

# Does EMU lead to European wage-setting?

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## 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 European level is the risk of higher wage demands in the closed European economy. In contrast to bargainers at national level, bargainers at European level are not confronted with wage competitors in similar industries in other member states. Wage competition is therefore absent, resulting in higher wage demands (Danthine and Hunt, 1994; Calmfors and Driffill, 1988). The second argument is the availability of wage policy to adjust for (asymmetric) shocks. Wage bargaining should take place at a sufficiently decentralised level to allow wage adjustment in countries affected by the shock, without affecting other countries. Bargaining on a European scale cannot react sufficiently responsive as it is not able to provide a country-specific wage adjustment without involving other member states and is therefore not suitable to correct country-specific shocks.

If this is true, is the concern that wage bargaining would shift from the national to the European level justified? Two strands of literature have dealt with this issue. On the one hand, industrial relations literature has looked into the consequences of globalisation and economic integration on trade unions, wages and employment. One of the main conclusions that comes forward from this literature is that in many cases globalisation increases inter-union rivalry, reduces union power and puts a downward pressure on wages. Increasingly, unions regard international co-operation as one of the means to combat the negative effects of globalisation (Blyton, ea., 1999; Royle, 1999; Huemer ea., 1999). Note however that downward pressure on wages as such is not a sufficient condition to incite unions to co-operate. Wage reductions may increase employment and union rent.

On the other hand, a number of authors has modelled the labour market implications of product market integration. Sørensen (1993) as well as Huizinga (1993) conclude that product market integration leads to increased competitive pressure. 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 co-operation among unions. This conclusion is confirmed by Naylor (1998 and 1999).

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In this paper, we develop a model to verify a number of the above statements. Contrary to the previous literature, we specifically focus on asymmetries in the labour market. Section 2 describes the general features of the model. In section 3, we attempt to determine whether EMU does indeed increase 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 responsive when set jointly, is not supported.

## 2. The model

The setting of the model is inspired by the work of Huizinga (1993) and Naylor (1998 and 1999) and builds on some of our earlier work (Borghijs and Du Caju, 1999; Borghijs 2000). The general setting is a two-country model in which we denote country  $i$  as the home country and country  $j$  as the foreign country. There is one firm per country and both firms produce a homogeneous product  $q_i$  with a technology characterised by decreasing returns to scale in the single input labour ( $n_i$ ). A country-specific efficiency parameter  $a_i$  is added:

$$q_i = a_i \sqrt{n_i} \quad \text{with } a_i > 0$$

Total production  $Q$  by both firms then equals:

$$Q = q_i + q_j$$

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

$$TC_i = w_i n_i = \frac{w_i q_i^2}{a_i^2}$$

$$MC_i = \frac{2w_i q_i}{a_i^2}$$

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

$$p_i = a - 2bq_i$$

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

$$p = a - bQ$$

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 country  $i$  is not influenced by the quantity produced by the firm in country  $j$ . The profit function for firm  $i$  is then given by:

$$\rho_i = (a - 2bq_i)q_i - \frac{w_i q_i^2}{a_i^2}$$

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:

$$p_i = (a - bQ)q_i - \frac{w_i q_i^2}{a_i^2}$$

Each firm confronts one monopoly trade union in each country, which represents all the workers employed by the respective firms. We use the monopoly union model in order to determine the wages, in which the unions have the objective of rent-maximisation and have no influence over employment, which is unilaterally determined by the firms. 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 decision of the unions is more complex than that of the firms. Firms only have to determine the optimal level of output. Apart from setting the optimal wage, unions also have to determine the level at which the wage is set. They can either decide not to co-ordinate in which case they set the wages separately. Or they can eliminate wage competition and set the wages jointly. In case the unions determine the wages separately in their respective firms<sup>1</sup>, 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:

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

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

$$U_c = \sum_i (w_i - \bar{w}_i)n_i$$

Note that co-operation in wage-setting does not imply that a common wage is set for both firms. Potential wage differences between the two countries are not equalised 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 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

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<sup>1</sup> In our setting, decentralised, industry and national bargaining coincide since we only consider one industry. The relevant distinction is the one between national and international bargaining.

backward induction, first solving for the firm's output decision in stage 2 and then for the unions' wage decision 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 1. Having obtained these values, we are now able to address the issues discussed in the introduction of the paper.

### 3. Does EMU increase the incentives for trade union co-operation?

The first issue we address is whether EMU increases the probability that trade unions will co-operate across national borders to set wages jointly. As already explained above, previous research has indicated that this may indeed be the case. We want to investigate further under what conditions trade unions want to co-operate and which factors influence their decision. We consider EMU as a factor that promotes product market integration, which is modelled as the 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 topic 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 situation of unions in the integrated product market (comparison of model 2.1 and 2.2).

A key argument of the industrial relations literature inciting unions to co-operate across national borders is the downward pressure globalisation and economic integration exert on wages and social standards in general. Unions become closer competitors as suppliers of labour in the international market. We look if our model reproduces 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 in separate product markets is given by:

$$w_i = 2 b a_i^2 + \bar{w}_i$$

whereas the optimal wage for union  $i$  in the integrated product market is given by:

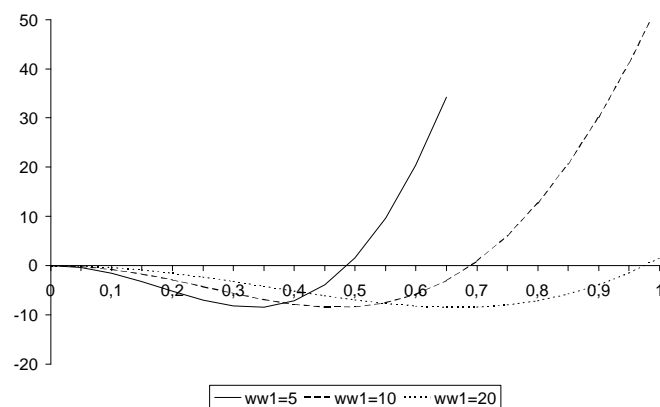
$$w_i = \bar{w}_i + \frac{b a_i^2 + \bar{w}_i \quad b a_j^2 + \bar{w}_j \quad 4 \bar{w}_i \quad b a_j^2 + \bar{w}_j + b a_i^2 \quad 3 b a_j^2 + 4 \bar{w}_j}{2 b a_j^2 + \bar{w}_j}$$

In order to demonstrate that unions are indeed subject to downward wage pressure from economic integration, we demonstrate that the difference of the former minus the latter is positive for all parameter values. The proof is simplified by replacing  $3 b a_j^2 + 4 \bar{w}_j$  with  $4 (b a_j^2 + \bar{w}_j)$  to obtain a more simple form.

$$\bar{w}_i + \frac{b a_i^2 + \bar{w}_i \quad b a_j^2 + \bar{w}_j \quad 4 \bar{w}_i \quad b a_j^2 + \bar{w}_j + b a_i^2 \quad 3 b a_j^2 + 4 \bar{w}_j}{2 b a_j^2 + \bar{w}_j} < \bar{w}_i + b a_i^2 + \bar{w}_i$$

It is clear that even after this manipulation, the wage after integration is still smaller than the before integration. It follows that product market integration lowers wage demands. This can be intuitively understood. Before integration, there is no competition in the product market. Both firms operate as monopolists in their respective product markets. Lower wage demands by the foreign union  $j$  does not shift demand and production to firm  $j$  away from firm  $i$ . This is not so in the integrated product market. Both firms are direct competitors. Lower wage demands in country  $j$  shift demand and output towards firm  $j$ , increasing employment for union  $j$ . An integrated product market thus not only causes competition in the product market, but also (wage competition) in the labour market, forcing wages down.

Wages are however only one component of union utility and the downward wage pressure does not necessarily constitute an incentive for unions to co-operate. It may be that the wage decrease is compensated by an increase in employment so that union rent increases when the 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 economic integration decreases union rent and constitutes an incentive to co-operate in order to limit the rent losses. In the figure below, the difference between union rent after and before integration is depicted in function of  $\hat{a}_i$ , which varies from 0 to 1 for different levels of  $\bar{w}_i$  (5, 10 and 15)<sup>2</sup>. If product market integration would lower union rent, we would expect negative values for the difference. Without stating a formal proof, it is clear that product market integration not always lowers union rent. The combination of relatively high productivity and a low reservation wage appears to be the best environment for high integration benefits.



The fact that unions sometimes benefit from product market integration (partially) 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 is the benefit from co-operation? The answer is that unlike in separate product markets, union co-operation (further) improves the position of the trade

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

unions in the labour market. The intuitive explanation is that unions can profit from the combination of higher employment - which is the consequence of higher output due to competition and lower prices in the integrated product market – and higher wages - which is the 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 or separate wage-setting, as the maximum attainable union rent is identical under both regimes. For simplicity, we assume that unions in this product market setting choose to set the wage separately and do not co-operate. This can be motivated by the fact that it is not unrealistic to assume that co-operation is not free. Without formally introducing a cost of union co-operation<sup>3</sup>, it is not difficult to imagine that union rent when co-operating is slightly below individual union rent when setting the wage separately.

The situation is 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. From the following expression, it is clear that - for a given wage  $w_j$  in the foreign country – the home union can attract production and employment to the home country by lowering the wage  $w_i$ :

$$q_i = \frac{a a_i^2 2 w_j + b a_j^2}{4 w_i w_j + b a_i^2 + b a_j^2 4 w_j + 3 b a_i^2}$$

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 the wage:

$$w_j = \frac{4 b w_i a_j^2 + 3 b^2 a_j^2 a_i^2 + 8 w_i \bar{w}_j + 8 b a_i^2 \bar{w}_j}{4 w_i + b a_i^2}$$

It is straightforward to verify that wage decreases in union  $i$  provoke wage decreases in union  $j$ . This in turn provokes symmetric reactions from union  $i$ . It is for this reason that unions can increase their rent by neutralising the downward pressure on wages.

In order to verify formally the claim that union utility is increased when unions co-operate compared to separate wage-setting, the two rent levels for the integrated product market given in table 1 have to be compared. 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 ( $U_1 + U_2$ ) is positive for all parameter values. This difference can be considered as a measure of the incentive for unions to co-operate.

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 in the separate wage-setting scenario with the joint union rent obtained from co-operation. We therefore 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 that:

$$U_{ci} > U_i \quad i = 1,2$$

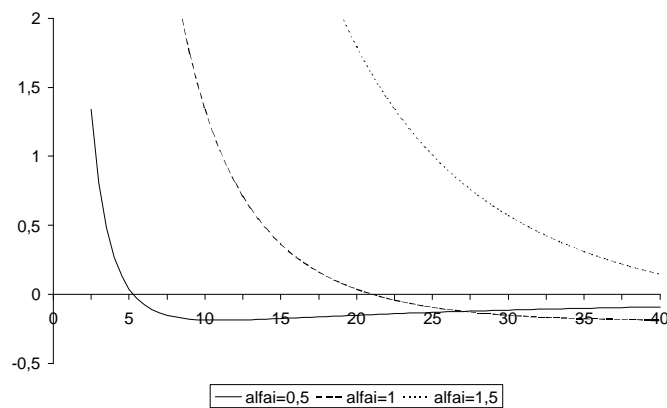
<sup>3</sup> For a formal derivation of the model when co-operation is costly, see Borghijs and Du Caju (1999)

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

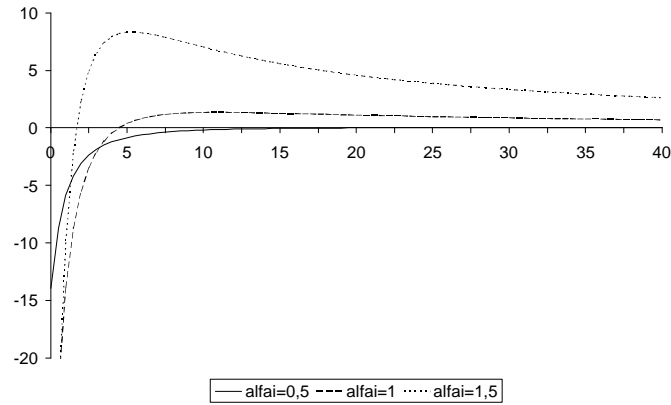
$$U_{ci} - U_i = \frac{a_i^2 a_j^2 (\bar{a}_j + \bar{w}_i)}{32\bar{w}_i (\bar{a}_j^2 + \bar{w}_j) - 8\bar{w}_i a_j^2 - b\bar{a}_j^2 + 4\bar{w}_j} - \frac{8\bar{w}_i^2 a_i^2 (\bar{a}_j^2 + \bar{w}_j)}{(\bar{a}_i^2 + \bar{w}_i) (\bar{a}_j^2 + \bar{w}_j) - b\bar{a}_i^2 - b\bar{a}_j^2 + 4\bar{w}_j} - \frac{a_i^2 + 2\bar{w}_i}{(\bar{a}_i^2 + \bar{w}_i) (\bar{a}_j^2 + \bar{w}_j) + b\bar{a}_i^2 - 3b\bar{a}_j^2 + 4\bar{w}_j}$$

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

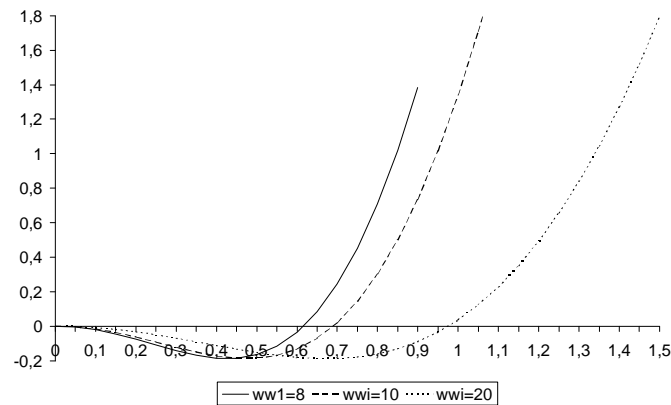
It turns out that this restriction is more restrictive than the comparison of the total union rents. Although total rent is always higher when unions co-operate, it is not guaranteed that every single union is better off when co-operating compared to the situation in which the wage is set separately. 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 changes dramatically. In order to get a better idea under what circumstances co-operating unions are better off, we evaluate the evolution of the rent difference when the parameters of the model change.



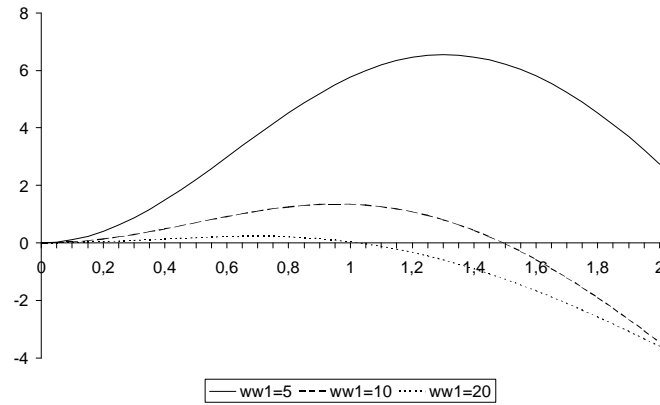
The first parameter we vary is  $\bar{w}_i$ , which varies from 0 to 40 while the other parameters keep their benchmark value. The efficiency parameter  $\bar{a}_i$  also takes three different values to measure the effect of the interaction of changes in  $\bar{w}_i$  and  $\bar{a}_i$ . It is clear from the simulation that for low levels of  $\bar{w}_i$ , the incentive is positive. Increasing values of  $\bar{w}_i$  decrease the co-operation incentive for union  $i$ . Negative values are not excluded. As the reservation wage becomes relatively large with respect to  $\bar{w}_j$ , union  $i$  has no incentive to co-operate. Thereafter, the incentive starts increasing again and converges to 0 at very high levels of  $\bar{w}_i$ . The influence of the efficiency parameter is clear. Whereas high levels of the reservation wage have a negative impact on the co-operation incentive, increasing efficiency shifts the curve upwards and delays the reservation wage at which the incentive becomes negative.



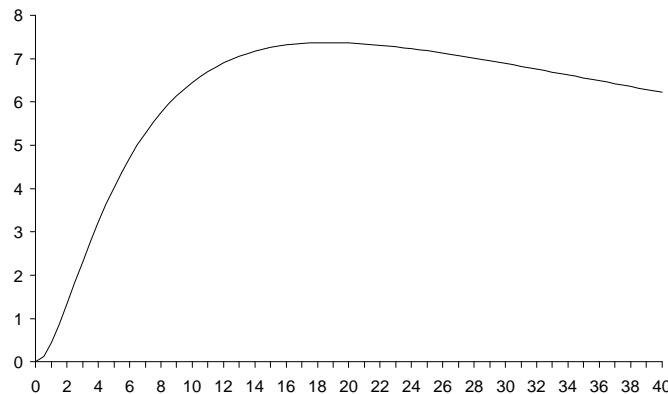
A similar picture arises when  $\bar{w}_j$  varies. For low levels of the reservation wage abroad compared to the reservation wage in the home country  $i$ , union  $i$  has no incentive to cooperate in wage-setting, as the utility it gets from setting the wage separately is higher than when setting the wage jointly. As the reservation wage abroad rises, the incentive becomes positive. After reaching a peak the incentive decreases again and converges to 0. In this case, higher productivity in the home country - represented by higher values of  $\hat{a}_i$  - shifts the curve upwards, yields higher maximum benefits and gives positive benefits at lower levels of  $\bar{w}_j$ .



The next thing to look at is variations in the efficiency parameters. We start by varying  $\hat{a}_i$ . We have run some simulations on the impact of variations in  $\hat{a}_i$  on the incentive to co-operate for several levels of  $\bar{w}_i$  and a fixed level of  $\bar{w}_j$ . The global picture that emerges is that for low values of  $\hat{a}_i$  compared to the fixed value of  $\hat{a}_j$ , there is no incentive to co-operate. This cannot be compensated by low levels of the reservation wage in country  $i$ . Negative values remain. The reservation wage is however crucial for the switching point to positive incentives. Higher values of  $\bar{w}_i$  delay the switching point.



Again, a similar picture arises when  $\hat{a}_j$  varies for different levels of the  $\bar{w}_i$ . The global picture that arises is that for low levels of  $\hat{a}_j$ , union  $i$  has an incentive to co-operate. Initially, as  $\hat{a}_j$  increases the incentive to co-operate increases as well. Further productivity increases in the foreign country lower the co-operation incentive for union  $i$  as the benefit of co-operation shift to the foreign union. The level of incentive thereby depends on the reservation wage. For lower levels of  $\bar{w}_i$ , union  $i$  has a higher incentive to co-operate and it takes high levels of  $\hat{a}_j$  for union  $i$  to become disinterested in co-operating. High levels of  $\bar{w}_i$  on the contrary restrict the co-operation incentive and lower the level of  $\hat{a}_j$  at which the co-operation incentive for union  $i$  becomes negative.



The final interesting determinant of the co-operation incentive is the parameter  $b$ , the measure of the price sensitivity of product demand. Higher levels of  $b$  imply that the sensitivity of product demand declines. It is a standard result that the price elasticity of product demand is lower in more concentrated product markets. We are therefore interested to learn in what kind of product market environment the incentive is the largest in more competitive product markets or in more concentrated product markets. From the simulation, it is clear that the incentive rises when  $b$  rises, ie when product markets become more concentrated, except for very high levels of  $b$ , for which the incentive decreases again.

The conclusion that emerges from the above simulations is that an individual union has the highest co-operation incentive when its reservation wage is relatively low and when productivity is relatively high compared to the other union. This however means from the viewpoint of the other union that its reservation wage is relatively high and that the

productivity is relatively low, which results in negative co-operation incentives. As co-operation is a mutual agreement between the two unions, it appears that co-operation is more unlikely as 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.

**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 want to have a closer look at the labour market consequences of trade union co-operation. In this section, we discuss the effect of trade union co-operation on the level of 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:

$$w_{ci} - w_i = \frac{b_i^2 + 2\bar{w}_i - 3b_j^2 - 4\bar{w}_j}{2(a_j^2 + \bar{w}_j)} - \frac{b_i^2 + 2\bar{w}_i - 3b_j^2 - 4\bar{w}_j}{2(b_i^2 + \bar{w}_i + b_j^2 + \bar{w}_j + 2b_i a_j^2 + 4\bar{w}_j)}$$

is strictly positive for all parameter values. It is not difficult<sup>4</sup> to demonstrate that this is indeed the case. We therefore conclude 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 have a closer look at the claim that wages that are set jointly would be less responsive to asymmetric shocks than separately set wages. The idea is that when wages are set separately, they can respond to changes in the national economy, whereas jointly set wages reflect the situation in both economies, thereby responding less flexibly to changes in one of the countries considered. The ultimate consequence would then be that employment in the joint wage-setting scenario is more affected (both positively as well as negatively) than in the separate wage-setting scenario.

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  $a_j$  from 1 to 0,9. This represents a negative productivity shock in the foreign country. As productivity in the home country 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 the home and foreign country by calculating the elasticity with

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

which the variables respond to the productivity change. In the case of the home wage response e.g., this elasticity is given by:

$$\eta_{a_j}^{w_i} = \frac{dw_i}{da_j} \frac{a_j}{w_i}$$

The values of the elasticities for both wage-setting scenarios are summarised in the table below. Positive values mean that the variable concerned decreases as the negative productivity shock occurs.

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

A striking fact is the different reaction of the **wage** in the home country. When wages are set separately, the productivity decline in the foreign country raises wage demands in the home country. This result holds for all parameter values. Under joint wage-setting, the productivity shock lowers the wage in the home country. Again, this result holds for all parameter values. The wage set for the foreign country is lowered under both wage-setting scenarios. We moreover 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 the home country 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 the foreign country and the home wage which is lowered in response to the productivity shock. In the separate wage-setting scenario, the positive employment effect of the relative productivity increase in the home country is dampened by the increase in the home wage. The employment reaction in the foreign country relates to this. The productivity decrease obviously leads to lower employment in the foreign country. But whereas the negative employment effect is dampened by the wage increase in the home country when wages are set separately, shifting employment back to the foreign country, employment is further shifted away from the foreign country to the home country due to the wage decrease in the joint wage-setting scenario. We can thus conclude that employment in the foreign country is more negatively affected when wages are set jointly, but not because the foreign wage would react less flexibly, but because the home wage falls in line with the foreign wage, rather than rises as in the separate wage-setting scenario<sup>5</sup>. Further simulations suggest that total employment is less affected when wages are

<sup>5</sup> An additional conclusion that could be drawn and that relates to a topic not addressed in this paper, is that joint wage-setting seems to increase employment divergences when countries are hit by asymmetric shocks.

set jointly than when wages are set separately, contradicting the prediction that joint wage-setting would lead to higher unemployment when wages are set jointly.

Table 1: 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	$w_i = 2 \frac{b \alpha_i^2 + \bar{w}_i}{4}$	$w_i = 2 \frac{b \alpha_i^2 + \bar{w}_i}{4}$
Employment	$n_i = \frac{a^2 \alpha_i^2}{16 b \alpha_i^2 + 4 \bar{w}_i}$	$n_i = \frac{a^2 \alpha_i^2}{16 b \alpha_i^2 + 4 \bar{w}_i}$
Union rent	$U_i = \frac{a^2 \alpha_i^2}{32 b \alpha_i^2 + 16 \bar{w}_i}$	$U_c = \frac{1}{16} a^2 \left[ \frac{\alpha_i^2}{2 b \alpha_i^2 + \bar{w}_i} + \frac{\alpha_j^2}{2 b \alpha_j^2 + \bar{w}_j} \right]$
Output	$q_i = \frac{a \alpha_i^2}{8 b \alpha_i^2 + 4 \bar{w}_i}$	$q_i = \frac{a \alpha_i^2}{8 b \alpha_i^2 + 4 \bar{w}_i}$
Price	$p_i = a - \frac{a b \alpha_i^2}{4 b \alpha_i^2 + 2 \bar{w}_i}$	$p_i = a - \frac{a b \alpha_i^2}{4 b \alpha_i^2 + 2 \bar{w}_i}$
Profit	$\pi_i = \frac{a^2 \alpha_i^2}{16 b \alpha_i^2 + 8 \bar{w}_i}$	$\pi_i = \frac{a^2 \alpha_i^2}{16 b \alpha_i^2 + 8 \bar{w}_i}$

Table 1 (continued): Overview of the key labour and product market variables

	Model 2 Integrated product market Separate wage-setting	Joint wage-setting
Wage	$w_i = \bar{w}_i + \frac{b \alpha_j^2 (\bar{w}_i - \bar{w}_j)}{2 (b \alpha_j^2 + \bar{w}_j)}$	$w_i = \frac{b \alpha_j^2 (\bar{w}_i - \bar{w}_j) + 4 \bar{w}_j}{2 b \alpha_j^2 + 4 \bar{w}_j}$
Employment	$n_i = \frac{a^2 (b \alpha_j^2 + \bar{w}_i) (b \alpha_j^2 + \bar{w}_j)}{4 b^2 \alpha_j^2}$	$n_i = \frac{a^2 \alpha_j^2 (b \alpha_j^2 + \bar{w}_j)}{4 (b \alpha_j^2 + \bar{w}_j)}$
Union rent	$U_i = \frac{a^2 (b \alpha_j^2 + \bar{w}_i) (b \alpha_j^2 + \bar{w}_j)}{8 b^2 \alpha_j^2}$	$U_c = \frac{a^2 \alpha_j^2 (b \alpha_j^2 + \bar{w}_j)}{16 \bar{w}_i (b \alpha_j^2 + \bar{w}_j)}$
Output	$q_i = \frac{a (b \alpha_j^2 + \bar{w}_i) (b \alpha_j^2 + \bar{w}_j)}{2 b}$	$q_i = \frac{a \alpha_j^2 (b \alpha_j^2 + \bar{w}_j)}{8 \bar{w}_i (b \alpha_j^2 + \bar{w}_j)}$
Price	$p = \frac{a (b \alpha_j^2 + \bar{w}_i) (b \alpha_j^2 + \bar{w}_j)}{2 (b \alpha_j^2 + \bar{w}_i) (b \alpha_j^2 + \bar{w}_j) + b \alpha_j^2 (b \alpha_j^2 + 4 \bar{w}_j)}$	$p = \frac{a (b \alpha_j^2 + \bar{w}_i) (b \alpha_j^2 + \bar{w}_j)}{4 \bar{w}_i (b \alpha_j^2 + \bar{w}_j) + b \alpha_j^2 (b \alpha_j^2 + 4 \bar{w}_j)}$
Profit	$\pi_i = \frac{a^2 (b \alpha_j^2 + \bar{w}_i) (b \alpha_j^2 + \bar{w}_j)}{8 (b \alpha_j^2 + \bar{w}_i) (b \alpha_j^2 + \bar{w}_j) + b \alpha_j^2 (b \alpha_j^2 + 4 \bar{w}_j)}$	$\pi_i = \frac{a^2 \alpha_j^2 (b \alpha_j^2 + \bar{w}_j)}{8 (b \alpha_j^2 + \bar{w}_i) (b \alpha_j^2 + \bar{w}_j) + b \alpha_j^2 (b \alpha_j^2 + 4 \bar{w}_j)}$

## Appendix

In this section, we analytically derive the reduced forms of the relevant variables for firms and unions. This is done by solving the model by backward induction. We first derive the optimal output, assuming that the wage set by the unions is given. This semi-reduced form allows to calculate labour demand, which is substituted into the union rent function. This procedure is repeated for the two product market settings (separate and integrated product markets) and the two union options (separate wage-setting and joint wage-setting).

### *Model 1: Separate product markets*

In model 1, our two-country setting consists of two separate markets in which two monopolistic firms operate in their domestic product market. In case 1, the two monopolists are confronted in the labour market with separate trade unions. 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/countries.

#### Case 1: Separate wage-setting

##### Stage 2: Profit maximisation

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

$$\text{Max}_{q_i} p_i = (a - 2bq_i)q_i - \frac{w_i q_i^2}{a_i^2}$$

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

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

Since both firms operate as monopolists in their respective (separate) product markets, the optimal quantity of 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 as calculated in stage 2, each union calculates the rent-maximising wage by optimising its rent function:

$$\text{Max}_{w_i} U_i = \frac{w_i}{a_i} \left( \frac{a a_i^2}{2 w_i + 4 b a_i^2} \right)^2$$

Solving for the rent-maximising wage gives:

$$w_i = 2 \frac{a_i^2}{b}$$

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

#### Case 2: Joint wage-setting

##### Stage 2: Profit maximisation

It is not difficult to see that 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 from case 1. We therefore refer to case 1 for the solution. 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. This will become clear in stage 1.

### Stage 1: Rent maximisation

As we now assume that unions set the wages jointly, they maximise a joint union rent function, whereby the decision variables  $w_1$  and  $w_2$  are set to optimise the joint union rent:

$$\text{Max}_{w_1, w_2} U_c = \frac{a_1^2 w_1^2}{2w_1 + b a_1^2} + \frac{a_2^2 w_2^2}{2w_2 + b a_2^2}$$

This results in the following wage demands for resp. country 1 and 2:

$$w_1 = 2 \frac{b a_1^2}{2 + b a_1^2}$$

$$w_2 = 2 \frac{b a_2^2}{2 + b a_2^2}$$

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

### 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 wages 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:

$$\text{Max}_{q_i} p_i = a - b q_i + q_j - \frac{w_i}{a_i^2} q_i$$

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

$$q_i = \frac{a - b q_j - \frac{w_i}{a_i^2}}{2 + b a_i^2}$$

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 yields an optimal output for each firm as a function of the wages of country  $i$  and  $j$ :

$$q_i = \frac{a_i^2 (2 + b a_j^2) (a - b a_j^2) - b a_i^2 a_j^2 (a - b a_i^2)}{4 w_i (1 + b a_j^2) + b a_i^2 (4 w_j + 2 b a_j^2)}$$

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

### Stage 1: Rent maximisation

Given labour demand as derived in stage 2, each union sets the rent-maximising wage:

$$\text{Max}_{w_i} U_i = \frac{a_i^2 w_i^2}{2w_i + b a_i^2} + \frac{a_j^2 w_j^2}{2w_j + b a_j^2}$$

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

$$w_i = \frac{4 b w_j a_i^2 + 3 b^2 a_i^2 a_j^2 + 8 w_j \bar{w}_i - 8 b a_j^2 \bar{w}_i}{4 a_j^2 + b a_i^2}$$

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

$$w_i = \bar{w}_i + \frac{b a_i^2 + \bar{w}_i - b a_j^2 \bar{w}_j}{2 b a_j^2 + \bar{w}_j}$$

## 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 output expressions.

### Stage 1: Rent maximisation

Joint wage-setting by the 2 unions results in the following optimisation problem:

$$\text{Max}_{w_1, w_2} U_c = \frac{a_i^2 a_j^2 (w_i - \bar{w}_i)(w_j - \bar{w}_j)}{4 w_i w_j + b a_i^2 + b a_j^2} + \frac{a_i^2 a_j^2 (w_i - \bar{w}_i)(w_j - \bar{w}_j)}{4 w_i w_j + b a_i^2 + b a_j^2}$$

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

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

Solving the set of the two reaction functions results in the following wage expression as a function of the parameters of the model:

$$w_i = \frac{b a_i^2 + 2 \bar{w}_i + 3 b a_j^2 4 \bar{w}_j}{2 b a_j^2 + 4 \bar{w}_j}$$

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

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