta_i}{2(2 - \beta_i)} (ck + w_j) \quad (17)$$

- The slope is positive and smaller than 1.<sup>9</sup>
- The position of the reaction function depends on the bargaining power of the union. A stronger union achieves higher wages than a weaker one (all other parameters constant).
- The slope of the reaction function increases with the bargaining power of the union and with the weight of the wage in the utility function of the union.

The intersection of the reaction functions of both firms describes the equilibrium of the game.

$$w_i^* = \frac{\alpha_i \beta_i (2(2 - \beta_j) + \alpha_j \beta_j) ck}{4(2 - \beta_i)(2 - \beta_j) - \alpha_i \beta_i \alpha_j \beta_j} \quad (18)$$

### 3.1.2 Wage Setting in a "Wage Leadership" System

Now assume sequential bargaining. In a "wage leadership" setting the bargaining partners of firm 1 (the "leader") have to maximize a Nash function, where the reaction of the "following" firm is incorporated (represented by  $w_j^*$ ).

$$\max_{w_i} \left( w_i^{\alpha_i} \left( \frac{ck + w_j^* - 2w_i}{3ac^2} \right)^{1-\alpha_i} \right)^{\beta_i} \left( \frac{(ck + w_j^* - 2w_i)^2}{9ac^2} \right)^{1-\beta_i} \quad (19)$$

<sup>8</sup>The results are not be affected by this restriction in a qualitative way, because an increasing disagreement pay-off has the same effect on wages as an increasing bargaining power.

<sup>9</sup>If the union is interested in "real wage" ( $U = \left(\frac{w}{P}\right)^\alpha L^{1-\alpha}$ , the reaction function is very similar and given for firm i by:  $w_i^* = \left( \frac{\beta_i + \sqrt{((2-\beta_i)^2 + 2\alpha_i\beta_i(2-\alpha_i\beta_i)) - 2}}{2(2-\alpha_i\beta_i-\beta_i)} \right) (ck + w_j)$   
This is also an increasing function in  $w_j$ .

Equilibrium wages are given in that system as:

$$\begin{aligned} w_l^* &= \frac{\alpha_l \beta_l (2(2 - \beta_f) + \alpha_f \beta_f) ck}{(4(2 - \beta_f) - \alpha_f \beta_f)(2 - \beta_l)} \\ w_f^* &= \frac{\alpha_f \beta_f ck}{2(2 - \beta_f)} \\ &\quad \left( \frac{(4(2 - \beta_f) - \alpha_f \beta_f)(2 - \beta_l) + \alpha_l \beta_l (2(2 - \beta_f) + \alpha_f \beta_f)}{(4(2 - \beta_f) - \alpha_f \beta_f)(2 - \beta_l)} \right) \end{aligned} \quad (20)$$

In this setting the resulting wages are higher for both firms, compared with the equilibrium of the uncoordinated setting. The wages increase more in the "leading" firm, employment and profit are lower. In the following firm employment and profit are higher.

### 3.2 "Linear City"

A second example for an imperfect product market is a "linear city" model. In this model firms are price setters. Two firms produce a homogeneous good with a simple Cobb-Douglas technology exhibiting constant returns to scale. ( $Y = cK^\alpha L^{1-\alpha}$ ). All consumers are identical except for their "home", their location. They have to incur costs for the transportation of the product from firm to "home". Caused by the constant returns to scale property of the production function the firms exhibit constant marginal costs (but depending on the wage and interest rate). No fixed costs are incurred and therefore the average costs are also constant.

Given the Cobb-Douglas production function, the labour demand function is given by:

$$L_i = \left( \frac{(1 - \alpha)r}{\alpha w_i} \right)^\alpha \frac{Y_i}{c} \quad (21)$$

( $r$  is the interest rate). We can also calculate the total cost function:

$$TC_i = \frac{1}{c} \left( \frac{r}{\alpha} \right)^\alpha \left( \frac{w_i}{1 - \alpha} \right)^{1-\alpha} Y_i = k_i Y_i \quad (22)$$

with:  $k_i = \frac{1}{c(1-\alpha)} \left( \frac{(1-\alpha)r}{\alpha} \right)^\alpha w_i^{1-\alpha}$

Note that  $k_i$  is increasing with  $w_i$ .

The "linear city" model is a very simple way to describe heterogeneous consumers.<sup>10</sup> In this model each consumer  $x$  is characterized by his location on the interval  $[0,1]$ . The city is of the length of 1 and consumers are uniformly distributed, so the density along  $[0,1]$  is 1.

The locations of the two firms are given by the extreme points of the city. Firm 1 is located at 0 and firm 2 at 1.<sup>11</sup> Consumer  $x$  incurs quadratic transportation costs  $tx^2$  when he buys at firm 1 and  $t(1-x)^2$  when he buys at firm 2.<sup>12</sup>

The consumers have unit demands, each consumes one or zero unit of the good, depending on the price and the transportation costs. Let  $s^0$  be the gross surplus for each consumer when he is consuming the good. He will buy only if the net surplus  $s^0 - p - \min(tx^2, t(1-x)^2)$  is positive (or zero). Let me assume that the gross surplus is high enough, such that all consumers buy. Therefore the overall output is given and fixed.

<sup>10</sup> A different interpretation is that the goods are heterogeneous and consumers have different preferences.

<sup>11</sup> If firms are located in the interior of the city, the results do not change qualitatively. Employers and the unions prefer extreme locations when consumers are distributed uniformly, because this ensures market power.

<sup>12</sup> A model with linear transportation costs has no equilibrium in pure strategies. The quadratic formulation avoids this problem. See Tirole (1988).

The transportation costs parameter  $t$  is a measure for the competitiveness of the product market. With a higher  $t$  firms have more market power, because consumers do not care as much about price differences.

Consumer  $x$  is indifferent between buying at firm 1 or 2, if

$$p_1 + tx^2 = p_2 + t(1-x)^2 \quad (23)$$

Because consumers only differ in location, consumers who live left of  $x$  will buy from firm 1 and consumers living right of  $x$  will buy from firm 2. So the demand function for firm  $i$  is

$$D_i(p_i, p_j) = \frac{1}{2} + \frac{p_j - p_i}{2t} \quad (24)$$

Given the demand and cost functions, firms profits are

$$\pi_i = (p_i - k_i)D_i(p_i, p_j) \quad (25)$$

Firms are price-setters, they maximize profits by selecting prices for their products. The optimal price decision depends on the price of the competitor.

$$\frac{d\pi_i}{dp_i} = 0 \Rightarrow \frac{1}{2} + \frac{p_j - p_i}{2t} - \frac{p_i - k_i}{2t} = 0 \quad (26)$$

The reaction functions of the price setting game are therefore:

$$p_i = \frac{t + p_j + k_i}{2} \quad (27)$$

The optimal price rises with the competing price. The concrete value depends also positively on the degree of competition and on the marginal costs of production. A Nash-equilibrium of this game is described by the intersection of the reaction functions.

$$p_i^* = \frac{2k_i + k_j}{3} + t \quad (28)$$

Equilibrium prices depend on the cost structure of the production processes and on transportation costs. It is important to note that the equilibrium price of a firm's product does not only depend on its own marginal costs but also on the costs of the competitor.

When firms have set their prices, we can calculate their output using the demand functions.

$$Y_i = \frac{1}{2} + \frac{k_j - k_i}{6t} \quad (29)$$

To be positive the restriction  $k_i \leq k_j + 3t$  must hold. Residual demand and therefore labour demand (equation 21) decreases with firm's own wage and increases with the wage paid by the competitor. The same is true for profit, as long as the above inequality is valid.

$$\pi_i = \frac{t}{2} + \frac{k_j - k_i}{3} + \frac{(k_j - k_i)^2}{18t} \quad (30)$$

The overall output is given by one, because gross surplus is assumed to be high.

### 3.2.1 Wage Setting in an Uncoordinated System

Given the solution of the employment (output) setting stage, unions can set wages. As before wage setting occurs at firm level. For simplicity let me use here the simple "monopoly union" model. The wage rate is set unilaterally by the unions, this is equivalent to  $\beta_i = 1$  in a "right to manage" model. The results in these different models should be similar, but in the monopoly case we can not investigate the effects of changing bargaining power. The firm can decide over employment after unions have set wages.

Additionally let us assume here that unions simply maximize the wage bills.

$$U_i = w_i L_i \quad (31)$$

A union can calculate the labour demand function and can select the wage rate which maximizes utility.

Substituting equilibrium output (29) into  $L_i$  (21) we get the utility function  $w_i L_i$ .

$$w_i L_i = \frac{T(1-\alpha)}{2} \left( 1 + \frac{T}{3t} (w_j^{1-\alpha} - w_i^{1-\alpha}) \right) w_i^{1-\alpha} \quad (32)$$

with T describing the technology.  $T = \left( \frac{(1-\alpha)r}{\alpha} \right)^\alpha \frac{1}{c(1-\alpha)}$

Maximizing the wage bill over  $w_i$  the reaction function that follows is given by:

$$w_i = \left( \frac{t + T w_j^{1-\alpha}}{2T} \right)^{\frac{1}{1-\alpha}} \quad (33)$$

This function describes the dependency of the optimal wage, given the wage rate paid by the competing firm. The wage of firm i is an increasing function of the wage paid in firm j and is smaller than 1. (The inequality derived by the restriction of non negative quantities in equation 29 is also an inequality restriction on wage differences!)

The Nash equilibrium of the game is simply given by the intersection of the two reaction functions:

$$w_i^* = \left( \frac{3t}{T} \right)^{\frac{1}{1-\alpha}} \quad (34)$$

Thus the wage rate is determined by the transportation costs and technological factors (with given interest rate). An increase of transportation costs increases the product market power of firms and therefore unions can get out more. In a competitive market, where transportation costs are zero, the unions can not force through a mark up on competitive wages.

### 3.2.2 Wage Setting in a "Wage Leadership" System

The situation is different with sequential wage setting. The union that can set its wage after the decision of its rival has the opportunity to react. It will prefer this situation. Assume union 1 is the leader. To solve this model I substitute the reaction function of union 2 into the utility function of union 1.

$$\max_{w_1} w_1 L_1 = \frac{T(1-\alpha)}{2} \left( 1 + \frac{T}{3t} (w_2^{*(1-\alpha)} - w_1^{1-\alpha}) \right) w_1^{1-\alpha} \quad (35)$$

The solution is

$$w_{1,l}^* = \left( \frac{9t}{2T} \right)^{\frac{1}{1-\alpha}} \quad w_{2,f}^* = \left( \frac{15t}{4T} \right)^{\frac{1}{1-\alpha}} \quad (36)$$

Comparing the resulting equilibrium wages with those of an uncoordinated system (equation 34), it can be easily checked that wages are higher for both firms in the wage leadership scenario than in the uncoordinated one. Employment and profits are lower in the "leading" firm and higher in the "following" firm, compared with the uncoordinated setting.

## 4 Conclusions

Can self interested trade unions, organized at the firm level, coordinate their wage policies by "wage leadership", given an oligopolistic product market? In such an environment local bargaining involves externalities whereas a completely centralized bargaining structure would internalize it. If, for some exogenous reasons, a complete centralization is not possible other forms of coordination are needed. Such a form of coordination could be the introduction of "wage leadership". The wage bargaining will be finished in a "leading" firm, before other trade unions and firms start the bargaining process. So the "following" bargaining partners can refer to a guiding wage. In this paper it is argued that a "wage leadership" system cannot substitute a complete centralization. "Wage leadership" works in the right direction and the externalities will be internalized to some extent. So there exists an incentive to try it. All unions win! But it involves some asymmetries between the competing firms and between the trade unions.

In the paper explicit solutions are derived for two examples of oligopolies, the classical Cournot model and the "linear city" with price setting firms. In both models wages are higher in the "wage leadership" setting than in an uncoordinated one, but only with completely centralized bargaining wages reach a maximum. The higher wages, compared with an uncoordinated setting, involve some costs in form of lower employment.

Caused by an asymmetrical increase of the wages the employment levels changes in different ways in the "leading" and "following" firms. The "wage leader" loses employment, but the union is more than compensated by the wage increase (if the wage is important for the union in any way). The situation in the "following" firm is completely different. Here wages and employment increase. But wages increase less than in the "leading" firm and therefore relative costs of production fall. So the competitiveness of the "following" firm increases and employment rises. The analysis of profits shows a different picture. Indeed profits of the "following" firm rise, caused by improved competitiveness, but the "leading" firm loses. So firm owners will try to avoid being the "leader". But even the unions are treated asymmetrical and it is not obvious what union - "leader" or "follower" - will win more. In the example of a linear Cournot model the bargaining power of the unions is one crucial variable. In many constellations both unions prefer to be "follower", only if one union is relatively strong this union will be the "leader" and no conflict about timing arises.

Is there any "real life" situation that could be described by such a model? In some European countries collective bargaining is organized in "wage rounds". In Germany the "IG Metall" is informally the "wage leader" (see for example Bispinck (1993)). In Austria bargaining in the metal sector is also very important and so this sector acts as the "wage leader" for the others (see for example Traxler (1993)). But this "wage leadership" is different from that described in our model, because the goods produced in different sectors are no substitutes. Thus the external effects can differ from those modeled here. But let me interpret the model as one of international competition. The outcome of collective bargaining in the metal sector of Germany is very important to the bargaining partners in the metal sector of other European countries, because relative wages determine demand to some extent. The increasing competition in the European Union alters the labour market and bargaining institutions and they have to react. But European countries start with considerable differences in these institutions and institutions cannot adjust very quickly. A centralization at the European level seems not possible in the short or medium run, and so one way to coordinate at an international level might be the introduction of "wage leadership".

The existence of the described asymmetries makes an instrument for redistribution necessary, otherwise the coordination will fail. But why should such an instrument exist when unions and firms cannot centralize the bargaining process in the first place? It is therefore hard to believe that "wage leadership" will be used as a coordination method, although an implicit (not coordinated) "wage leadership" will be in action in future.

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