

Unions in Oligopolistic, Vertically Connected Industries

Thomas Grandner,
Vienna University of Economics and Business Administration

Draft: September, 1999

Abstract A model of two unionized, vertically connected oligopolistic industries is analyzed. Economic performance, measured by consumer prices, depends on the institutional setting of wage bargaining. Two externalities may occur, namely an *integration* and a *competition externality*, which have contrary effects. With decentralized bargaining no externalities can be internalized resulting in low consumer prices. With bargaining at the industry level only the competition externality is internalized resulting in high prices. With centralized bargaining both externalities can be internalized resulting again in low prices. With at least two firms in each industry, the decentralized setting performs best. Performance improves with an increase in the competition of the product markets.

Keywords: Vertical industry structure; Unions; Wage determination

JEL-Classification: L13, J50, J31

1 Introduction

This paper analyses the effects of different institutional arrangements of union-firm bargaining in a vertically connected industry. The key feature of this partial equilibrium model is the imperfection of the markets. On the one hand there are two vertically connected product markets (industries), modelled by Cournot oligopolies, with independent firms active in both markets.¹ Within this context one industry produces an input good that is used for production in the other industry. On the other hand there is an imperfect labor market, modelled by firm-union wage bargaining. This imperfection of the markets is possibly a source for externalities.

Several papers have analyzed oligopolistic commodity markets combined with models of trade unions. For example Dobson (1994), Corneo (1995), Santoni (1996) and Vannetelbosch (1997) have used a Cournot model, while Dowrick (1989) and De Fraja (1993) used one with conjectural variations, with the Cournot and Bertrand models as special cases.

In all these papers the institutional setting of the bargaining was important, because different arrangements influenced the costs of production to a different degree. De Fraja, Dobson, Corneo and Santoni investigated different institutional settings by introducing sequential bargaining, and found that such bargaining resulted in wages higher than those found in a simultaneous wage setting. (De Fraja elaborates on this with a multi-period model with staggered wage bargaining). It is important to note that all papers bring out one common feature that is independent from the concrete model of oligopoly: rising rivals' wage rates increase firm's own profit and therefore allows an increase in the firm's own wage rate. This creates a *competition externality*, which is ignored by decentralized bargaining. For this reason, in all these papers the wage is higher with centralized bargaining than with a decentralized wage bargaining. An exception is Vannetelbosch, where wage need not be higher in the centralized than in the decentralized setting, because of the assumption of incomplete information and the specific concept of solution he uses.

The introduction of the vertically structured production process in this paper adds the possibility of another externality, called *integration externality*. Wage bargaining outcome in the upstream industry influences the downstream industry through the input price, and the wage bargaining in downstream industry influences the demand for the upstream industry product. The effect of this externality is contrary to that of the competition externality. Wages rise when the integration externality is ignored, therefore decentralized bargaining should exhibit higher wages.

Both externalities can be internalized with completely centralized bargaining. Wage bargaining at the industry level ignores the integration externality, resulting in higher wages, higher prices for the final product and therefore lower employment. With com-

¹ With imperfect markets double marginalization could arise and firms would possibly prefer to integrate vertically. Greenhut and Ohta (1979) have shown that vertically connected Cournot-duopolies the integrated solution is the equilibrium structure. But with oligopolies producing heterogeneous goods Lin (1988) have shown, that separation is the equilibrium. Interestingly for the present paper, Abiru, Nahata, Raychaudhuri and Waterson (1998) get a separation result for Cournot oligopolies with an unequal number of active firms in the two industries.

pletely decentralized bargaining both externalities become effective and wages are lower than in industry-specific bargaining setting, where only the competition externality is internalized.²

The level of market competition, measured by the number of firms, affects wages and final product price depending on the institutional setting. With centralized bargaining or bargaining at the industry level wages do not vary with the number of active firms, while with decentralized bargaining wages fall as the level of market competition rises. The final product price is reduced with more competition independently from any of the analyzed bargaining institutions.

2 The Structure of the Product Market

In the present model two industries exist; one produces a homogeneous intermediate good, called the upstream industry, labelled by subscript u , and the other produces a homogeneous final good, called the downstream industry, labelled by subscript d . Both industries are organized in an oligopolistic fashion, described by the Cournot model.³ In the upstream industry there are m identical firms active, firm j produces x_j units of the homogeneous product, $j = 1, \dots, m$. Industry output is given therefore by $X = \sum_{j=1}^m x_j$. In the downstream industry n identical firms are active, firm i produces q_i , $i = 1 \dots n$, and $Q = \sum_{i=1}^n q_i$.

Demand for final product is given by a linear function

$$P_d = a - sQ \tag{1}$$

with P_d as the price of the final product.

Production technology is very simple. Each firm from the downstream industry produces one unit of the final output by use of $1/c_d$ units of labor and with one unit of the intermediate product. So the profit function of a typical firm in the downstream industry is

$$\pi_{d,i}(q_1, \dots, q_n) = q_i \left(a - sQ - P_u - \frac{w_{d,i}}{c_d} \right), \quad i = 1, \dots, n. \tag{2}$$

with $P_u - \frac{w_{d,i}}{c_d}$ as the marginal cost for firm i , P_u as the price of the intermediate input and $w_{d,i}$ as the wage paid in firm i .

² Although the present model is a partial equilibrium analysis I would like to point to the macroeconomic literature on the relationship between the degree of the centralization of collective bargaining and the macro economic performance. Calmfors and Driffill (1988) show empirically that this relationship is U-shaped. Recently, the stability of this finding has been doubted and an update of the Calmfors and Driffill paper (OECD 1997, chapt. 3) shows that the relationship between economic performance and the structure of collective bargaining measured in various ways is not statistically significant for most measures, except a negative relationship between earning inequality and centralization of the bargaining process.

³ A rigorous discussion of oligopoly theories can be found, for example, in Shapiro (1989).

In the Cournot model the strategic variable for the firm is the quantity of the output. Each of the firms assume that all other firms will keep the produced quantities fixed. The unique Cournot solution for this oligopolistic market is given by⁴

$$q_i = \frac{a - P_u - n \frac{w_{d,i}}{c_d} + \frac{W_{d,-i}}{c_d}}{s(n+1)} \quad (3)$$

with $W_{d,-i} = \sum_{l=1}^n w_{d,l} - w_{d,i}$.
Industry output is given by

$$Q = \frac{n(a - P_u) - \frac{W_d}{c_d}}{s(n+1)} \quad (4)$$

with $W_d = \sum_{l=1}^n w_{d,l}$.

Equation (4) restricts the maximum price that downstream firms would pay for the intermediate product. In equilibrium the overall output of the downstream and the upstream industry must be equal. Substituting X for Q , (4) can be rearranged to

$$P_u = a - \frac{W_d}{c_d n} - \frac{s(n+1)}{n} X \quad (5)$$

This demand function connects the two industries vertically. The slope of the demand for the intermediate good depends on the degree of competition in the final goods industry, measured by the number of firms, and on the slope parameter of the final good demand. The intermediate good demand function becomes flatter with an increase in the competition of the downstream industry. The reason is that equilibrium downstream industry output increases with n , but individual firm output is reduced. This property is passed on to the upstream industry. Therefore the price of the intermediate good does not react to the same extent to an increase in output, if the downstream industry is highly competitive.

Labor is the only input used in the upstream industry, and one unit of output is produced with $1/c_u$ units labor. The profit function of a typical firm in the upstream industry has the following form

$$\pi_{u,j}(x_1, \dots, x_m) = x_j \left(P_u - \frac{w_{u,j}}{c_u} \right) = x_j \left(a - \frac{W_d}{c_d n} - \frac{w_{u,j}}{c_u} - \frac{s(n+1)}{n} X \right) \quad (6)$$

with $w_{u,j}$ as the wage paid by the upstream firm j .

The Cournot solution for the intermediate good industry can be described by

$$x_j = \frac{n \left(a - \frac{W_d}{c_d n} - m \frac{w_{u,j}}{c_u} + \frac{W_{u,-j}}{c_u} \right)}{s(n+1)(m+1)} \quad (7)$$

with W_u and $W_{u,-j}$ defined analogously to W_d and $W_{d,-i}$.

Upstream industry output is given by

⁴ The solution of a Cournot model with linear demand is derived, for example, in Selten (1986).

$$X = \frac{nm \left(a - \frac{W_d}{c_d n} - \frac{W_u}{c_u m} \right)}{s(n+1)(m+1)} \quad (8)$$

Industry output depends negatively on a firm's own wage rate (marginal costs) and on the wages paid in the final goods industry. Competition in both industries influences output positively.

In the upstream industry output reacts qualitatively in the same way as in the downstream industry. A uniform wage increase in an industry reduces the overall output. The equilibrium output of an individual firm would be reduced by a wage increase within that firm, but would be increased by an increase in the competitors' average wage.

Substituting (8) into (5) gives

$$P_u = \frac{a - \frac{W_d}{c_d n} + \frac{W_u}{c_u}}{(m+1)} \quad (9)$$

Substituting (9) into (3) results in

$$q_i = \frac{nm \left(a - \frac{W_u}{c_u m} \right) + (nm + n + 1) \frac{W_{d,-i}}{c_d} - (n^2 m + n^2 - 1) \frac{w_{d,i}}{c_d}}{ns(n+1)(m+1)} \quad (10)$$

It is important to see in which different ways wages affect output within each industry and between the two industries. Products of an industry are substitutes and products of different industries are complements. If wages can be set strategically, the reaction curves have a positive slope with respect to wages within that industry, but a negative slope with respect to wages of the different industry, as can be seen in (7) and (10).

Remember that in equilibrium $Q = X$, thus (8) also gives the overall output of the final goods industry.

The price of the final product is given by

$$P_d = \frac{(n+m+1)a + nm \left(\frac{W_d}{c_d n} + \frac{W_u}{c_u m} \right)}{(n+1)(m+1)} \quad (11)$$

and depends positively on the marginal costs and negatively on the number of firms in both industries.

As a result profits in a downstream respectively upstream industry firm is given by

$$\pi_{d,i} = \frac{\left(nm \left(a - \frac{W_u}{c_u m} \right) - (n^2 m + n^2 - 1) \frac{w_{d,i}}{c_d} + (nm + n + 1) \frac{W_{d,-i}}{c_d} \right)^2}{sn^2(n+1)^2(m+1)^2} = sq_i^2 \quad (12)$$

$$\pi_{u,j} = \frac{\left(na - \frac{W_d}{c_d} - nm \frac{w_{u,j}}{c_u} + n \frac{W_{u,-j}}{c_u} \right)^2}{sn(n+1)(m+1)^2} = \frac{s(n+1)}{n} x_j^2 \quad (13)$$

A firm's profit rises with the wage of the competitors in that industry, because the competition situation improves. Accompanied with this improvement is an increase in the equilibrium output. However, a firm's profit falls with that firm's wage and with the wages paid in the second industry because costs rise. Again, accompanied with these profit reductions, is a reduction in output.

3 The Wage Bargaining

Before describing the bargaining process it is important to clarify the informational and institutional structure used in the model. The assumption is made that all participants are well informed about the product market structure, the relevant production functions and the institutional setting of the wage bargaining. All relevant aspects of the bargainings, for example utility functions or bargaining power, are taken to be common knowledge.

There are many different institutional structures possible. Three specific bargaining settings are analyzed in this paper and all hold a common time structure: a decentralized bargaining setting, a centralized one at the industry level and a completely centralized one. All bargainings take place simultaneously and wage bargaining precedes the employment decision.

Specifically, I will analyze the following institutional settings:

1. Completely decentralized bargaining. Wage bargainings take place simultaneously at the firm level. All other wages in the two industries are considered as given for the bargaining partners.
2. Industry-specific centralized bargaining. In each industry only one union and one representative of the firms' owners bargain over a uniform industry wage rate. Both bargainings take place at the same time and the bargaining partners consider the uniform wage rate paid in the other industry as given.
3. Completely centralized bargaining. One union and one representative of the firms' owners decide about a uniform wage rate.

Unions and firms only bargain over wages. The outcome of wage bargaining is described by a generalized Nash bargaining solution.⁵ After wages are fixed through the bargaining process, firm owners decide about employment levels, calculating the employment level that maximizes profit according to the product market model presented above. This is the so called *right to manage model*. An alternative type of union-employer bargaining model would be the *efficient bargaining* of McDonald and Solow (1981), where the bargaining partners simultaneously agree upon the wage rate and the level of employment. But there are several reasons why bargaining over wages and employment level is not observed frequently, although bargaining only over wages is known to be inefficient.⁶ One category

⁵ The Nash bargaining and its connection to non-cooperative bargaining games is discussed in Binmore (1987).

⁶ See Layard, Nickell and Jackman (1991).

of arguments stresses informational problems; with incomplete information, it may be difficult to put through a signed contract. A second category reflects on insider behavior of the union members. An additional argument can be introduced here. In the present paper a simultaneous wage and employment decision is not compatible with the described oligopolistic product market competition when bargaining is centralized at the industry level or is completely centralized. A centralized employment decision, like in the efficient bargaining model, always ends up in a cartel, because the objective of profit earners is the overall industry profit and the overall industry profit is increased by agreeing on a cartel. In the right to manage model the sequence of wage setting and employment setting ensures competition at the product market.

The assumption is made that unions are interested in the sum of rents, $L(w - \bar{w})$, where L is employment, w the wage rate and \bar{w} is the reservation wage, exogenously given in this model.⁷ Firms are interested in profits and their disagreement payoff is set to zero. β describes the bargaining power of the union and lies in the interval $[0, 1]$. With $\beta = 1$ the model describes the *monopoly union*, with $\beta = 0$ the model degenerates to a perfect competitive labor market.

So, the Nash function that will be maximized over wages is

$$N(w) = \left(L(w)(w - \bar{w}) \right)^\beta \pi(w)^{1-\beta} \quad (14)$$

Note that L depends on w , because employment is set in a profit maximizing way.

To keep the analysis simple, a uniform bargaining power for all unions within an industry in the decentralized setting is assumed.

Additionally, for equilibrium to exist in all cases one assumes

$$\bar{w} < \frac{c_d c_u a}{c_d + c_u} \quad (15)$$

3.1 Decentralized Bargaining

With decentralized bargaining there is no coordination between different bargaining units. The firm owner and the firm-union select their own wage rate. All bargainings take place simultaneously and the bargaining partners take all other wage rates as given exogenously.⁸

⁷ This assumption is compatible with the standard assumption that unions are interested in the expected wage when labor force is normalized to one and the disagreement payoff is set to \bar{w} , see Corneo (1995).

⁸ In the Appendix the Nash-product for all three institutional settings is shown.

Proposition 1: In a complete decentralized bargaining setup

wages are given by

$$w_{d,i} = \bar{w} + \frac{\beta_d(2 - \beta_u)nm^2 \left(c_d a - (c_d + c_u) \frac{\bar{w}}{c_u} \right)}{k_1} \quad (16)$$

$$w_{u,j} = \bar{w} + \frac{(2 - \beta_d)\beta_u(n^2m + n^2 - 1) \left(c_u a - (c_d + c_u) \frac{\bar{w}}{c_d} \right)}{k_1} \quad (17)$$

and the final output price by

$$P_d = \frac{\left(k_1(n + m + 1) + k_2nm \right) a + (k_1 - k_2)nm \frac{c_d + c_u}{c_d c_u} \bar{w}}{k_1(n + 1)(m + 1)} \quad (18)$$

with $k_1 = (2 - \beta_d)(n^2m + n^2 - 1) \left((2 - \beta_u)m + \beta_u \right) + \beta_d(2 - \beta_u)nm^2$
and $k_2 = \beta_d(2 - \beta_u)nm^2 + (2 - \beta_d)\beta_u(n^2m + n^2 - 1)$

To derive these results the upstream and the downstream industries are analyzed separately in the first step.

For a single upstream industry firm the Nash-product, that has to be maximized, is derived by substituting (7) and (13) into (14). The firm-union and the upstream firm bargain over a firm specific wage rate, assuming all other wage rates in the upstream and downstream industry are given, keeping in mind the restriction of the product market. The explicit solution of this problem is given by the following reaction function

$$w_{u,j} = \frac{\beta_u c_u a - \beta_u c_u \frac{W_d}{c_d n} + \beta_u W_{u,-j} + (2 - \beta_u) m \bar{w}}{2m} \quad (19)$$

Two externalities arise with the decentralized bargaining setting. The *competition externality* is effective because a rise of the firm's own wage would increase the utility level of all other upstream industry bargaining partners by improving their competitive situation. This can be seen by the positive dependency of the optimal reaction on the average wage paid in the other upstream firms. With decentralized bargaining this effect will be ignored by the bargaining partners.

The *integration externality* arises because an increase in the firm's own wage rate reduces the utility of all downstream firm bargaining partners by increasing their costs. This can be seen by the negative dependency of the optimal reaction on the average wage paid by the downstream firms. This effect will also be ignored in a decentralized setting.

The slope of the reaction function with respect to the average wage paid in the downstream industry is $-\frac{\beta_u c_u}{2c_d m}$ and depends on the degree of competition in the upstream in-

dustry. The function becomes flatter with a higher degree of competition. The reason is that with decentralized bargaining the dependency from the other industry is reduced if the intra-industry competition is increased. With a very high value for m the only decisive variables are the reservation wage and the average wage of the own industry competitors. The slope of the reaction function with respect to the average wage paid in the competing upstream firms is $+\frac{\beta_u(m-1)}{2m}$. The function becomes steeper with more firms active in the upstream industry, because more competition makes each firm more vulnerable with respect to differences in their production costs.

The Nash solution for a representative downstream firm is given by

$$w_{d,i} = \frac{\beta_d c_d n m a - \beta_d c_d n \frac{W_u}{c_u} + \beta_d (n m + n + 1) W_{d,-i} + (2 - \beta_d) (n^2 m + n^2 - 1) \bar{w}}{2(n^2 m + n^2 - 1)} \quad (20)$$

As before, the effects of the two externalities can be seen in the reaction function. The integration externality occurs because a higher wage in the downstream firm does not only reduce downstream industry output, but also reduces the upstream industry output, caused by the vertical connection between the two industries.

Again, none of the externalities can be internalized by decentralized bargaining. The slope with respect to the average wage paid in the upstream industry is $-\frac{\beta_d c_d n m}{2c_u(n^2 m + n^2 - 1)}$. The function becomes flatter with more competition in the downstream industry and steeper with an increasing number of firms in the upstream industry. The slope of the reaction function with respect to the average wage paid by the competitors in the downstream industry is $+\frac{\beta_d(nm+n+1)(n-1)}{2(n^2m+n^2-1)}$ and becomes steeper with more firms in the downstream industry and flatter with more firms in the upstream industry. Note that, contrary to the reaction function of an upstream firm, the slope of this reaction function with respect to both average wages depends on the degree of competition in both industries.

Equilibrium, which is presented in Proposition 1, can be found by the intersection of these reaction functions.

Equilibrium wages and final output price depend on unions' bargaining power, on productivity parameters and on the degree of competition in both industries. With bargaining power being zero in either industry, equilibrium wages for that industry are given by the reservation wage. Caused by the integration externality, with a rising bargaining power of the unions in one of the industries, the wage rates increase in that industry. Contrary to this, industry wages fall with a rising bargaining power of the other industry's unions.

Because of the competition externality, wage mark-ups also depend on the number of firms. Wage rates decrease in an industry with the degree of competition within this industry, although they increase with the degree of competition in the other industry. To see this, start with a reaction function of an upstream firm: for a given average of wages in all other firms, the optimal wage of firm j would be reduced with an increase in the number of firms in the upstream industry. A change in the number of downstream firms

would not change the optimal wage reaction. Therefore w_d would fall and w_u rise with an increasing n , and w_d increase and w_u fall with an increasing m .⁹

The final product price would fall with an increase in the competition level for any industry.

3.2 Industry-Specific Centralized Bargaining

This scenario describes a situation where wages are bargained at the industry level. In each industry one union and one representative of the firm owners bargain over wages simultaneously. Therefore the bargaining partners know that wages have to be uniform within each industry, but can be different between the industries.

With uniform industry wages the equilibrium firm output, described in (7) and (3), simplifies to

$$\begin{aligned} x_j &= \frac{n \left(a - \frac{w_d}{c_d} - \frac{w_u}{c_u} \right)}{s(n+1)(m+1)} \\ q_i &= \frac{m \left(a - \frac{w_d}{c_d} - \frac{w_u}{c_u} \right)}{s(n+1)(m+1)} \end{aligned} \quad (21)$$

Proposition 2: In a industry specific centralized bargaining setup

wages are given by

$$w_d = \bar{w} + \frac{\beta_d(2 - \beta_u) \left(c_d a - (c_d + c_u) \frac{\bar{w}}{c_u} \right)}{4 - \beta_d \beta_u} \quad (22)$$

$$w_u = \bar{w} + \frac{\beta_u(2 - \beta_d) \left(c_u a - (c_d + c_u) \frac{\bar{w}}{c_d} \right)}{4 - \beta_d \beta_u} \quad (23)$$

and the final output price by

$$P_d = \frac{\left((4 - \beta_d \beta_u)(n+m+1) + nm(\beta_d(2 - \beta_u) + \beta_u(2 - \beta_d)) \right) a + (2(2 - \beta_d - \beta_u) + \beta_d \beta_u) nm \frac{c_d + c_u}{c_d c_u} \bar{w}}{(4 - \beta_d \beta_u)(n+1)(m+1)} \quad (24)$$

As before, the analysis starts with each industry separately.

The upstream industry union and the representative of the upstream industry profit earners bargain over the upstream industry wage rate, assuming that the downstream industry wage rate is given and keeping in mind the solution of the product market.

The explicit result of the Nash bargaining is given by

⁹ Derivatives are shown in the Appendix.

$$w_u = \bar{w} + \frac{\beta_u \left(c_u \left(a - \frac{w_d}{c_d} \right) - \bar{w} \right)}{2} \quad (25)$$

The reaction function has a negative slope with respect to the downstream industry wage rate, because lower wages and therefore lower costs in the downstream industry result in a lower final product price and therefore in a higher demand for the final product. This higher demand also brings about a higher demand for the intermediate product, caused by the vertically structured production process. This would increase the rent that can be distributed between the upstream firms and their unions. But with industry-specific bargaining the integration externality would be ignored.

Contrary to the decentralized setting, the reaction function does not depend on the degree of competition in the product market, because the competition externality is internalized.

Maximizing the relevant Nash-product for the downstream industry over the wage rate, given the upstream industry wage rate, results in the following reaction function

$$w_d = \bar{w} + \frac{\beta_d \left(c_d \left(a - \frac{w_u}{c_u} \right) - \bar{w} \right)}{2} \quad (26)$$

This function has a negative slope with respect to the upstream industry wage rate, showing the effect of the integration externality. Moreover the competition externality is internalized and therefore the industry reaction function does not depend on the degree of competition in any industry.

The intersection of these reaction functions describes equilibrium, as described in Proposition 2.

The wage mark-up is positive, if the bargaining power of the industry union is positive. Both equilibrium wages rise with the bargaining power of the firm's union and decrease with union's bargaining power in the other industry. The wage increase which is caused by an increase in the firm's union's bargaining power is self-explanatory. If the union's bargaining power in the other industry rises, wages increase there and equilibrium output falls. With this reduction of output the rent that can be distributed between profit and wage earners shrinks and the wage rate falls.

Equilibrium wages in both industries also rise with an increase in the productivity parameter for either industry.

As in the decentralized setting, the final product price depends negatively on product market competition in both industries.

3.3 Completely Centralized Bargaining

With completely centralized bargaining, wages are set uniformly in both industries. So the union and the representative of the profit earners bargain over a unique wage rate, keeping

in mind the restriction of the subsequent vertical Cournot oligopoly solution.

Proposition 3: In a completely centralized bargaining setup

the wage is given by

$$w = \bar{w} + \frac{\beta \left(c_d c_u a - (c_d + c_u) \bar{w} \right)}{2(c_d + c_u)} \quad (27)$$

and the final output price by

$$P_d = \frac{\left(2(n + m + 1) + \beta nm \right) a + (2 - \beta) nm \frac{c_d + c_u}{c_d c_u} \bar{w}}{2(n + 1)(m + 1)} \quad (28)$$

Equilibrium wage exceeds the reservation wage by an amount that depends positively on union's bargaining power, on product demand and on productivity parameters. With $\beta = 0$ the wage is set to the reservation wage. The competition and the integration externality are internalized. Therefore the equilibrium wage rate does not depend on the product market competition in any industry.

The price of the final product depends positively on the bargaining power and negatively on the productivity parameters and on the degree of product market competition in any industry.

3.4 Comparison

Competition and integration externality are internalized in different ways by the bargaining partners depending on the specific institutional setting of the bargaining process. The competition externality results in low wages, because bargaining partners ignore how a wage increase positively affects their horizontal competitors. The integration externality results in high wages, because bargaining partners ignore the negative effect of a rising wage on firms in the other industry. With decentralized bargaining none of these externalities can be internalized and therefore a positive and a negative externality is effective. Contrary to this both externalities are internalized with completely centralized bargaining. With bargaining at the industry level, the competition externality can be internalized while the integration externality is effective.

Proposition 4: The final product price is highest with an industry-specific centralized bargaining and lowest with decentralized bargaining.

Proof: see Appendix

On the one hand, with bargaining at the industry level, the integration externality is effective, resulting in high wages and therefore in higher prices. On the other hand the competition externality is internalized, resulting again in high wages. Thus the two wage pressing effects are combined. With decentralized or centralized bargaining, there are two contrary effects and a wage pressing effect is neutralized by a wage dampening effect, at least partly. Measured by a low final good price, decentralized wage bargaining performs best and the performance improves with the number of firms in any industry. If in both industries a monopoly would exist, then no competition effect would appear and decentralized bargaining would be equivalent to bargaining at the industry level. Centralized bargaining would perform best in this case. But with more competitive product markets the final good price would be lower with decentralized bargaining.

Proposition 4 can be interpreted in terms of wages. Equation (11) shows the connection between wages and the final product price. Wages are low with decentralized bargaining and high with bargaining at the industry level. With completely centralized bargaining wages are equal in both industries, independent of the productivity parameters. On average wages are lower with completely centralized bargaining than with bargaining at the industry level. At least one of the wages in the industry-specific setting has to be higher than in the centralized setting.

To summarize the results, the assumption is made that all unions will have the same bargaining power ($\beta_d = \beta_u = \beta$) and that only two firms are active in both industries.

	Solutions for duopolies		
	Decentralized	Industry	Centralized
w_d	$\bar{w} + \frac{8\beta(c_d a + (c_d + c_u)\frac{\bar{w}}{c_u})}{44 - 3\beta}$	$\bar{w} + \frac{\beta(c_d a + (c_d + c_u)\frac{\bar{w}}{c_u})}{2 + \beta}$	$\bar{w} + \frac{\beta(c_d c_u a + (c_d + c_u)\bar{w})}{2(c_d + c_u)}$
w_u	$\bar{w} + \frac{11\beta(c_d a + (c_d + c_u)\frac{\bar{w}}{c_u})}{44 - 3\beta}$	$\bar{w} + \frac{\beta(c_u a + (c_d + c_u)\frac{\bar{w}}{c_d})}{2 + \beta}$	$\bar{w} + \frac{\beta(c_d c_u a + (c_d + c_u)\bar{w})}{2(c_d + c_u)}$
P_d	$\frac{(220 + 61\beta)a + 88(2 - \beta)\frac{c_d c_u}{c_d + c_u}\bar{w}}{9(44 - 3\beta)}$	$\frac{(10 + 13\beta)a + 4(2 - \beta)\frac{c_d c_u}{c_d + c_u}\bar{w}}{9(2 + \beta)}$	$\frac{(5 + 2\beta)a + 2(2 - \beta)\frac{c_d c_u}{c_d + c_u}\bar{w}}{9}$

In the downstream industry the wage is lower with centralized bargaining than with bargaining at the industry level as long as $c_d > \frac{\beta c_u}{2}$. In the upstream industry the wage is lower with centralized bargaining than with bargaining at the industry level as long as $c_d < \frac{2c_u}{\beta}$.

The wage is higher in the downstream industry with centralized bargaining than with decentralized bargaining as long as $c_d < \frac{c_u(28 - 3\beta)}{16}$ and higher in the upstream industry as long as $c_d > \frac{22c_u}{22 - 3\beta}$.

With bargaining at the industry level equilibrium wages are always higher than at the decentralized level. This is also true with more firms, because the difference between wages increases with the number of firms.

Price is therefore lowest with decentralized bargaining and highest with bargaining at industry level.

4 Conclusions

This paper analyzed a model of unionized, vertically connected oligopolistic industries. Two externalities may occur which have contrary effects. The integration externality is related with the inter-industrial economic activity and the competition externality is related with the intra-industrial activity. These externalities can be internalized to some extent by bargaining units, depending on the specific institutional arrangement of the wage bargaining.

Three different institutional settings have been analyzed: a completely decentralized setting, an industry specific one and a completely centralized one. Neither of the externalities can be internalized with completely decentralized bargaining. Both can be internalized with a completely centralized one. In both cases, a positive effect will neutralize a negative effect to some extent. With wage bargaining at the industry level only the competition externality, which describes a positive effect for the competitors within a sector, is internalized. The integration externality, which is negative for firms in the other sector, is effective and bargaining therefore results in higher wages.

The degree of product market competition does not influence equilibrium wages with centralized and industry-specific bargaining, but wages do react on the number of firms with decentralized wage bargaining. Thus with higher competition the decentralized setting will show lower final product prices and higher output.

References

- Abiru, Masahiro, Babu Nahata, Subhashis Raychaudhuri, and Michael Water-son**, “Equilibrium Structures in Vertical Oligopoly,” *Journal of Economic Behavior and Organization*, 1998, *37*, 463–480.
- Binmore, Ken**, “Nash Bargaining Theory I,” in K. Binmore and P. Dasgupta, eds., *The Economics of Bargaining*, Oxford: Basil Blackwell, 1987, pp. 27–46.
- Calmfors, Lars and John Driffill**, “Bargaining Structure, Corporatism and Macroeconomic Performance,” *Economic Policy: A European Forum*, 1988, (6), 13–61.
- Corneo, Giacomo**, “National Wage Bargaining in an Internationally Integrated Product Market,” *European Journal of Political Economy*, 1995, *11*, 503–520.
- De Fraja, Giovanni**, “Staggered vs. Synchronised Wage Setting in Oligopoly,” *European Economic Review*, 1993, *37*, 1507–1522.
- Dobson, Paul**, “Multifirm Unions and the Incentive to Adopt Pattern Bargaining in Oligopoly,” *European Economic Review*, 1994, *38*, 87–100.
- Dowrick, Steve**, “Union-Oligopoly Bargaining,” *The Economic Journal*, 1989, *99*, 1123–1142.

- Greenhut, Melvin L. and Hiroshi Ohta**, “Vertical Integration of Successive Oligopolists,” *American Economic Review*, 1979, 69 (1), 137–141.
- Layard, Richard, Stephen Nickell, and Richard Jackman**, *Unemployment. Macroeconomic Performance and the Labour Market*, Oxford: Oxford University Press, 1991.
- Lin, Y. Joseph**, “Oligopoly and Vertical Integration: Note,” *American Economic Review*, 1988, 78 (1), 251–254.
- McDonald, Ian and Robert Solow**, “Wage Bargaining and Employment,” *American Economic Review*, 1981, 71, 896–908.
- OECD**, “Employment Outlook,” July 1997.
- Santoni, Michele**, “Union-Oligopoly Sequential Bargaining: Trade and Industrial Policies,” *Oxford Economic Papers*, 1996, 48 (4), 640–663.
- Selten, Reihard**, “Elementary Theory of Slack-ridden Imperfect Competition,” in Joseph E. Stiglitz and G. Frank Mathewson, eds., *New Developments in the Analysis of Market Structure*, Basingstoke: Macmillan, 1986, pp. 126–144.
- Shapiro, Carl**, “Theories of Oligopoly Behavior,” in R. Schmalensee and R. Willig, eds., *Handbook of Industrial Organization, Vol.I*, Amsterdam: North-Holland, 1989, pp. 329–414.
- Vannetelbosch, Vincent**, “Wage Bargaining with Incomplete Information in an Unionized Cournot Oligopoly,” *European Journal of Political Economy*, 1997, 13, 353–374.

5 Appendix

Decentralized Bargaining

The maximization problem of a representative upstream firm

$$\max_{w_{u,j}} \left[\left(\frac{x_j(w_{u,j})}{c_u} (w_{u,j} - \bar{w}) \right)^{\beta_u} (\pi_{u,j}(w_{u,j}))^{1-\beta_u} \right] \quad (29)$$

The first order condition is

$$(2 - \beta_u) \frac{d x_j}{d w_{u,j}} (w_{u,j} - \bar{w}) + \beta_u x_j = 0 \quad (30)$$

The maximization problem of a representative downstream firm

$$\max_{w_{d,i}} \left[\left(\frac{q_i(w_{d,i})}{c_d} (w_{d,i} - \bar{w}) \right)^{\beta_d} (\pi_{d,i}(w_{d,i}))^{1-\beta_d} \right] \quad (31)$$

The first order condition is

$$(2 - \beta_d) \frac{d q_i}{d w_{d,i}} (w_{d,i} - \bar{w}) + \beta_d q_i = 0 \quad (32)$$

Industry Specific Bargaining

The maximization problem of the bargaining partners in the upstream industry

$$\max_{w_u} \left[m \left(\frac{x_j(w_u)}{c_u} (w_u - \bar{w}) \right)^{\beta_u} (\pi_u(w_u))^{1-\beta_u} \right] \quad (33)$$

The first order condition is

$$(2 - \beta_u) \frac{d x_j}{d w_u} (w_u - \bar{w}) + \beta_u x_j = 0 \quad (34)$$

The maximization problem of the bargaining partners in the downstream industry

$$\max_{w_d} \left[n \left(\frac{q_i(w_d)}{c_d} (w_d - \bar{w}) \right)^{\beta_d} (\pi_d(w_d))^{1-\beta_d} \right] \quad (35)$$

The first order condition is

$$(2 - \beta_d) \frac{d q_i}{d w_d} (w_d - \bar{w}) + \beta_d q_i = 0 \quad (36)$$

Completely Centralized Bargaining

The maximization problem of the bargaining partners

$$\max_w \left[\left(\left(m \frac{x_j(w)}{c_u} + n \frac{q_i(w)}{c_d} \right) (w - \bar{w}) \right)^{\beta} (m\pi_u(w) + n\pi_d(w))^{1-\beta} \right] \quad (37)$$

Using equation (21) and define $z(w) = \frac{a-w/c_d-w/c_u}{s(n+1)(m+1)}$.

So $x_j = nz(w)$ and $q_i = mz(w)$.

Rewrite the maximization problem

$$\max_w \left[\left(\left(\frac{nm}{c_u} + \frac{mn}{c_d} \right) z(w)(w - \bar{w}) \right)^\beta \left((nsm^2 + ms(n+1)n) z(w)^2 \right)^{1-\beta} \right] \quad (38)$$

The problem is equivalent to

$$\max_w \left[z(w)^{2-\beta} (w - \bar{w})^\beta \right] \quad (39)$$

The first order condition reads as

$$\frac{\beta}{2-\beta} z(w) = -\frac{d z(w)}{d w} (w - \bar{w}) \quad (40)$$

Some Comparative Statics

Decentralized Bargaining:

$$\frac{dw_{d,i}}{dn} = -\frac{\beta_d(2-\beta_d)(2-\beta_u)m^2((2-\beta_u)m+\beta_u)(n^2m+n^2-1)\left(c_da-(c_d+c_u)\frac{\bar{w}}{c_u}\right)}{((2-\beta_d)(n^2m+n^2-1)((2-\beta_u)m+\beta_u)+\beta_d(2-\beta_u)nm^2)^2} < 0 \quad (41)$$

$$\frac{dw_{u,j}}{dn} = \frac{\beta_d\beta_u(2-\beta_d)(2-\beta_u)m^2(n^2m+n^2-1)\left(c_ua-(c_d+c_u)\frac{\bar{w}}{c_d}\right)}{((2-\beta_d)(n^2m+n^2-1)((2-\beta_u)m+\beta_u)+\beta_d(2-\beta_u)nm^2)^2} > 0 \quad (42)$$

$$\frac{dw_{d,i}}{dm} = \frac{\beta_d(2-\beta_d)(2-\beta_u)(2m(n^2-1)+\beta_u(m-2)+2\beta_un^2)nm\left(c_ua-(c_d+c_u)\frac{\bar{w}}{c_u}\right)}{((2-\beta_d)(n^2m+n^2-1)((2-\beta_u)m+\beta_u)+\beta_d(2-\beta_u)nm^2)^2} > 0 \quad (43)$$

$$\begin{aligned} \frac{dw_u}{dm} &= \beta_u(2-\beta_d)(2-\beta_u)\left(c_ua-(c_d+c_u)\frac{\bar{w}}{c_d}\right) \times \\ &\times \frac{\beta_d n^3 m^2 - (n^2 m + n^2 - 1)((2-\beta_d)(n^2 m + n^2 - 1) + 2\beta_d n m)}{((2-\beta_d)(n^2 m + n^2 - 1)((2-\beta_u)m + \beta_u) + \beta_d(2-\beta_u)nm^2)^2} < 0 \end{aligned} \quad (44)$$

for all $m, n \geq 2$

$$\frac{d P_d}{d n} = -\frac{m\left(a - \frac{c_d+c_u}{c_d c_u} \bar{w}\right)}{(n+1)^2(m+1)} \left(\frac{nk'_2(n+1) + k_2}{k_1} - \frac{nk'_1 k_2(n+1)}{k_1^2} - 1 \right) \quad (45)$$

$$\frac{d P_d}{d n} = \frac{m\left(a - \frac{c_d+c_u}{c_d c_u} \bar{w}\right)}{(n+1)^2(m+1)k_1^2} (nk_1 k'_2(n+1) + k_1 k_2 - nk'_1 k_2(n+1) - k_1^2) \quad (46)$$

$$\frac{d P_d}{d n} = \frac{m \left(a - \frac{c_d + c_u}{c_d c_u} \bar{w} \right)}{(n+1)^2 (m+1) k_1^2} (n(n+1)(k_1 k_2' - k_1' k_2) + k_1(k_2 - k_1)) \quad (47)$$

$$k_2 - k_1 < 0 \quad \text{by definition} \quad (48)$$

$$k_1 k_2' - k_1' k_2 = m (4n^2 \beta_u (2 - \beta_d) - n^2 \beta_u^2 (2 - \beta_d) - 4n^2 (2 - \beta_d)) < 0 \quad (49)$$

Proof of Proposition 4

Assumption: $\beta_d = \beta_u = \beta$

Completely Centralized vs. Industry Specific Wage bargaining

The final product price in the sector specific centralized setting differs from that in completely centralized setting by:

$$\Delta P_{d,i-c} = \frac{\beta(2-\beta)mn \left(a - \frac{c_d + c_u}{c_d c_u} \bar{w} \right)}{2(2+\beta)(m+1)(n+1)} > 0 \quad (50)$$

Industry Specific vs. Decentralized Wage bargaining

$$\Delta P_{d,i-d} = \frac{k_3 \left(a - \frac{c_d + c_u}{c_d c_u} \bar{w} \right)}{(2+\beta)(n+1)(m+1) \left((2-\beta)(n^2 m^2 - m) + 2n^2 m + \beta(n^2 - 1 + nm^2) \right)} > 0 \quad (51)$$

with $k_3 = \beta(2-\beta)nm(1 - nm^2 - n^2 + 2n^2 m^2 - 2m + n^2 m) > 0$

for all $n, m \geq 2$

Decentralized vs. Completely Centralize Wage bargaining

$$\Delta P_{d,d-c} = \frac{k_4 \left(a - \frac{c_d + c_u}{c_d c_u} \bar{w} \right)}{2(n+1)(m+1) \left((2-\beta)(n^2 m^2 - m) + 2n^2 m + \beta(n^2 - 1 + nm^2) \right)} < 0 \quad (52)$$

with $k_4 = \beta(2-\beta)nm(-1 + nm^2 + n^2 - n^2 m^2 + m) < 0$

for all $n, m \geq 2$ ■