

Market Shares of Price Setting Firms and Trade Unions

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Abstract: In a unionized duopoly with price setting firms market shares in different wage determination settings are analyzed. I compare decentralized, centralized and sequential wage determination. In the decentralized setting the union in the more productive firm can exploit the differences in productivity for rising local wages. The rising wages in the more productive firm result in smaller differences of unit costs, therefore the market shares are split more equally in the decentralized setting than with centralized wage determination. Sequential wage determination results in an asymmetric outcome. Compared with the simultaneous case the market share of the wage-leader firm is smaller, because the competitor is able to undercut the wage. Additionally with sequential wage determination the union representing the workers of the more productive firm cannot exploit the productivity advantage by raising the wage rate by the same extent as in the simultaneous case.

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1 Introduction

Firms use different instruments in competing for market shares: high quality, extra services, low prices. In all circumstances the costs of production (including development) are an important factor for the possibility of market penetration. The level of costs is influenced through a variety of channels, including different institutional settings of labor markets, sometimes described in economic literature by trade union models. The influence of trade unions on the performance of firms and the whole economy is highly controversial. On the one hand the monopoly character of unions is emphasized, resulting in high wages and therefore high costs (see Oswald (1985) or Farber (1986)), on the other hand unions are seen as institutions promoting productivity and lowering average costs (see Freeman and Medoff (1984)). But it is not only the pure existence of unions that matters, also the specific bargaining structure is important - the level where bargaining takes place, the time structure, etc. - and differences in these bargaining structures bring out different economic results. Calmfors and Driffill (1988) and Layard, Nickell and Jackman (1991) have emphasized this point. Highly centralized and highly decentralized bargaining structures perform best, because wage setting externalities are internalized to a high degree in these settings. Moene, Wallerstein and Hoel (1993) have combined this idea with a microeconomic theory of trade unions.

Unions influence production costs and thereby competition. Beside the cost structure the organization of the commodity market is important. In an oligopolistic market structure not only the firm's own costs are crucial, profits also depend on costs of rival firms and therefore on their wage setting institutions. These interdependencies are described in De la Croix (1994).

There exists no generally accepted model of oligopoly. Models differ substantially in their results and therefore the selection of the concrete type of the model seems to be crucial. In several papers oligopolistic commodity markets and trade unions are combined. Dobson (1994), Corneo (1995) and Vannetelbosch (1997) have used a Cournot model, Dowrick (1989) and De Fraja (1993) used one with conjectural variations with the Cournot and Bertrand model as special cases. It is important to notice that one feature is common to all these models: rising rivals' wage rates increases own profit and therefore allows to increase the own wage rate. This is true in a quantity and price setting framework (see Grandner (1996)).

In this paper the influence of the wage setting institution on firms' market shares is analyzed. Unions do not influence the productivity but determine the cost level of production. Firms are price-setter and the competitive behavior is described by a "linear city". A centralized wage determination is compared with a non-centralized and with a sequential one. Sequential wage bargaining in Cournot-oligopoly which is analyzed in Corneo (1995) and Grandner (1996) results in asymmetric solutions. Staggered wage setting (a dynamic version of the sequential bargaining) is analyzed in De Fraja (1993) and results in a symmetric but different solution compared to a simultaneous setting.

With a decentralized wage setting the market is shared more equally than in a centralized scenario, because decentralized unions can exploit differences in productivity for rising local wages. With a sequential wage determination firms with equal productivities do not have identical market shares. Additionally the union of the more productive firm cannot exploit the productivity advantage by the same extent as in the simultaneous case.

In the following section the time structure of the model is explained. The oligopolistic commodity market structure is described in section 3 and the relevant labor demand functions are derived. In section 4 the wage setting is analyzed and firms' market shares are determined for different wage setting scenarios.

2 The Structure of the Model

Two firms produce horizontally differentiated goods and consumers differ in their preferences. So the product market is characterized by imperfect competition and firms have price setting power, modeled by a "linear city". The labor market is characterized by unionized workers. In each of the two firms one independent union with an exogenously given number of members is active. In each firm the wage setting stage is modeled by a "monopoly union", which sets unilaterally wages. Two alternative models of wage setting are discussed in literature: the "efficient bargaining" model (McDonald and Solow (1981)) and the "right to manage" model with the monopoly union as a special case. There are several arguments for using the right to manage model, a justification is given by Layard et al. (1991). With the simultaneous wage and employment decisions of the efficient bargaining model the specific interaction between imperfect product market and labor market, which is necessary for my results, disappears. The solution of the monopoly union model is, like the solution of a more general "right to manage" model, located on the labor demand function. This is important for all results. So for my purpose these models qualitatively point in the same direction.

After both unions have decided about the wage in their firms, the firms set their prices. Quantities and therefore employment are given by commodity demand. Unions have all relevant information and take them into consideration when they decide about wages. Thus, the model has the following time structure:

1. Both unions set wages (simultaneously or sequentially).
2. Both firms set product prices simultaneously, knowing the own and the rival's cost function (determined by respective wage rates). Given the two product prices, product demand determines employment.

Unions anticipate that both labor demand functions are depending on equilibrium product prices. So we have to solve the model recursively, starting with the price setting stage. Knowing equilibrium prices and quantities, labor demand can be calculated and wage determination can be analyzed.

3 The Product Market: A Linear City

I analyze the duopolistic product market situation in a "linear city" model. Consumers differ in their preferences of specific brands, described by their location in the "linear city", they are identical in all other respects. The differences in location should be interpreted as different preferences for specific brands¹. The city is of length 1 and consumers are

¹A different interpretation could be that goods are homogeneous and firms differ in their locations and set linear gate prices. Consumers vary in distance to the gates of firms and have to incur transportation costs.

uniformly distributed, so the density along the interval $[0,1]$ is 1. Each consumer is characterized by his location on $[0,1]$.

The two firms supply two different brands, they are located at the extreme points of the city. Firm 1 is located at 0 and firm 2 at 1.² Consumer x incurs quadratic "taste deviation costs" tx^2 when he buys at firm 1 and $t(1-x)^2$ when he buys at firm 2, because the brand supplied by the firm differs from the most preferred one. The consumers have unit demands, each consumes zero or one unit of the good, depending on price and taste deviation 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 overall demand - and in equilibrium overall output - is given and fixed. The taste deviation cost parameter t measures the competitiveness of the product market. With a higher t firms have more market power, because consumers do not react so sensibly on price differences.

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

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

Because consumers only differ in location, consumers left to 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

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

These demand functions describe the market shares of both firms, because market demand and therefore overall output is exogenously given by one (the length of the city). The firm with lower costs will have the larger market share.

For demand to be positive for each firm, the price difference must not be larger than the parameter of the taste deviation costs ($|p_j - p_i| \leq t$). Otherwise, one firm gets the complete market.

Both price setting firms produce with a simple technology.

$$Y_i = c_i L_i \quad (2)$$

where Y_i stands for the output, $c_i > 0$ is a productivity parameter and $L_i \geq 0$ is employment. All arguments derived in this paper are based on the slope of the reaction functions. As long as using a more complicated production function qualitatively does not change the reaction function of the price game all results remain valid. The simple production function, being usual in related literature, for example in De Fraja (1993) and Corneo (1995), ensures explicit solutions.

Labor is the only input used in production, characterized by constant marginal and average costs.

$$MC_i = AC_i = \frac{w_i}{c_i}$$

²I do not analyze a location setting game. But employers and unions prefer extreme locations when consumers are distributed uniformly, because this ensures market power. See Tirole (1988).

The cost function depends positively on the wage rate and negatively on the productivity parameter.

Given the demand and cost functions, firms' profits are

$$\pi_i = \left(p_i - \frac{w_i}{c_i} \right) D_i(p_i, p_j)$$

Firms are price-setters, they maximize profits by selecting prices for their products. The selection of an optimal price is a strategic decision and depends on the price of the competitor. The reaction functions of the price setting game are:

$$p_i = \frac{t + p_j + \frac{w_i}{c_i}}{2} \quad (3)$$

The optimal price rises with the competitor's price. The concrete price depends positively on the taste deviation cost parameter, this means it depends negatively on the degree of competition, and positively on marginal production costs. The Nash-equilibrium of this game is described by the intersection of these reaction functions.

$$p_i^* = \frac{\frac{2w_i}{c_i} + \frac{w_j}{c_j}}{3} + t = \frac{2}{3} \frac{w_i}{c_i} + \frac{1}{3} \frac{w_j}{c_j} + t \quad (4)$$

Equilibrium prices depend on marginal costs of both firms and on taste deviation costs. It is important to note that a firm's equilibrium product price does not only depend on its own marginal costs but also on the costs of its rival. Rising own costs lead to a higher equilibrium price, but the same holds true for higher costs of the competitor, because prices are strategic complements.

When firms have set their prices, their output can be calculated using the demand functions (1).

$$Y_i = \frac{1}{2} + \frac{\frac{w_j}{c_j} - \frac{w_i}{c_i}}{6t} = \frac{1}{2} + \frac{c_i w_j - c_j w_i}{6t c_i c_j} \quad (5)$$

If marginal costs are equal in both firms the market shares are split equally. With different marginal costs the low cost firm can attract more buyers by lower prices.

Using equation (2) we get the labor demand function:

$$L_i = \frac{Y_i}{c_i} = \frac{3t c_i c_j + c_i w_j - c_j w_i}{6t c_i^2 c_j} \quad (6)$$

Residual product demand and labor demand decrease with the firm's own rising wage and increase with the wage paid by competitor. The overall output is given by one, because gross surplus is assumed to be high. Market shares of both firms are positive if

$$\left| \frac{w_j c_i - w_i c_j}{3c_i c_j} \right| < t. \quad (7)$$

As long as inequality (7) is valid, profit is positive related to labor demand.

$$\pi_i = \frac{(3tc_i c_j + c_i w_j - c_j w_i)^2}{18t c_i^2 c_j^2}$$

4 Wage Setting

Given the solution of the employment (output) setting stage, unions can set wages. Union membership is exogenously given. Unions are risk neutral and try to maximize the expected wage of a representative member.

$$U_i = w_i \frac{L_i}{\bar{L}_i} + b \left(1 - \frac{L_i}{\bar{L}_i}\right) = (w_i - b) \frac{L_i}{\bar{L}_i} + b \quad (8)$$

where b is the alternative income of a worker and \bar{L}_i the exogenously given labor force of firm i . L_i is employment of firm i , with $\bar{L}_i \geq L_i$.

4.1 Decentralized Wage Setting

In the decentralized wage setting scenario, wages can differ in the two firms. In that case each union tries to maximize the utility function (8) separately.

Substituting equation (6) into equation (8) we get the utility function to be maximized,

$$\max_{w_i} U_i = \frac{(w_i - b)(3tc_i c_j + c_i w_j - c_j w_i)}{6t c_i^2 c_j \bar{L}_i} + b. \quad (9)$$

The solution of this maximizing problem gives the reaction function of union i . The optimal wage rate for each union depends positively on the wage of the union in the competing firm.

$$w_i = \frac{c_i w_j + b c_j + 3t c_i c_j}{2c_j} \quad (10)$$

The reaction function is valid only if the wage is not smaller than the alternative income, that means

$$b \leq \frac{3t c_i c_j + c_i w_j}{c_j} \quad (11)$$

For all values of w_j violating this inequality the wage in firm i is set equal to alternative income: $w_i = b$. So there possibly is a kink in the reaction function. Inequality (11) is equivalent to (7) with w_i substituted by b . I assume that inequality (7) holds for both firms.

Proposition 1 *Equilibrium wages of both firms depend positively on the alternative income level, on the own productivity and on the taste deviation costs. Wages fall with increasing productivity of the competitor.*

Nash-equilibrium of the game is given by the intersection of the reaction functions (10):

$$w_i^* = \frac{b(2c_j + c_i)}{3c_j} + 3tc_i \quad (12)$$

and the proof of the proposition is evident.

Substituting (12) into inequality (7), it can be shown that the market share is positive if

$$\left| \frac{b(c_i - c_j)}{9c_i c_j} \right| < t. \quad (13)$$

It is impossible that in equilibrium both wages are set equal to alternative income, because both firms cannot have zero market shares simultaneously.

Proposition 2 *Wage setting "power" of union i (the rent) rises with productivity of firm i and with taste deviation costs. It decreases with the productivity of the competing firm. An increase of the alternative income enables the union of the more productive firm to raise the wage markup.*

The difference between the equilibrium wage paid at firm i and alternative income is given by:

$$w_i - b = \frac{b(c_i - c_j)}{3c_j} + 3tc_i \quad (14)$$

So the rent rises with t and c_i and falls with c_j , because $\partial(w_i - b)/\partial c_j = -bc_i/3c_j^2 < 0$.

Proposition 3 *In a decentralized setting the equilibrium market shares of firms depend on differences in productivities. The more productive firm has the larger market share. The market share depends also on the alternative income and on taste deviation costs. A higher alternative income increases and higher taste deviation costs lowers the market share of the more productive firm.*

This can be shown by deriving the equilibrium demand for firm i . Using equation (5) firm i 's output (its market share) and the corresponding labor demand can be calculated.

$$Y_{i,d} = \frac{1}{2} + \frac{b(c_i - c_j)}{18tc_i c_j} > 0 \quad (15)$$

(The subscript d stands for decentralized wage determination.) Therefore:

$$\frac{\partial Y_{i,d}}{\partial b} > 0 \quad \text{if } c_i - c_j > 0$$

$$\frac{\partial Y_{i,d}}{\partial t} = -\frac{b(c_i - c_j)}{18c_i c_j t^2} < 0$$

The market shares changes with productivities in the following way:

$$\frac{\partial Y_{i,d}}{\partial c_i} = -\frac{\partial Y_{j,d}}{\partial c_i} = \frac{b}{18tc_i^2}.$$

If both firms have the same productivity market is split equally. If productivities differ, the market share of the firm with the lower productivity increases with taste deviation costs. So in a less competitive market the market share of a low productive firm is higher than in competitive one.

4.2 Centralized Wage Setting

The model above describes unionized firms with decentralized wage setting. The next step is to derive the market shares in a centralized wage determination setting. In Corneo (1995) and Grandner (1996) it is shown, that with perfect information wages are higher in a centralized setting than in a decentralized one.³ In the presented model the level of wages is not important. The difference between centralized and decentralized wage setting is, that in the centralized setting wages are the same for both firms, irrespective of productivities. In that case market shares are only determined by differences in firms' productivities. Substituting the common wage w into equation (5) gives:

$$Y_{i,c} = \frac{1}{2} + \frac{w(c_i - c_j)}{6tc_i c_j} \quad (16)$$

where subscript c stands for centralized wage determination.

Note, every setting that ensures the same wages in both firms independently of productivities results in these market shares. If non-unionized firms have to pay a market clearing wage or a wage equal to the alternative income the market will be split in the described way. So if firms exhibit the same productivities, the market shares are exactly $\frac{1}{2}$, irrespective of the specific wage determination setting.

So the next proposition can be formulated:

Proposition 4 *If productivities of the firms are different, the market is shared more evenly in a decentralized wage determination setting than in a centralized one.*

Without loss in generality assume $c_i > c_j$, then

$$Y_{i,d} < Y_{i,c} \Leftrightarrow \frac{b(c_i - c_j)}{18tc_i c_j} < \frac{w(c_i - c_j)}{6tc_i c_j} \Leftrightarrow b < 3w$$

This is true by the definition of alternative income. The result is caused by the fact, that a firm with higher productivity can earn higher profits. But with a decentralized wage setting this higher profitability is used by its union to increase the wage. As a consequence market shares converge.

4.3 Sequential Wage Determination

It is not necessary that wage determinations take place simultaneously in both firms. Let the union in firm 1 be the wage leader. Union 2 is informed about the rival's wage when setting its own wage rate. (The wage determination in the sequential scenario is therefore a decentralized one.) The price setting stage follows after both unions have set wages.

³Vannetelbosch (1997) shows that this need not be true in the case of incomplete information.

A similar setting is also used in Corneo (1995) for a Cournot model. He makes the point that in a game where each union can choose the timing of wage setting endogenously, the sequential setting would be a Nash-equilibrium, because both unions would prefer a sequential setting to a simultaneous one, regardless to the concrete sequence. But it should be noted that the owner of a firm would strictly prefer to be a second mover.

The static version of wage leadership results in an asymmetric solution. In a dynamic version of staggered wage determination this asymmetry vanishes but the resulting wages are still different from simultaneously determined wages (see De Fraja (1993)). Market shares are influenced by an asymmetric wage setting behavior.

The utility function of union 1 to be maximized is:

$$\max_{w_1} U_1 = \frac{(w_1 - b)(3tc_1c_2 + c_1w_2^{opt} - c_2w_1)}{6tc_1^2c_2\bar{L}_1} + b$$

with w_2^{opt} being described by the reaction function (10). The solution of this problem is given by:

$$w_1 = \frac{9tc_1c_2 + b(c_1 + c_2)}{2c_2}$$

The wage of the wage leader is higher than in the simultaneous setting. Given w_1 the wage in firm 2 is set as:

$$w_2 = \frac{15tc_1c_2 + b(3c_1 + c_2)}{4c_1} \quad (17)$$

The wage of the follower is also higher than in the decentralized setting, because the reaction function has a positive slope. The increase of w_1 is larger than the increase of w_2 if the slope of the reaction function (10) of union 2 is smaller than 1.

$$\frac{\partial w_2}{\partial w_1} = \frac{c_2}{2c_1} \quad \text{is smaller than 1, if } c_2 < 2c_1$$

We can postulate the following proposition:

Proposition 5 *With sequential wage determination the market share of the wage leader firm is larger than with simultaneous wage determination.*

The market shares result from equation (15):

$$Y_1^{seq} = \frac{3}{8} + \frac{b(c_1 - c_2)}{24tc_1c_2} = \frac{9tc_1c_2 + b(c_1 - c_2)}{24tc_1c_2} \quad \text{and} \quad Y_2^{seq} = \frac{5}{8} + \frac{b(c_2 - c_1)}{24tc_1c_2} \quad (18)$$

$$Y_{1,d}^{sim} = \frac{9tc_1c_2 + b(c_1 - c_2)}{18tc_1c_2}$$

$$Y_1^{seq} < Y_{1,d}^{sim} \quad \text{if } 9tc_1c_2 + b(c_1 - c_2) > 0$$

If the wage leader firm 1 is more productive than firm 2 this inequality is valid in any cases. Otherwise the inequality is met if

$$t > \frac{b(c_1 - c_2)}{9c_1c_2}$$

But this restriction is given by (13).

Sequential wage determination leads to an asymmetric solution, even if technology is symmetric.

Proposition 6 *With rising productivity in firm i , the corresponding wage rise is smaller in the sequential than in the simultaneous setting. So the market share of the more productive firm increases less with rising productivity than in the simultaneous case.*

This is shown easily by calculating the following partial derivatives:

$$\begin{aligned} \frac{\partial Y_i}{\partial c_i} &= \frac{b}{24tc_i^2} && \text{with sequential wage setting} \\ \frac{\partial Y_i}{\partial c_i} &= \frac{b}{18tc_i^2} && \text{with simultaneous wage setting} \end{aligned}$$

5 Conclusions

In this paper I have analyzed the effects of different institutional settings of labor markets on the market shares of firms in an oligopolistic framework. The interdependence of firms in the product market influences the labor market. Wage setting in one firm creates an externality on other firms. Unions recognize these interdependencies and alter their wage setting behavior correspondingly in different settings.

The oligopolistic structure is described by two price setting firms located in a "linear city" at the extreme points. Firms supply heterogeneous products and consumers have different preferences. Competitiveness of the market is described by "taste deviation costs". With higher costs unions can increase wages above the competitive level (given by the level of alternative income). With simultaneous wage determination equilibrium wages are different, if productivities are different. The wage markup is larger in the more productive firm.

Decentralized wage determination by unions results in more even market shares compared to a centralized wage determination. Wage setting behavior of unions in a decentralized setting results in higher relative costs for more productive firms, compared to a centralized setting, and leads to a more even distribution of the market.

A sequential wage determination setting results in a lower market share for the wage leader firm than a simultaneous setting, because the competitor always can undercut wages and increases therefore its market share.

With sequential wage setting the market is not split evenly if firms have the same productivity. The wage leader firm gets the smaller share, because its union is able to change the distribution by rising the wage. Additionally, irrespective of being wage leader or follower the union of the more productive firm is not able to exploit the productivity advantage by rising the wage rate to the same extent as in the simultaneous case.

One problem that arise when verifying the results of this static model empirically is the fixed number of firms. I interpret a more uneven split of the market as a higher

concentration of an industry. As a first approximation I compare the Herfindahl-index for industries in two countries with different organized wage determination. Austria is an example for a country with highly centralized wage bargaining and the U.S. is one for decentralized wage bargaining (see Calmfors and Driffill (1988)). Using firm size in terms of employment as a proxy of market shares and comparing the Herfindahl-indices for the industries in these countries shows that industry in Austria is more concentrated than in the U.S.

Industrial establishments and employment by size of establishments

All Industries				
	establishments (shares)		employment (shares)	
size by employment	Austria	U.S.	Austria	U.S.
-4	0.3978	0.3480	0.0072	0.0133
5-9	0.1075	0.1781	0.0127	0.0260
10-19	0.1133	0.1531	0.0277	0.0462
20-49	0.1516	0.1527	0.0853	0.1044
50-99	0.0958	0.0756	0.1170	0.1161
100-499	0.1164	0.0798	0.4242	0.3567
500-999	0.0118	0.0084	0.1379	0.1252
1000-	0.0058	0.0042	0.1879	0.2121
Herfindahl-index	0.2286	0.2118	0.2562	0.2153

Sources: Austrian Central Statistical Office (data for 1995) and U.S. Census Bureau (data for 1992)

For this sample the domain of the Herfindahl-index has to be between 0.125 for no concentration and 1 for maximal concentration. The value is larger for the Austrian data in terms of establishments and in terms of employment.

In a dynamic setting the uneven split of the market shares could result in a slower drop out of less productive firms in a decentralized, but unionized wage determination, resulting in lower productivity growth. Comparing Austria with the U.S. we see that labor productivity growth between 1979 and 1997 was 20.6% in Austria and 10.5% in the U.S. (Data source: OECD: ECO).

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