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# **FACULTY OF APPLIED ECONOMICS**

DEPARTMENT OF ECONOMICS

## **DOES PRODUCT MARKET INTEGRATION LEAD TO EUROPEAN WAGE-SETTING?**

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RESEARCH PAPER 2001-001  
December 2000

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# Does product market integration lead to European wage-setting?

Alain Borghijs\*

This version: 4 December, 2000

## Abstract

It is argued that the "Europeanisation" of wage formation will increase wage demands and will decrease the wage responsiveness to country-specific asymmetric shocks, which would ultimately lead to higher unemployment. This paper addresses the issue whether European wage formation is a likely option by looking at the co-operation incentives for trade unions when European product markets integrate. Our theoretical framework allows for asymmetries in reservation wages and productivity between countries. It is found that the integration of product markets does not always result in European trade union co-operation. Considering the combination of the reservation wage and productivity as a measure of competitiveness, it is found that a certain degree of similarity in competitiveness between countries is required in order to reach a wage-setting agreement. We additionally find that trade union co-operation does lead to higher wage demands, and that the effects are larger when countries are more competitive, i.e. at lower levels of the reservation wage and higher productivity levels. The model does however not confirm the proposition that joint wage-setting decreases the wage responsiveness to asymmetric shocks and that it affects employment more than when wages are set separately.

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\* I would like to thank G. Di Bartolomeo, J. Gorter, W. Pauwels, A. Van Poeck and participants at workshops in Paris (ENEPRI) and The Hague (CPB) for useful suggestions and comments. I am grateful to the FWO for financial support. The usual disclaimer applies.

## 1. Introduction

The introduction of the Euro has strengthened the call for more flexibility in European labour markets. In this respect, Siebert (1997 and 1998) pleads against the "Europeanisation" of wage formation. The first argument against wage bargaining at the European level is the risk of higher wage demands in the closed European economy, which would lead to higher unemployment. In contrast to wage negotiators at the national level, unions at the European level do not have to compete with unions in similar industries in other member states. Wage competition is therefore absent, resulting in higher wage demands (Calmfors and Driffill, 1988; Danthine and Hunt, 1994; Corneo, 1995). The second argument is the availability of wage policy to accommodate the negative (employment) effects of asymmetric shocks. Wage bargaining should take place at a sufficiently decentralised level to allow wage adjustment in countries affected by the shock. Bargaining on a European scale cannot provide country-specific wage adjustment without involving other member states and is therefore not suitable to act as a shock absorber for country-specific shocks.

These arguments may cause some concern over the Europeanisation of wage bargaining, but do not give any answer to the question whether there is any possibility that wage bargaining may shift to the European level, notably as a consequence of EMU. We address this question by means of the Marshall-Hicks rules of derived labour demand, which state that the elasticity of labour demand is higher (Hamermesh, 1993):

- when demand for the product produced with that labour is more elastic
- the more easily labour is substituted for other input factors
- when supply of competing inputs is more elastic
- the greater the share of labour cost is in the total production cost

An increase in the elasticity of labour demand in a unionised economy weakens the unions' bargaining power in wage determination. Unions may attempt to restore their bargaining power by cross-border co-operation in wage determination. According to Burda (1999) EMU has an effect on the first three Marshall-Hicks rules. First, cost savings in international trade enlarge the relevant market for firms and increase competition in the product market, causing an increase in the elasticity of product demand with which the individual firm is confronted. Second, EMU accelerates the transnational organisation and relocation of production facilities, which facilitates the substitution between capital and labour. Third, the Europeanisation of national labour markets increases the elasticity of supply for competing inputs, notably for labour from other EMU-countries. Although the precise size of any of the three effects remains a debatable issue, they contribute undoubtedly to a likely increase in the elasticity of labour demand and to a weakening of union power.

In the discussion below, we focus on the first effect. Two strands of literature have dealt with the relationship between the elasticity of product demand and labour demand. First, industrial relations literature has analysed the consequences of globalisation and economic integration on trade unions, wages and employment. One of the main conclusions of this literature is that globalisation increases inter-union rivalry, weakens union power and puts a downward

pressure on wages (Boswell and Stevis, 1997; Breitenfellner, 1997; Huemer et al., 1999). Increasingly, unions regard international co-operation as one of the means to combat the negative effects of globalisation.

Second, a number of authors has modelled the labour market implications of integration in European product markets. Sørensen (1993) as well as Huizinga (1993) conclude that product market integration leads to increased competition in product and labour markets. Both models also predict a decrease in the level of prices and wages. In Driffill and van der Ploeg (1993 and 1995), the effects of removing trade barriers in the product market are considered. It is shown that lowering trade barriers increases the incentives for international trade union co-operation. This conclusion is confirmed by Naylor (1998 and 1999).

In this paper, we develop a model to verify a number of the above statements. Similar to Corneo (1995), we focus on asymmetries in the labour market. Section 2 describes the general features of the model. In section 3, we attempt to determine whether product market integration increases the incentives for trade union co-operation. We conclude that this is not always the case. We then look at the consequences of joint wage-setting for the level of wages (section 4) and the responsiveness of wages to asymmetric shocks (section 5). We find that trade union co-operation results in higher wages. The claim that wages would react less responsively to asymmetric shocks when set jointly, is not supported.

## 2. The model

The setting of the model is inspired by the work of Leontief (1946) and more recently Huizinga (1993) and Naylor (1998 and 1999). The asymmetries in our model are complementary to those considered by Corneo (1995)<sup>1</sup>. The model studies the interaction of firms and unions in 2 countries, denoted as country  $i$  and country  $j$ . There is one firm per country, which produces a homogeneous product  $q_i$  with a technology characterised by decreasing marginal productivity of the single input labour  $(n_i)$ <sup>2</sup>. Productivity also depends on the country-specific efficiency parameter  $\alpha_i$ :

$$q_i = \alpha_i \sqrt{n_i} \quad \text{with } \alpha_i > 0 \quad (1)$$

Total production  $q$  by both firms then equals:

$$q = q_i + q_j \quad (2)$$

For each firm, total cost ( $TC_i$ ) and marginal cost ( $MC_i$ ) depend on employment ( $n_i$ ), on the wage the firm has to pay to its workers ( $w_i$ ) and on the efficiency parameter  $\alpha_i$ :

$$TC_i = w_i n_i = \frac{w_i q_i^2}{\alpha_i^2} \quad (3)$$

$$MC_i = \frac{2w_i q_i}{\alpha_i^2} \quad (4)$$

<sup>1</sup> Corneo (1995) primarily focuses on the wage and employment consequences of heterogeneous degrees of wage bargaining centralisation. He briefly pays attention to differences in the reservation wages and does not consider productivity differences.

<sup>2</sup> Corneo (1995) and Naylor (1998 and 1999) assume constant marginal productivity with respect to labour.

In the product market, firms face a linear demand function. As we assume that demand is uniformly distributed over the two countries, product demand in each of the countries can be represented by the following inverse demand function:

$$p_i = a - 2bq_i \quad (5)$$

Product demand for the unified market can then be written as:

$$p = a - bq \quad (6)$$

Firms are assumed to be profit-maximising. The relevant profit function depends on the product market environment. We distinguish between two cases. In the first case, product markets are separate. This implies that product price in a country is not influenced by the quantity produced by the firm in the other country. The profit function for firm  $i$  is then given by:

$$\pi_i = (a - 2bq_i)q_i - \frac{w_i q_i^2}{\alpha_i^2} \quad (7)$$

In the second case, firms engage in Cournot output competition in an integrated product market. The output decisions of the two firms are strategically interdependent. The profit function of firm  $i$  is in this case given by:

$$\pi_i = (a - bq)q_i - \frac{w_i q_i^2}{\alpha_i^2} \quad (8)$$

Each firm confronts one monopoly trade union in each country, which represents all the workers employed by the respective firms. In order to determine the wages we use the monopoly union model, in which the union sets the wage level unilaterally, subject to the firm's labour demand curve. To the wage level determined by the union corresponds one level of employment that is hired by the firm (Booth, 1995). We assume that the unionised sector is sufficiently small, so that the unions can ignore the effect of wage-setting on the price level. We also assume that there is no labour mobility between the two countries.

The strategic decisions of the unions are more complex than those of the firms. Firms only have to determine the optimal level of output. Apart from setting the optimal wage, unions also have to decide whether to set the wage separately or jointly, i.e. to set the wage at the national or European level<sup>3</sup>. In case the unions determine the wages separately in their respective firms, each union's rent ( $U_i$ ) depends on the wage paid in its respective firm ( $w_i$ ), on the country-specific reservation wage ( $\bar{w}_i$ ) and on employment in the firm ( $n_i$ ). Union rent is given by:

$$U_i = (w_i - \bar{w}_i)n_i \quad (9)$$

<sup>3</sup> In this paper, we do not explicitly distinguish between wage-setting at the firm level, industry level or centralised level since we consider only one industry. The relevant distinction is between national and international bargaining. The analysis is however most consistent with industry-level bargaining.

In case unions set the wages jointly for both firms, union utility for the joint union ( $U_c$ ) is given by:

$$U_c = (w_i - \bar{w}_i)n_i + (w_j - \bar{w}_j)n_j \quad (10)$$

Note that wage-setting co-operation does not imply that a common wage is set for both firms. Potential wage differences between the two countries are not eliminated as we assume that labour is immobile

The game consists of two stages. In stage 1, in the case of separate wage-setting, both unions simultaneously choose the optimal wage for its firm, taking as given the wage set (by the competing union) in the other country and taking into account the firm's labour demand. In the case of union collusion and co-ordinated wage determination, the joint union chooses the wages for both firms subject to labour demand in each firm. In stage 2, the firms simultaneously determine output taking into account the wages determined in stage 1. Whether the output decision by the firm  $j$  influences the optimal output of firm  $i$  depends on the product market setting. When product markets are separate, firms operate as monopolists in their home market and do not have to take into account the output decision by the other firm. When the product market is integrated, output competition takes place. In order to solve the game, we proceed by backward induction, first solving for the firms' output decisions in stage 2 and then for the unions' wage decisions in stage 1. The solution of the model is described in the appendix.

Solving the model by backward induction results in an optimal wage for each of the cases and for each of the unions. By substituting these reduced-form wage expressions into the semi-reduced forms for employment, union rent, output, price and profit, we obtain the optimum values for these variables in function of the parameters of the model. These reduced forms are summarised in Table 2. Having obtained these values, we are now able to address the issues discussed in the introduction of the paper.

### 3. Does product market integration increase the incentives for trade union co-operation?

The first issue we address is the impact of product market integration on the probability that trade unions will co-operate across national borders to set wages jointly. As already explained above, previous research has indicated that integration of European product markets may accelerate the evolution towards European trade union co-operation. We want to investigate further under what conditions trade unions want to co-operate and which factors influence their decision. We therefore model product market integration as a discrete transition from a situation in which the two product markets are separated to a situation in which the product market is entirely integrated. We address this issue in two stages. First, we compare how the situation of unions changes when product markets integrate (comparison of model 1 and model 2). We then turn to the question if union co-operation may improve the position of unions in an integrated product market (comparison of model 2.1 and 2.2).

A key argument of the industrial relations literature why unions may want to co-operate across national borders is the downward pressure globalisation and economic integration exert on wages and social standards in general. Does our model reproduce the result that integration in the product market lowers wages when unions do not co-operate? For that purpose, we compare the wages set by separate unions in the two product market environments. The optimal wage for union  $i$  in a separate product market is given by (cf. model 1.1):

$$w_i = 2 (b \alpha_i^2 + \bar{w}_i) \quad (11)$$

whereas the optimal wage in the integrated product market is given by (cf. model 2.1):

$$w_i = \bar{w}_i + \frac{\sqrt{(b \alpha_i^2 + \bar{w}_i) (b \alpha_j^2 + \bar{w}_j) (4 \bar{w}_i (b \alpha_j^2 + \bar{w}_j) + b \alpha_i^2 (3 b \alpha_j^2 + 4 \bar{w}_j))}}{2 (b \alpha_j^2 + \bar{w}_j)} \quad (12)$$

In order to verify whether unions are subject to downward wage pressure when product markets integrate, we demonstrate that (12) is strictly smaller than (11) for all parameter values. The proof is simplified by replacing  $3b\alpha_j^2 + 4\bar{w}_j$  with  $4(b\alpha_j^2 + \bar{w}_j)$  to obtain the more simple expression.

$$\bar{w}_i + (b \alpha_i^2 + \bar{w}_i) \quad (13)$$

It is clear that after this simplification, which increases the value of (12), (13) is still smaller than (11). It follows that product market integration lowers wage demands.

The intuitive explanation is that product market competition is absent when product markets are separate. Both firms operate as monopolists in their respective product markets. Union  $i$  cannot attract production and employment to country  $i$  away from country  $j$  by lowering its wage demands. This is not so in the integrated product market in which both firms are direct competitors. From the following expression, it is clear that - for a given wage  $w_j$  - union  $i$  can attract production and employment to country  $i$  by lowering the wage  $w_i$ :

$$q_i = \frac{a \alpha_i^2 (2 \bar{w}_j + b \alpha_j^2)}{4 w_i (w_j + b \alpha_j^2) + b \alpha_i^2 (4 w_j + 3 b \alpha_j^2)} \quad (14)$$

But whereas firms compete in output, unions compete in wages. This process drives wages down. The following reaction function shows the reaction of union  $j$  when union  $i$  lowers its wage:

$$w_j = \frac{4 b w_i \alpha_j^2 + 3 b^2 \alpha_i^2 \alpha_j^2 + 8 w_i \bar{w}_j + 8 b \alpha_i^2 \bar{w}_j}{4 (w_i + b \alpha_i^2)} \quad (15)$$

It is straightforward to verify that wage decreases by union  $i$  provoke wage decreases by union  $j$ . This in turn provokes a symmetric reaction from union  $i$ . An integrated product market thus not only causes competition in the product market, but also (wage competition) in the labour market.

Wages are however only one component of union utility and wage competition does not necessarily constitute a co-operation incentive for unions. It may be that the wage decrease is compensated by an increase in employment so that union rent increases when economies integrate. Since the unions are interested in maximising union rent, we now turn to the impact of economic integration on union rent. We address the question whether product market integration decreases union rent and constitutes a co-operation incentive in order to limit the

rent losses. In Figure 1, the rent difference for union  $i$  after and before integration is depicted as a function of  $\alpha_i$ , which varies from 0 to 4, and of  $\bar{w}_i$ <sup>4</sup>, varying from 0 to 40<sup>5</sup>. If product market integration lowers union rent, we would expect negative values for the rent difference. Without stating a formal proof, it is clear that product market integration not always lowers union rent. The combination of high productivity and a low reservation wage in country  $i$  for given levels of productivity and the reservation wage in country  $j$  results in the largest rent increase for union  $i$  when product markets integrate.

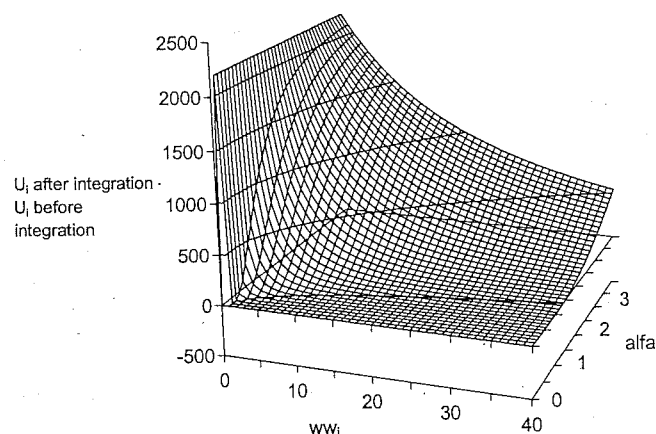


Figure 1: Union rent difference after and before integration

The fact that unions (sometimes) benefit from product market integration confirms the result of the symmetric model by Huizinga (1993), who finds that both firms and unions benefit from market integration, a result that is attributed to the fact that pre-integration bargaining outcomes are inefficient.

If lower wages are no sufficient condition for union co-operation and if integration may increase union rent, what advantage could unions take of co-operation? Some of the above-mentioned authors claim that – unlike in separate product markets – union co-operation (further) improves the position of the trade unions in the labour market. The intuitive explanation is that unions benefit from the combination of higher employment – as a consequence of higher output due to competition and lower prices in the integrated product market – and higher wages – as a consequence of increased wage-setting power when unions co-operate. Before integration, it is clear from table 1 that union co-operation does not yield any additional benefit. In fact, unions are indifferent between co-operation and separate wage-setting, as the maximum attainable union rent is identical in both cases. For simplicity, we assume that unions do not co-operate in this product market setting. This can be motivated by assuming that co-operation is not free. Without formally introducing a cost of union co-operation<sup>6</sup>, it is not difficult to imagine that the joint union rent is smaller than the sum of the individual union rents when setting the wage separately.

<sup>4</sup>  $ww_i$  in the figures corresponds to  $\bar{w}_i$  in the text.

<sup>5</sup> The benchmark values for the model parameters are:  $a = 400$ ;  $b = 2$ ;  $\alpha_i = \alpha_j = 1$  and  $\bar{w}_i = \bar{w}_j = 10$

<sup>6</sup> For a formal derivation of the model when co-operation is costly, see Borghijs and Du Caju (1999)



The situation would be different when the product market is integrated. As model 2.1 in the appendix demonstrates, competitive pressures in the product market are reflected in wage competition in the labour market. The individual unions no longer have monopoly power as suppliers of labour to produce the product  $q$ . Both firms and unions can now supply to the market. Union co-operation however restores the unions' monopoly power and prevents the effects of product market competition from spilling over on the labour market. Joint wage-setting would therefore result – according to these authors – in higher union rent than separate wage setting.

In order to verify formally the claim that union co-operation increases union rent, we compare the rent levels for separate and joint wage-setting when the product market is integrated. It can be shown that the difference of the joint union rent of the co-operating unions ( $U_c$ ) and the sum of the individual union rents ( $U_i + U_j$ ) is positive for all parameter values. This difference can be considered as a indicator of the incentive for union co-operation. Figure 2 suggests that the incentive is always positive and moreover indicates that the benefits from co-operation are higher, the lower the reservation wages for both unions, for given benchmark values for the efficiency parameters, and the higher the efficiency parameters, for given benchmark values for the reservation wages. We are thus able to confirm the claim that co-operation increases union rent in an integrated product market<sup>7</sup>.

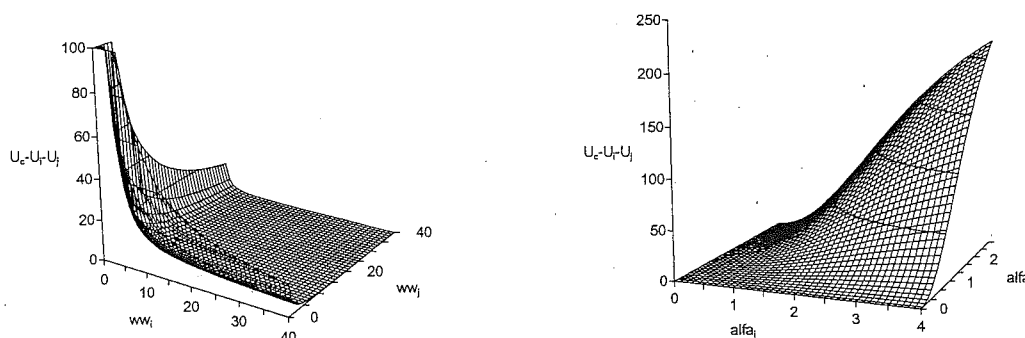


Figure 2: Union rent difference after and before co-operation

However, as there are no redistribution mechanisms among trade unions in the EU, it is not sufficient to compare the sum of individual union rents  $U_i + U_j$  with the joint union rent  $U_c$ . We additionally impose that every single co-operating trade union has to be better off. Denoting individual union rent when co-operating by  $U_{ci}$  and by  $U_i$  otherwise, this implies we have to verify for both unions that:

$$U_{ci} > U_i$$

<sup>7</sup> It could be argued, however, that the extra union rent is no sufficient condition for co-operation to take place, as the co-operative agreement is not a stable equilibrium. An individual union could deviate from the agreement by setting a lower wage than the other union. This is a standard Prisoners' dilemma situation. This situation can be overcome by assuming that the agreement between the unions is legally binding or by considering the union co-operation game as one stage of a repeated game.

The difference between co-operative union rent and separate union rent for union  $i$  is given by:

$$U_{ci} - U_i = \frac{a^2 \alpha_i^2 (b \alpha_j^2 + 2 \bar{w}_j)}{32 \bar{w}_i (b \alpha_j^2 + \bar{w}_j) + 8 b \alpha_i^2 (3 b \alpha_j^2 + 4 \bar{w}_j)} - \frac{1}{8 b^2 \alpha_i^2 (b \alpha_j^2 + \bar{w}_j)} \left( a^2 \sqrt{(b \alpha_i^2 + \bar{w}_i) (b \alpha_j^2 + \bar{w}_j) (4 \bar{w}_i (b \alpha_j^2 + \bar{w}_j) + b \alpha_i^2 (3 b \alpha_j^2 + 4 \bar{w}_j))} \right. \\ \left. -1 + \frac{(b \alpha_i^2 + 2 \bar{w}_i) (b \alpha_j^2 + \bar{w}_j)}{\sqrt{(b \alpha_i^2 + \bar{w}_i) (b \alpha_j^2 + \bar{w}_j) (4 \bar{w}_i (b \alpha_j^2 + \bar{w}_j) + b \alpha_i^2 (3 b \alpha_j^2 + 4 \bar{w}_j))}} \right)^2$$

The expression for union  $j$  can be obtained by switching  $i$ -s and  $j$ -s in the above expression.

This condition is more restrictive than the comparison of total union rent. Although total rent is always higher when unions co-operate, it is not guaranteed that every single union is better off when co-operating. When labour and product markets are symmetric, both conditions are essentially identical, as all gains can be split evenly. When product markets and / or labour markets are asymmetric, this result no longer holds. In order to get a better idea under what circumstances co-operating unions are better off, we evaluate the evolution of the rent difference for union  $i$  when the parameters of the model change.

Let us first turn to the evolution of the co-operation incentive for union  $i$  when the parameters for country  $j$  are kept constant. The rent difference for union  $i$  is depicted in Figure 3 for varying levels of  $\bar{w}_i$  and  $\alpha_i$ .

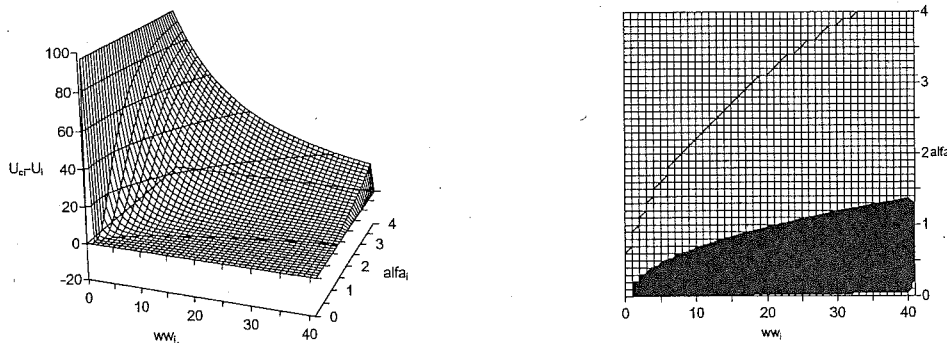


Figure 3: Co-operation incentive as a function of  $w_{wi}$  and  $\alpha_i$

The simulation clearly shows that the co-operation incentive for union  $i$  increases for decreasing levels of  $\bar{w}_i$  and increasing levels of  $\alpha_i$ . High levels of the reservation wage combined with low productivity levels on the contrary result in negative values for the co-operation incentive, which means that union  $i$  is better off setting the wage separately than setting the wage jointly with union  $j$ . The reservation wage and the efficiency parameter thus

have an opposite effect on the co-operation incentive. The 0-frontier (combinations of  $\bar{w}_i$  and  $\alpha_i$  for which union  $i$  is indifferent between co-operation and separate wage-setting) slopes upward. Increasing levels of the reservation wage have a negative impact on the co-operation incentive, but increasing productivity delays the reservation wage at which the incentive becomes negative. Intuitively explained, it emerges from the simulation that the most competitive union – i.e. the union situated in the country with the higher productivity and lower reservation wage – profits most from the co-operation agreement.

A second simulation exercise shows the effect on union  $i$ 's co-operation incentive for variations in the reservation wages  $\bar{w}_i$  and  $\bar{w}_j$  and for benchmark levels of the efficiency parameters ( $\alpha_i = \alpha_j = 1$ ).

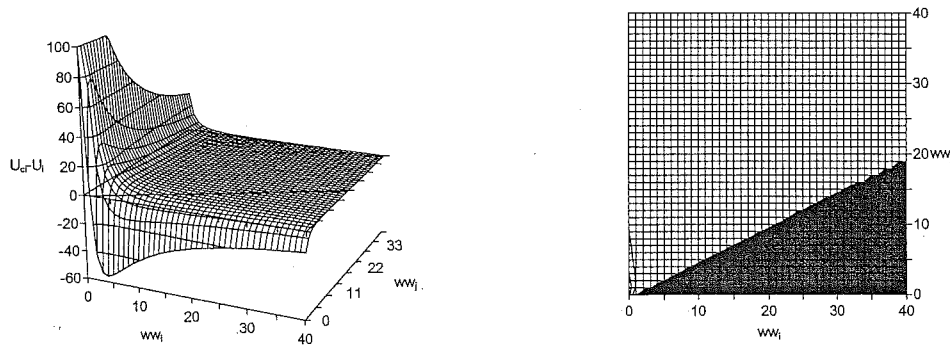


Figure 4: Co-operation incentive as a function of  $ww_i$  and  $ww_j$

The impact of  $\bar{w}_i$  is straightforward and has been discussed with the previous figure. Higher levels of the reservation wage in country  $i$  reduce the co-operation incentive. The effect of  $\bar{w}_j$  is ambiguous, which is especially clear at very low levels of  $\bar{w}_i$ . At the lower end, increases in  $\bar{w}_j$  have a positive impact on the incentive, reflecting that union  $i$  improves its competitiveness compared to union  $j$ . Further increases in  $\bar{w}_j$  subsequently have a negative effect - but never result in a negative incentive - as the total cake to be divided between the unions shrinks<sup>8</sup>. Like in the previous graph, the 0-frontier is upward-sloping. The higher  $\bar{w}_j$  is, the higher  $\bar{w}_i$  can become before the co-operation incentive becomes negative. Also note that - for the benchmark values of the efficiency parameters -  $\bar{w}_i$  can be approximately twice as large as  $\bar{w}_j$  before the incentive becomes negative. This will prove to be important when we determine the scope for co-operation for both unions.

<sup>8</sup> The fact that the total extra rent from co-operation shrinks for higher levels of the reservation wages is depicted in Figure 2.

A final simulation exercise concentrates on the co-operation incentive for union  $i$  for varying levels of  $\alpha_i$  and  $\alpha_j$  and constant and identical levels of the reservation wages ( $\bar{w}_i = \bar{w}_j = 10$ ).

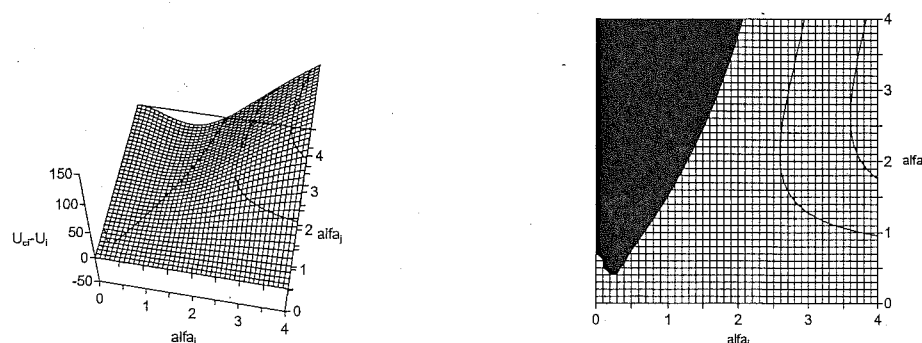


Figure 5: Co-operation incentive as a function of  $\alpha_i$  and  $\alpha_j$

As already explained above, increasing levels of  $\alpha_i$  have a positive impact on the co-operation incentive of union  $i$ . Increasing levels of  $\alpha_j$  have an ambiguous effect. Initially, the "cake"-effect dominates, reflecting that increasing levels of  $\alpha_j$  increase the size of the cake to be divided between the two unions, of which union  $i$  can claim a share. At higher levels of  $\alpha_j$ , the competitiveness effect dominates, resulting in a larger share of the cake that can be claimed by union  $j$ , reducing the co-operation incentive of union  $i$ . The level of  $\alpha_j$  at which the two effects outweigh each other, depends on the level of  $\alpha_i$ . At low levels of  $\alpha_i$ , the competitiveness effect dominates more rapidly to the advantage of union  $j$ , resulting more rapidly in a negative co-operation incentive for union  $i$ . At high levels of  $\alpha_i$ , the cake effect dominates much longer, resulting in positive incentives for a larger interval. Finally, the 0-frontier is upward sloping, and high levels of  $\alpha_j$  combined with low levels of  $\alpha_i$  result in a negative co-operation incentive for union  $i$ .

The conclusion that emerges from the above simulations is that the most competitive union has the higher co-operation incentive; i.e. when its reservation wage is relatively low and when productivity is relatively high compared to the other union. This however means from the position of the other union that its reservation wage is relatively high and that the productivity is relatively low, which may result in negative co-operation incentives. As co-operation is a mutual agreement between the two unions, it is therefore more unlikely to occur if asymmetries between the two countries are large. Similar product and labour market structures increase the chances of a co-operation agreement with which both unions are better off. We now focus on the question under what conditions both unions want to co-operate.

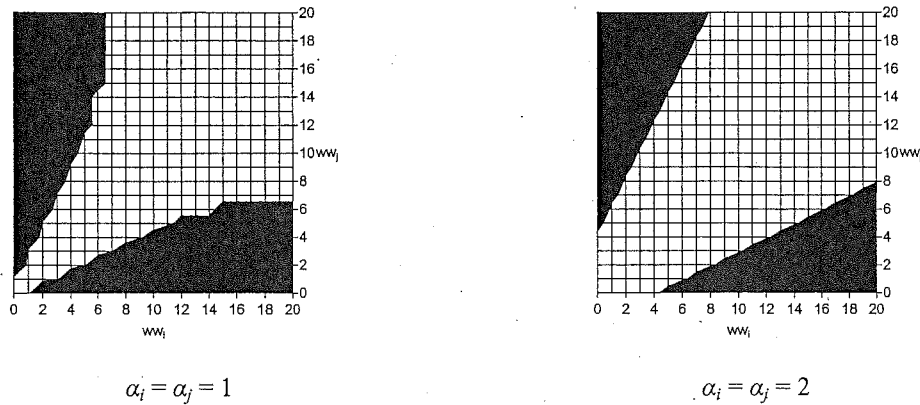


Figure 6: Co-operation incentives as a function of  $ww_i$  and  $ww_j$

Both panels in Figure 6 represent the projection of the incentive for both unions on the  $(\bar{w}_i, \bar{w}_j)$  plane. The black areas mark the combinations of  $\bar{w}_i$  and  $\bar{w}_j$  for which one of the unions is not willing to co-operate. In the lower-right areas, union  $i$  is not willing to co-operate, whereas the upper-left areas represent the combinations of  $\bar{w}_i$  and  $\bar{w}_j$  for which union  $j$  is not willing to co-operate. For given levels of  $\alpha_i$  and  $\alpha_j$ , large differences in reservation wages lead to non-co-operative behaviour of one of the unions and thus to separate wage-setting. In both cases, the unwillingness to co-operate follows from a bad relative competitive position with respect to the other union. Symmetry in reservation wages increases the likelihood of union co-operation. The higher the respective fallback wages, the larger the scope for co-operation. Higher levels of productivity also widen the scope for co-operation.

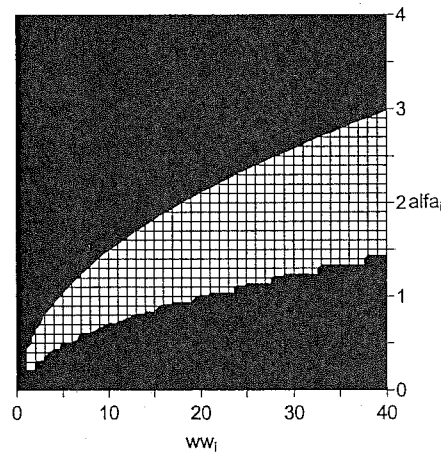


Figure 7: Co-operation incentives as a function of  $ww_i$  and  $\alpha_i$

Figure 7 nicely summarises the reasoning developed above. The white area represents the scope for co-operation for given levels of  $\alpha_j$  (1) and  $\bar{w}_j$  (10) when  $\alpha_i$  and  $\bar{w}_i$  vary. The lower black area- in which  $\alpha_i$  does not compensate high levels of  $\bar{w}_i$  - results in a negative co-operation incentive for union  $i$ . The upper black area results in bad competitive position of country  $j$  and hence in a negative union rent difference for union  $j$ . It clearly reflects the idea that a certain amount of symmetry in competitiveness is required between the two unions in

order to reach a co-operative wage bargaining agreement. For given levels of productivity and reservation wage in country  $j$ , country  $i$  can underperform on one of the criteria and still be willing to co-operate, provided that it outperforms country  $j$  on the other criterion. Country  $i$  can e.g. have a higher reservation wage than country  $j$ , but if this is compensated by higher productivity in country  $i$ , both unions are willing to co-operate.

#### 4. Does co-operative wage-setting lead to higher wages?

After having demonstrated that product market integration increases the incentive for union co-operation under certain conditions, we focus our attention on the labour market consequences of trade union co-operation. In this section, we evaluate the claim that trade union co-operation increases wage demands.

If we denote the wage set by the joint union for country  $i$  with  $w_{ci}$  and the wage set by the separate union  $i$  for country  $i$  with  $w_i$ , we must demonstrate that the difference:

$$w_{ci} - w_i = \frac{(b \alpha_i^2 + 2 \bar{w}_i)(3 b \alpha_j^2 + 4 \bar{w}_j)}{2 b \alpha_j^2 + 4 \bar{w}_j} - \left( \bar{w}_i + \frac{\sqrt{(b \alpha_i^2 + \bar{w}_i)(b \alpha_j^2 + \bar{w}_j)(4 \bar{w}_i(b \alpha_j^2 + \bar{w}_j) + b \alpha_i^2(3 b \alpha_j^2 + 4 \bar{w}_j))}}{2(b \alpha_j^2 + \bar{w}_j)} \right)$$

is strictly positive for all parameter values. It is not difficult<sup>9</sup> to demonstrate that this is indeed the case. Figure 8 gives an idea of the wage increase for different parameter values. The left panel shows the absolute wage increase, the right panel the percentage wage increase when unions switch from separate wage-setting to joint wage-setting.

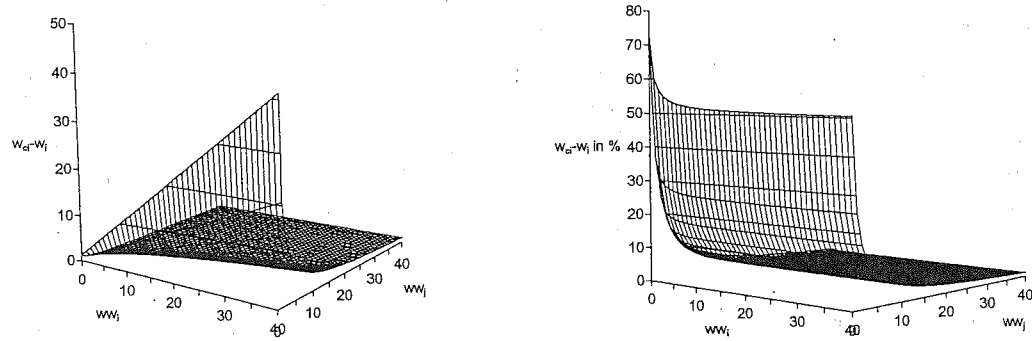


Figure 8: Wage difference as a function of  $ww_i$  and  $ww_j$

The left panel shows a clearly positive and almost linear relationship between the reservation wage  $\bar{w}_i$  and the wage difference. As a similar relationship exists between the  $\bar{w}_i$  and  $w_{ci}$  on the one hand and between  $\bar{w}_i$  and  $w_i$  on the other hand, we can conclude that the higher the wage is before co-operation, the larger the wage increase is. The largest percentage increase however occurs at the lowest values of  $\bar{w}_i$ , which is consistent with the result that a high

<sup>9</sup> In the first term on the right hand side, replace 3 with 2, which makes the positive term smaller. Replacing 3 with 4 in the second term increases the value of the negative term. As this simplified difference equals 0, the original difference is strictly positive.

degree of competitiveness guarantees high co-operation benefits. For higher levels of  $\bar{w}_i$ , the relative wage increase remains stable. The reservation wage  $\bar{w}_j$  has a clear negative impact on the wage increase of union  $i$ . Higher levels of  $\bar{w}_j$  - for given levels of  $\bar{w}_i$  - cause a sharp decrease in the absolute level as well as in the percentage wage increase.

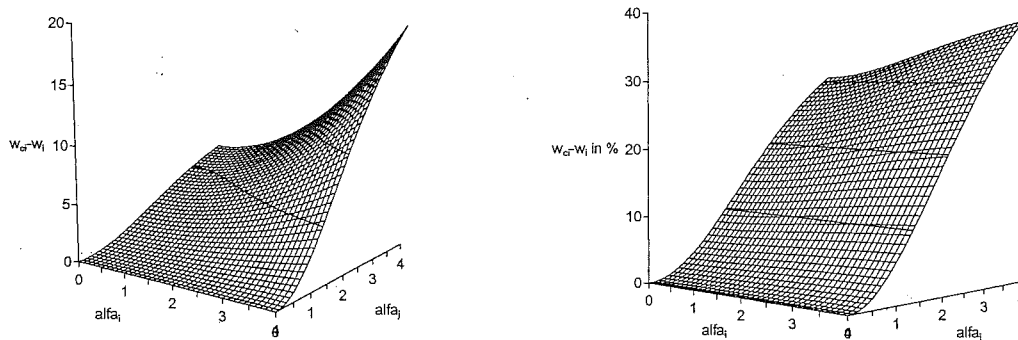


Figure 9: Wage difference as a function of  $\alpha_i$  and  $\alpha_j$

Figure 9 shows the evolution of the absolute (in the left panel) and relative (in the right panel) evolution of the wage difference for changes in the efficiency parameters. Increasing levels of  $\alpha_i$ , and thus of union  $i$ 's competitiveness, lead to expected increases in the wage difference, both in absolute and relative terms. The impact of  $\alpha_j$  may seem counterintuitive at first sight. It could be expected that increasing levels of  $\alpha_j$  deteriorate the competitiveness of union  $i$ , resulting in a reduction the wage difference. Figure 9 however shows that  $\alpha_j$  has a positive impact on the wage difference. This result can be explained by subdividing the effect of  $\alpha_j$  on the wage difference in the effects of  $\alpha_j$  on  $w_i$  and  $w_{ci}$ . This is depicted in Figure 10.

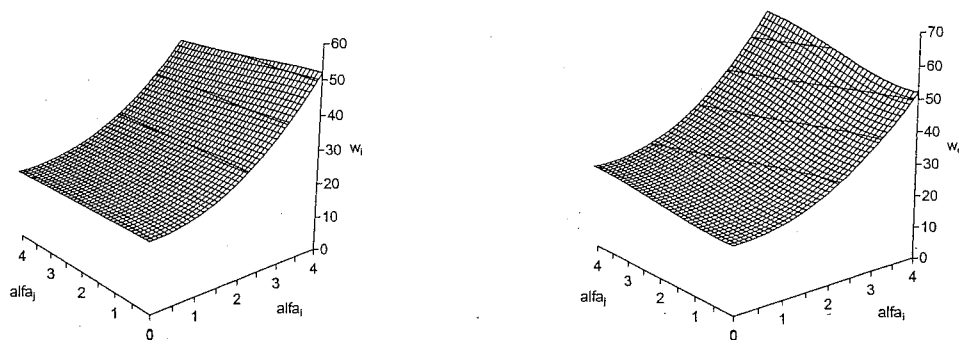


Figure 10: The effect of  $\alpha_j$  on  $w_i$  and  $w_{ci}$

The different reactions of  $w_i$  and  $w_{ci}$  on changes in  $\alpha_j$  are clear from the left respectively right panel. When wages are set separately, an increase in  $\alpha_j$  causes a decline in  $w_i$ . This wage reaction reflects the response of union  $i$  to the increased competitiveness of union  $j$ . Higher productivity in country  $j$  weakens the competitiveness of country  $i$ , leading to lower wage demands by union  $i$ . Hence then negative relationship between  $\alpha_j$  and  $w_i$ . When wages are set jointly, an increase in  $\alpha_j$  causes a rise in  $w_{ci}$ . This is the consequence of the co-operative agreement between the unions not to undercut each other's wage. Union  $i$  sets higher wages in

response to the wage increase by union  $j$ . The combination of the reaction of  $w_i$  and  $w_{ci}$  on changes in  $\alpha_j$  results in a rising wage difference as  $\alpha_j$  increases.

The overall conclusion from this section is that trade union co-operation does lead to higher wage demands compared to the scenario in which trade unions set their wages separately.

## 5. Are jointly set wages less responsive to asymmetric shocks?

We now turn to the claim that co-operative wage-setting would make wages less responsive to asymmetric shocks than separately set wages. This claim draws a parallel between income policy and monetary policy and refers to the inadequacy of the single currency in dealing with asymmetric shocks. The idea is that co-operating unions would set a wage in accordance with the average economic situation in the member states. This common wage would be unable to mitigate the consequences of an asymmetric shock in one of the member states without affecting the other members. The ultimate consequence would be that employment in the joint wage-setting scenario is more affected than in the separate wage-setting scenario. Our model however clearly indicates that setting a common wage for both countries is not a desirable option. Under almost all circumstances, unions can increase their rent by diversifying the wages between the two countries, even if they co-operate. This can be demonstrated by comparing the rent-maximising wage outcomes for union  $i$  and union  $j$  in the co-operative wage-setting scenario and which are given by:

$$w_{ci} = \frac{(b \alpha_i^2 + 2 \bar{w}_i)(3 b \alpha_j^2 + 4 \bar{w}_j)}{2 b \alpha_j^2 + 4 \bar{w}_j} \quad (16)$$

and

$$w_{cj} = \frac{(b \alpha_j^2 + 2 \bar{w}_j)(3 b \alpha_i^2 + 4 \bar{w}_i)}{2 b \alpha_i^2 + 4 \bar{w}_i} \quad (17)$$

respectively. It is not difficult to show that the only case in which (16) and (17) are identical, is when both  $\bar{w}_i = \bar{w}_j$  and  $\alpha_i = \alpha_j$ . When the model is asymmetric, union  $i$  and  $j$  maximise the (joint) union rent by setting different wages.

Although we have demonstrated that unions optimally set different wages for different countries - even when they co-operate - it may still be the case that union co-operation is less suited for mitigating the negative effects of asymmetric shocks. We have a closer look at this claim by means of the model in the following way: we begin with the symmetric benchmark values for the parameters and decrease the level of  $\alpha_j$  from 1 to 0.9. This represents a negative productivity shock in country  $j$ . As productivity in country  $i$  is unaffected, the productivity shock can be considered as a country-specific asymmetric shock. We investigate the effect of the productivity shock on wages ( $w_i$  and  $w_j$ ) and employment ( $n_i$  and  $n_j$ ) in both countries by calculating the elasticity with which the variables respond to the productivity change. The wage response in country  $i$  e.g. is given by:

$$\varepsilon_{\alpha_j}^{w_i} = \frac{\partial w_i}{\partial \alpha_j} \frac{\alpha_j}{w_i} \quad (18)$$



The values of the elasticities for both wage-setting scenarios are summarised in Table 1. A positive value means that the variable concerned decreases as the negative productivity shock occurs.

	Separate wage-setting	Joint wage-setting
$\varepsilon_{\alpha_j}^{w_i}$	-0.0032	0.0791
$\varepsilon_{\alpha_j}^{w_j}$	0.1784	0.1818
$\varepsilon_{\alpha_j}^{n_i}$	-0.1338	-0.2797
$\varepsilon_{\alpha_j}^{n_j}$	1.3447	1.3566

Table 1: Wage and employment response to an asymmetric shock

The opposite signs of the elasticities for  $w_i$  indicate that the wage in country  $i$  reacts differently to the productivity shock in the two wage-setting scenarios. The reason for this has been discussed in section 4. The wage in country  $j$  is lowered in response to the productivity shock in both scenarios. This is reflected in the positive sign of both elasticities. Declining productivity and competitiveness in country  $j$  dampen wage demands. We however do not find any evidence that the wage would react more flexibly under the separate wage-setting scenario than under the joint wage-setting scenario. On the contrary, the elasticity is consistently lower in the separate wage-setting scenario.

Employment in country  $i$  is positively influenced in both cases. The size of the effect is however considerably larger when wages are set jointly. This can be explained by the combined effect of the relative productivity increase with respect to country  $j$  and the moderation of  $w_i$  in response to the productivity shock. In the separate wage-setting scenario, the positive employment effect of the relative productivity increase in country  $i$  is dampened by the increase in  $w_i$ . The employment reaction in country  $j$  relates to this. The productivity decrease leads to lower employment in country  $j$ . But whereas the negative employment effect is dampened by the wage increase in country  $i$  when wages are set separately, shifting employment back to country  $j$ , employment is further shifted away from country  $j$  to country  $i$  due to the decrease of  $w_i$  in the joint wage-setting scenario. We can thus conclude that employment in country  $j$  is more negatively affected when wages are set jointly, but not because  $w_j$  would react less flexibly, but because  $w_i$  follows the downward evolution of  $w_j$ . Further simulations suggest that total employment is less affected when wages are set jointly than when wages are set separately, contradicting the prediction that joint wage-setting would lead to higher unemployment.

## 6. Conclusions

In this paper, we studied the impact of product market integration on the incentives for trade union co-operation on an international scale and its consequences for the evolution of wage demands and for the responsiveness wages to asymmetric shocks. The framework allowed for asymmetries in reservation wages and productivity between countries. The main conclusions of the paper are the following:

- Product market integration lowers wage demands when trade unions continue setting wages separately.
- International trade union co-operation always yields a higher joint union rent than when unions set their wages separately. The extra rent is larger when reservation wages are lower and when productivity is higher.
- Individual unions, however, do not necessarily benefit alike from the extra co-operation rent. Large differences in competitiveness between the two countries result in non-co-operative behaviour of one of the unions.
- Trade union co-operation in an integrated product market results in higher wage demands. Wage increases are larger when productivity levels are higher and when reservations wages are lower.
- Joint wage-setting does not reduce the responsiveness of wages to asymmetric shocks. It is found that total employment is less affected by the (productivity) shock than when wages are set separately by each union.

The conclusions of the paper give some idea of the impact EMU may have on labour market variables and trade unions. It suggests that the introduction of the single currency and the integration process in the product market it entails does not necessarily increase the incentives of trade unions to co-operate on an international scale. Positive co-operation incentives require similarity in competitiveness among the member states. It however does not exclude co-operation between trade unions situated in countries with different levels of social protection, provided these differences are compensated by differences in productivity. A further conclusion is that wage moderation may become more difficult to sustain when national trade unions pull together on a European scale.

The paper also sheds some light on the issue of convergence in European labour markets. It is shown that wages in the member states react differently to an asymmetric shock under the two wage-setting scenarios. Whereas separate wage-setting implies that wages in the member states react in different directions, joint wage-setting disciplines wage reactions and causes wages to react in the same direction. Less wage divergence necessarily implies more employment divergence, given the set-up of the model. It is shown that employment diverges more under joint wage-setting than under separate wage-setting in response to an asymmetric shock. It would be an interesting exercise to test the robustness of this result when co-operating trade unions would not only care about maximising union rent, but also about limiting wage and employment differences between the member states.

## Appendix

In this section, we analytically derive the reduced forms of the relevant variables for firms and unions. The model is solved by backward induction. We first derive the optimal output, assuming that the wage set by the unions is given. From this expression, labour demand can be derived, which is substituted into the union rent function. This procedure is repeated for separate and integrated product markets and for separate wage-setting and joint wage-setting.

### *Model 1: Separate product markets*

In model 1, our two-country setting consists of two separate product markets in which two monopolistic firms operate in their domestic market. In case 1, the two monopolists are confronted with separate trade unions in the labour market. This corresponds to the case in which no international co-operation between trade unions takes place. In case 2 the joint union sets the wages for the two firms.

#### Case 1: Separate wage-setting

##### Stage 2: Profit maximisation

Each firm optimises its profit function, taking the wage  $w_i$  set by its union as given:

$$\max_{q_i} \pi_i = (a - 2b q_i) q_i - \frac{q_i^2 w_i}{\alpha_i^2}$$

This yields the following expression for the profit-maximising output:

$$q_i = \frac{a \alpha_i^2}{2 w_i + 4 b \alpha_i^2}$$

Since both firms operate as monopolists in their respective (separate) product markets, the optimal output produced by firm  $i$  is not influenced by the output of firm  $j$ . This is also true for the wage. Output in firm  $i$  is only influenced by the wage set by union  $i$ , and not by the wage set by union  $j$ .

##### Stage 1: Rent maximisation

Given labour demand, which can be derived from the profit-maximising output calculated in stage 2, each union calculates the rent-maximising wage by optimising its rent function:

$$\max_{w_i} U_i = (w_i - \bar{w}_i) \left( \left( \frac{a \alpha_i^2}{2 w_i + 4 b \alpha_i^2} \right) / \alpha_i \right)^2$$

Solving for the rent-maximising wage gives:

$$w_i = 2 (b \alpha_i^2 + \bar{w}_i)$$

Similar to the result for the optimal output, we find that the optimal wage for union  $i$  is not influenced by the wage set by union  $j$ . Note further that increases in the reservation wage and the efficiency parameter exert an upward pressure on the optimal wage.

### Case 2: Joint wage-setting

#### Stage 2: Profit maximisation

As no changes take place in the product market, the setting of the product market is identical to case 1. Firms do not react differently, so that the output decisions for given wages do not differ. We therefore refer to case 1 for the solution of the optimal output as a function of the wage. Note that the optimal output may ultimately differ from the one calculated in case 1, as it is not guaranteed at this stage that unions set the same wages. The wage outcome will be determined in stage 1.

#### Stage 1: Rent maximisation

As we now assume that unions set the wages jointly, they maximise a joint union rent function. The decision variables  $w_i$  and  $w_j$  are chosen such that the joint union rent is optimised:

$$\text{Max}_{w_i, w_j} U_c = (w_i - \bar{w}_i) \frac{a^2 \alpha_i^2}{(2w_i + 4b\alpha_i^2)^2} + (w_j - \bar{w}_j) \frac{a^2 \alpha_j^2}{(2w_j + 4b\alpha_j^2)^2}$$

This results in the following wage demands for respectively country  $i$  and  $j$ :

$$w_i = 2(b\alpha_i^2 + \bar{w}_i)$$

$$w_j = 2(b\alpha_j^2 + \bar{w}_j)$$

Note that the wages set in this case are identical to the wages set when unions do not co-operate.

### *Model 2: Integrated product market*

In model 2, the product market setting consists of one integrated market in which two firms Cournot compete. In case 1, two separate trade unions simultaneously but independently set the wage in their respective countries. In case 2, the joint union sets the wages for both firms.

### Case 1: Separate wage-setting

#### Stage 2: Profit maximisation

Unlike in model 1, the single price depends on the quantities produced by both firms. The optimisation problem for each firm is given by:

$$\text{Max}_{q_i} \pi_i = (a - b(q_i + q_j))q_i - \frac{q_i^2 w_i}{\alpha_i^2}$$

This yields the following output reaction function for firm  $i$ :

$$q_i = \frac{(a - bq_j)\alpha_i^2}{2(w_i + b\alpha_i^2)}$$

Unlike in model 1, output in firm  $i$  negatively depends on output in firm  $j$ . Firms interact as strategic substitutes. Solving the set of reaction functions for firm  $i$  and for firm  $j$  yields an optimal output for each firm as a function of the wages of country  $i$  and  $j$ :

$$q_i = \frac{a \alpha_i^2 (2 w_j + b \alpha_j^2)}{4 w_i (w_j + b \alpha_j^2) + b \alpha_i^2 (4 w_j + 3 b \alpha_j^2)}$$

Note that higher wages in country  $j$  raise output in firm  $i$ .

#### Stage 1: Rent maximisation

Given the output decisions as a function of the wages, each union determines labour demand and sets the rent-maximising wage:

$$\text{Max}_{w_i} U_i = (w_i - \bar{w}_i) \frac{a^2 \alpha_i^2 (2 w_j + b \alpha_j^2)^2}{(4 w_i (w_j + b \alpha_j^2) + b \alpha_i^2 (4 w_j + 3 b \alpha_j^2))^2}$$

From the first order condition, the following reaction function can be derived:

$$w_i = \frac{4 b w_j \alpha_i^2 + 3 b^2 \alpha_i^2 \alpha_j^2 + 8 w_j \bar{w}_i + 8 b \alpha_j^2 \bar{w}_i}{4 (w_j + b \alpha_j^2)}$$

It follows that unions are strategic complements. Higher wages set by union  $j$  result in higher wage demands by union  $i$ . Solving the set of reaction functions yields 4 roots for  $w_i$ , of which the following is economically feasible:

$$w_i = \bar{w}_i + \frac{\sqrt{(b \alpha_i^2 + \bar{w}_i) (b \alpha_j^2 + \bar{w}_j) (4 \bar{w}_i (b \alpha_j^2 + \bar{w}_j) + b \alpha_i^2 (3 b \alpha_j^2 + 4 \bar{w}_j))}}{2 (b \alpha_j^2 + \bar{w}_j)}$$

#### Case 2: Joint wage-setting

#### Stage 2: Profit maximisation

As in model 1, the optimisation problem for firms when unions set the wage jointly is identical to the one when unions set the wage separately and results in the same expressions for optimal output.

#### Stage 1: Rent maximisation

Joint wage-setting by the two unions results in the following optimisation problem:

$$\text{Max}_{w_i, w_j} U_c = (w_i - \bar{w}_i) \frac{a^2 \alpha_i^2 (2 w_j + b \alpha_j^2)^2}{(4 w_i (w_j + b \alpha_j^2) + b \alpha_i^2 (4 w_j + 3 b \alpha_j^2))^2} + (w_j - \bar{w}_j) \frac{a^2 (2 w_i + b \alpha_i^2)^2 \alpha_j^2}{(4 w_i (w_j + b \alpha_j^2) + b \alpha_i^2 (4 w_j + 3 b \alpha_j^2))^2}$$

This yields the following reaction function for union  $i$ :

$$w_i = \frac{8 w_j^2 (b \alpha_i^2 + 2 \bar{w}_i) + 2 b w_j \alpha_j^2 (7 b \alpha_i^2 + 12 \bar{w}_i) + b^2 \alpha_j^2 (8 \alpha_j^2 \bar{w}_i + \alpha_i^2 (3 b \alpha_j^2 - 4 \bar{w}_j))}{4 (2 w_j^2 + b w_j \alpha_j^2 + b \alpha_j^2 (b \alpha_i^2 + 2 \bar{w}_i))}$$

Solving the set of the two reaction functions results in three roots for  $w_i$ . Economically feasible is the following wage expression as a function of the parameters of the model:

$$w_i = \frac{(b \alpha_i^2 + 2 \bar{w}_i) (3 b \alpha_j^2 + 4 \bar{w}_j)}{2 b \alpha_j^2 + 4 \bar{w}_j}$$

Note that in model 2, the expressions for the optimal wage in case 1 and 2 are not identical.

Table 2: Overview of the key labour and product market variables

	<i>Model 1</i> <i>Separate product markets</i>	
	Separate wage-setting	Joint wage-setting
Wage	$w_i = 2 (b \alpha_i^2 + \bar{w}_i)$	$w_{ci} = 2 (b \alpha_i^2 + \bar{w}_i)$
Employment	$n_i = \frac{a^2 \alpha_i^2}{16 (2 b \alpha_i^2 + \bar{w}_i)^2}$	$n_{ci} = \frac{a^2 \alpha_i^2}{16 (2 b \alpha_i^2 + \bar{w}_i)^2}$
Union rent	$U_i = \frac{a^2 \alpha_i^2}{32 b \alpha_i^2 + 16 \bar{w}_i}$	$U_{ci} = \frac{a^2 \alpha_i^2}{32 b \alpha_i^2 + 16 \bar{w}_i}$
Output	$q_i = \frac{a \alpha_i^2}{8 b \alpha_i^2 + 4 \bar{w}_i}$	$q_{ci} = \frac{a \alpha_i^2}{8 b \alpha_i^2 + 4 \bar{w}_i}$
Price	$p_i = a - \frac{a b \alpha_i^2}{4 b \alpha_i^2 + 2 \bar{w}_i}$	$p_{ci} = a - \frac{a b \alpha_i^2}{4 b \alpha_i^2 + 2 \bar{w}_i}$
Profit	$\pi_i = \frac{a^2 \alpha_i^2}{16 b \alpha_i^2 + 8 \bar{w}_i}$	$\pi_{ci} = \frac{a^2 \alpha_i^2}{16 b \alpha_i^2 + 8 \bar{w}_i}$

Model 2	
Integrated product market	
	Separate wage-setting
Wage	$w_i = \bar{w}_i + \frac{\sqrt{(b\alpha_i^2 + \bar{w}_i)(b\alpha_j^2 + \bar{w}_j)}(4\bar{w}_i(b\alpha_j^2 + \bar{w}_j) + b\alpha_i^2(3b\alpha_j^2 + 4\bar{w}_j))}{2(b\alpha_j^2 + \bar{w}_j)}$
Employment	$n_i = \frac{a^2 \left( -1 + \frac{(b\alpha_i^2 + 2\bar{w}_i)(b\alpha_j^2 + \bar{w}_j)}{\sqrt{(b\alpha_i^2 + \bar{w}_i)(b\alpha_j^2 + \bar{w}_j)}(4\bar{w}_i(b\alpha_j^2 + \bar{w}_j) + b\alpha_i^2(3b\alpha_j^2 + 4\bar{w}_j))} \right)^2}{4b^2\alpha_i^2}$
Union rent	$U_i = \frac{1}{8b^2\alpha_i^2(b\alpha_j^2 + \bar{w}_j)}$ $U_{ci} = \frac{a^2\alpha_i^2(b\alpha_j^2 + 2\bar{w}_j)}{32\bar{w}_i(b\alpha_j^2 + \bar{w}_j) + 8b\alpha_i^2(3b\alpha_j^2 + 4\bar{w}_j)}$
Output	$q_i = \frac{a \left( 1 - \frac{(b\alpha_i^2 + 2\bar{w}_i)(b\alpha_j^2 + \bar{w}_j)}{\sqrt{(b\alpha_i^2 + \bar{w}_i)(b\alpha_j^2 + \bar{w}_j)}(4\bar{w}_i(b\alpha_j^2 + \bar{w}_j) + b\alpha_i^2(3b\alpha_j^2 + 4\bar{w}_j))} \right)}{8\bar{w}_i(b\alpha_j^2 + \bar{w}_j) + 2b\alpha_i^2(3b\alpha_j^2 + 4\bar{w}_j)}$
Price	$p = \frac{a(b\alpha_i^2(2b\alpha_j^2 + 3\bar{w}_j) + \bar{w}_i(3b\alpha_j^2 + 4\bar{w}_j))}{2\sqrt{(b\alpha_i^2 + \bar{w}_i)(b\alpha_j^2 + \bar{w}_j)}(4\bar{w}_i(b\alpha_j^2 + \bar{w}_j) + b\alpha_i^2(3b\alpha_j^2 + 4\bar{w}_j))}$
Profit	$\pi_i = \frac{a^2 \left( 2(b\alpha_i^2 + \bar{w}_i)(b\alpha_j^2 + \bar{w}_j)(\alpha_j^2\bar{w}_i + \alpha_i^2(b\alpha_j^2 + \bar{w}_j)) + (-\alpha_j^2\bar{w}_i + \alpha_i^2\bar{w}_j) \sqrt{(b\alpha_i^2 + \bar{w}_i)(b\alpha_j^2 + \bar{w}_j)}(4\bar{w}_i(b\alpha_j^2 + \bar{w}_j) + b\alpha_i^2(3b\alpha_j^2 + 4\bar{w}_j)) \right)}{8(4\bar{w}_i(b\alpha_j^2 + \bar{w}_j) + b\alpha_i^2(3b\alpha_j^2 + 4\bar{w}_j))}$
	Joint wage-setting
Wage	$w_{ci} = \frac{(b\alpha_i^2 + 2\bar{w}_i)(3b\alpha_j^2 + 4\bar{w}_j)}{2b\alpha_j^2 + 4\bar{w}_j}$
Employment	$n_{ci} = \frac{a^2\alpha_i^2(b\alpha_j^2 + 2\bar{w}_j)^2}{4(4\bar{w}_i(b\alpha_j^2 + \bar{w}_j) + b\alpha_i^2(3b\alpha_j^2 + 4\bar{w}_j))^2}$
Union rent	$U_{ci} = \frac{a^2\alpha_i^2(b\alpha_j^2 + 2\bar{w}_j)}{32\bar{w}_i(b\alpha_j^2 + \bar{w}_j) + 8b\alpha_i^2(3b\alpha_j^2 + 4\bar{w}_j)}$
Output	$q_{ci} = \frac{a\alpha_i^2(b\alpha_j^2 + 2\bar{w}_j)}{8\bar{w}_i(b\alpha_j^2 + \bar{w}_j) + 2b\alpha_i^2(3b\alpha_j^2 + 4\bar{w}_j)}$
Price	$p_c = \frac{a(b\alpha_i^2(2b\alpha_j^2 + 3\bar{w}_j) + \bar{w}_i(3b\alpha_j^2 + 4\bar{w}_j))}{4\bar{w}_i(b\alpha_j^2 + \bar{w}_j) + b\alpha_i^2(3b\alpha_j^2 + 4\bar{w}_j)}$
Profit	$\pi_{ci} = \frac{a^2\alpha_i^2(b\alpha_j^2 + 2\bar{w}_j)(b\alpha_j^2(5b\alpha_i^2 + 6\bar{w}_i) + 8(b\alpha_i^2 + \bar{w}_i)\bar{w}_j)}{8(4\bar{w}_i(b\alpha_j^2 + \bar{w}_j) + b\alpha_i^2(3b\alpha_j^2 + 4\bar{w}_j))^2}$

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