The Effect of International Trade on Trade Union Density

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Abstract

Trade union density has been decreasing across the world at the same time as increasing globalisation. In this paper the two phenomena are linked. Increasing international product market competition harms unionised workers more than workers who bargain wages individually. This is as union wages are a function of average revenue but individually bargained wages are a function of marginal revenue. Increasing competition narrows the gap between average and marginal revenue. This lowers the incentive to be a member of a trade union, which leads to a fall in trade union density. This paper focuses on two dimensions of trade openness, falling costs of transportation, and increases in the number of countries in a trade bloc. Globalisation can lead to falling union density despite a stable union wage premium and increasing union wages.

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1 Introduction

Trade unions have declined. Though there have been some exceptions, trade union density has declined across the world. In most countries this decline has slowed and the stabilisation of union densities has been as general as their decline. Unions tend very much to be national organisations, linked to the peculiarities of their respective nations. However, the international parallels in the trends of unionisation have been remarkable, and that these global parallel movements of trade union density should occur at the same time as increasing globalisation suggests a link between the two.

At the same time as the fall in unionisation there has been an increase in the number of countries in trade blocs. The European Union (EU) has expanded from six original members to nine in 1972, to 12 by 1986, 15 in 1995, and by 2007, 27 countries were members of the European Union. The depth of integration can also be charted by looking at the change of names from the European Coal and Steel Community, to the European Economic Community, to the European Community, to the present European Union. Though the EU is perhaps the best example of a trade bloc increasing in size, there are others, such as NAFTA for North America and Mercosur for South America.

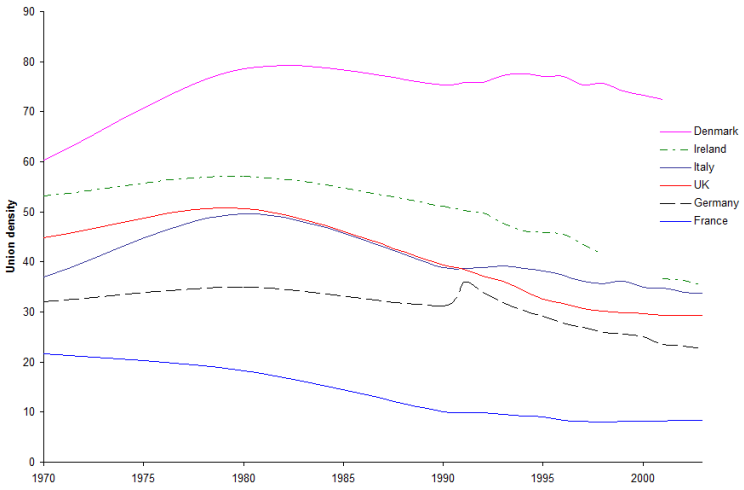

Figure 1: Trade union density for selected EU countries. Source: Visser (2003)

Figure 1 shows the similarity of trends in union density for six European countries which had been EU members before 1980. There has been a similar movement in trade union density for European countries, despite their having different trade

union systems. This pattern takes the form of a peak in union density around the year 1980. It is also interesting to look at the pattern of unionisation of the Nordic countries. As can be seen from Figure 1 and Figure 2, though Denmark has a level of unionisation similar to Finland and Sweden, its trend has more in common with countries which were members of the EU by 1973. In contrast, Sweden and Finland which joined the EU at the same time show a similar trend in unionisation.

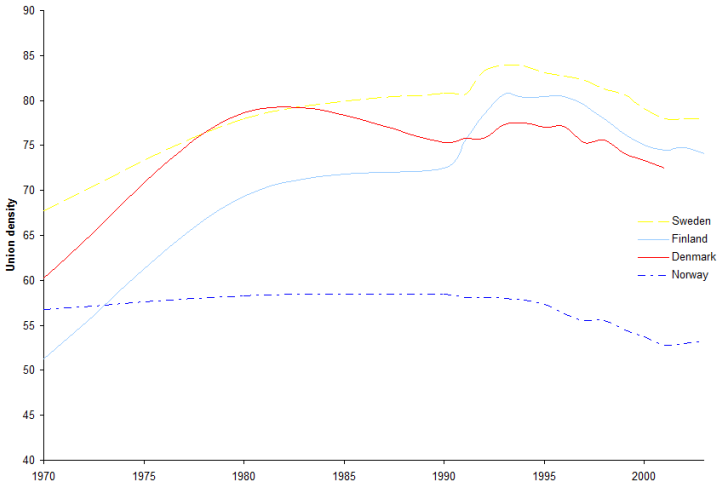

Figure 2: Trade union density for Nordic countries. Source: Visser (2003)

The increasing size and depth of trade blocs such as the European Union has been associated with decreasing trade union density. Interestingly, despite the decline in unionisation, there is evidence that the union premium has remained stable. Kaufman (2002) shows some evidence that union wage premiums have remained stable since 1980, while Bratsberg and Ragan (2002) have found that though there were some rises and falls in wage premiums in some sectors, overall they remained stable. Also, union wages performed better than non-union wages in the face of international competition, though unions lost members. In an empirical investigation Slaughter (2007) examined how globalisation can affect trade union density. He found a link between foreign direct investment and falling unionisation (though foreign affiliates actually had higher levels of unionised workers) and did not find a relationship between trade and falling unionisation. However, in his examination he looked at trade flows, rather than the number of countries with which a country trades.

In this paper I ask how does increasing the number of countries in a trade bloc affect trade union density?

Acemoglu et al. (2001) explain the decrease in union density as being the result of skill biased technical change ending alliances between skilled and unskilled workers. I provide an alternative explanation for the decrease in trade union density. I present a general equilibrium model with endogenous trade union formation. I will show that increasing international competition can decrease the rents available to firms for which the union can bargain. This can make union membership less attractive, and so decrease union membership, though wage premiums will remain stable. In order to show the effects of increasing the number of countries in a trade bloc has on union density a general equilibrium model with labour market frictions is presented. The main ingredients of the model are endogenous trade union formation; membership of a trade union is costly; there are many symmetrical countries; the labour market is frictional; there are two homogeneous goods; and entry into the Cournot sector is costly.

In this paper trade unions provide bargaining services. If the labour revenue product function of a firm is concave (Stole and Zwiebel, 1996), such as with Cournot competition, workers benefit from combining together to bargain wages, as opposed to individual bargaining. Unions can bargain with the firm for the distribution of rents. However trade union membership is costly. Apart from the financial cost in terms of paying union dues each period, there are also costs such as the necessity of union members to take part in union activities such as union meetings or voting at union elections. These activities can occupy the time of workers, leaving less time for other activities. If an increase in the number of countries in a trade bloc reduces the rents available, workers will be less willing to pay the cost of union membership. As wages under union bargaining are a function of the average revenue per worker of the firm (as opposed to marginal revenue which is the case with individual bargaining) union wages are more affected by changes in international competition than non-union wages are. Increased competition reduces the difference between marginal revenue and price, so the difference between average revenue and marginal revenue is also decreased. Therefore, the increase in the number of countries in a trade bloc can help to explain the decrease in trade union density across the world. Increasing the number of countries in a trade bloc leads to an increase in the number of firms, and this causes an increase in the level of product market competition, reducing rents. Huizinga (1993) shows how greater integration can lead to lower wages due to product market competition, though Naylor (1998) shows that with monopoly unions, integration can lead to higher wages. This is as if a tariff decreases the demand for the firm's product may increase and this can cause an increase in the wage.

I also provide a mechanism by which unionisation can increase when a small number of countries join a trade bloc, but union density eventually decreases as

more unions join the trade bloc. In this paper, when countries open to trade there is an incentive for firms to export, as they chase rents in other countries. However, it is costly to transport goods internationally, and this cost is in terms of workers employed to transport the goods. As more workers are employed to transport the good, this means that less workers are available to produce the Cournot good. Production of the Cournot good falls and its price rises. This benefits the unionised workers more than non-union workers. This is as this increase in price increases the average revenue per worker of a firm more than it increases the marginal revenue of the firm. As being a member of a union becomes more attractive, more workers are willing to pay the costs of union membership and join the union. As the number of countries in the trade bloc increases, the effect of increased product market competition becomes stronger than the effect of workers being diverted into transporting the good. After an initial rise in union density, union density declines.

The paper is laid out as follows. In section two a brief review of the literature is given, in section three the model is outlined, in section four the results of the model are given and section five concludes.

2 Literature review

Though there has been some empirical research on the decline in union density, there has been a lack of theoretical research. Machin (2000) finds the main reason that trade unions have declined in Britain is a failure to organise in new establishments. Empirical research on the effect of globalisation on union density has been undertaken. For European economies Blaschke (2000) finds that trade has a small negative effect on unionisation. Slaughter (2007) investigates the link between globalisation and falling unionisation in the US. Though a link is found between increasing foreign direct investment and falling unionisation, no link is found with trade. However it was the level of trade, rather than openness to trade which was examined. Using UK data Konings and Walsh (2000) find that employment loss as a result of increased product market competition is higher in non-unionised firms than unionised firms. This is as product market competition reduces the rents that unionised workers can bargain over, thereby reducing the incentive to fire workers. Neumann and Rissman (1984) suggest that unionisation has declined as governments now provide services that were previously provided by unions, thereby reducing the selective incentive of joining a union. However, Waddington and Whiston (1997) find that reasons to do with collective bargaining are the main reasons that people join unions and that union services only play a secondary role. Schnabel and Wagner (2007) find that personal characteristics

and the characteristics of the workplace are important in determining who joins a union and social characteristics play a minor role. They also point out that strike pay is a selective incentive and that a cost benefit analysis of union membership ignores the free rider problem.

Although wage bargaining tends to be more centralised in Europe than in the US, firm level wage bargaining is still important. Using Swedish data Granqvist and Regnér (2008) find that local bargaining signficantly raises wages, Plasman et al. (2006) finds that local bargaining raises wages by about four per cent in Belgium, Denmark and Spain. Braun and Scheffel (2007) find that in Germany those covered by a collective firm agreement gain a premium of 5.7 per cent. For Italy, Dell 'Aringa and Lucifora (1994) find a 4.4 per cent premium for blue collar workers and a 7.7 per cent premium for white collar workers who are covered by firm level collective bargaining agreements.

There has been a lack of general equilibrium models with endogenous union membership. Delacroix (2006) presents a model in which some sectors are unionised and others are not. However he does not look at why some firms within a sector are unionised and others are not. Preugschat (2008) presents a model where a centralised union decides how many firms to organise and it is costly to organise a firm. It is found that an increase in the entry and exit rate of firms due to deregulation can lead to a decline in union density.

3 The model

There are m symmetrical countries, and two homogeneous goods; a good characterised by Cournot competition, X, and a competitively traded good, Y. Each country is equally endowed with a continuum of two factors, labour (L), and resources (R). It is useful to think of land as the resource. Labour and resources are used in the competitively traded good sector and only labour is used in the Cournot sector. Though goods can be transported internationally, factors can not. Competitively traded good sector firms are small and produce in only one country (though they may sell their product in any country). In contrast, firms in the Cournot good sector are large and hire a continuum of workers. Firms can not move internationally. There are no multinational enterprises. The competitively traded good serves as numeraire for the economy. The competitively traded good can be freely traded internationally, though as all countries are symmetrical the competitively traded good is not traded in equilibrium. There are no costs to entering the competitively traded good sector apart from the cost of posting a vacancy. There is a cost (in terms of labour) for transporting the Cournot good

internationally. Union formation only occurs in the Cournot sector. In the competitively traded good sector the good is traded competitively and the revenue labour product function is linear. Therefore in the absence of a cost of union membership workers in the competitively traded good sector would be indifferent to being a member of a union. As trade union membership is costly, workers would not wish to join a union.

In presenting the model I shall first outline the labour market and workers value functions. I shall then outline the product market, showing how the utility function leads to product demands and solving the problem of the firm leads to product supply. I then proceed to explain how wages are bargained. Finally for this section, the equilibrium is outlined.

3.1 Labour market

The labour market is characterised by frictional unemployment. This means that if a firm posts a vacancy this period there is a probability that they shall fill this vacancy and have a worker next period. It is costly to post a vacancy. A frictional labour market provides a framework in which wages are bargainined. Country i has a continuum of measure L_i workers. There is a Cobb-Douglas matching technology $su_i^{\rho}v_i^{1-\rho}$, which gives the total number of matches between unemployed workers (the mass of workers looking for a job) with vacancies, where u_i is the mass of unemployed workers in country i, v_i is simply the total sum of the vacancies posted by the different firms operating in country i, ρ is the labour market match elasticity of unemployment (and $1-\rho$ is the match elasticity of vacancies) and s is a parameter that affects the total number of matches between unemployed workers and vacancies. It should be noted that u_i is the mass of unemployed workers and not the rate of unemployment.

Dividing the total number of vacancies by the number of unemployed workers we get labour market tightness which is written as

$$\theta_i = \frac{v_i}{u_i}, \quad i = 1, 2...m. \tag{1}$$

Dividing the matching function by v_i we get the intensive matching function

$$q(\theta_i) = s\left(\frac{u_i}{v_i}\right)^{\rho} = s\theta_i^{-\rho}. \tag{2}$$

If a firm posts a vacancy this period, the probability that it will fill the vacancy this period (and so have a worker available to work next period) is given by $q(\theta_i)$.

3.1.1 Workers' value functions

It is assumed that all agents in the economy are risk neutral. Workers in a country may work for a firm in the competitively traded good sector or in the Cournot sector. In the Cournot sector they are paid wages which are either negotiated by a union or by individual bargaining. It is only in the Cournot sector that workers will join unions. This is as in the competitively traded good sector firms have a linear revenue labour product function and there is no incentive for these workers to join unions.

Workers do not become members of unions permanently, but each period they choose whether or not to become a member of a union. If the workers of a firm unionise they all unionise. A closed shop agreement operates in unionised firms. The Nash equilibrium for whether workers unionise or not can be that either:

- all firms in the Cournot sector are unionised
- no firm in the Cournot sector is unionised
- or a mixed solution.

The value to a worker of having a job in a unionised firm is denoted as W_i^U and the value to a worker of being employed in a Cournot firm with individual bargaining is denoted as W_i^I. Each period Cournot sector workers face a probability μ of being in a union. If $W_i^U > W_i^I$ then $\mu = 1$, if $W_i^U < W_i^I$ then $\mu = 0$, and if $W_i^U = W_i^I$ then we have a mixed strategy equilibrium and $\mu \in [0, 1]$. So workers will only join a union if the benefit of joining is greater than or equal to the cost.

It is useful to describe how the equilibrium level of union density is arrived at. As shown by Stole and Zwiebel (1996), with imperfect competition (such as Cournot competition) firms in which wages are negotiated through individual bargaining will hire more workers than firms where wages are negotiated through union bargaining. This is as with individual bargaining, firms negotiate with workers treating each worker as the marginal worker. Firms are aware that if they hire an extra worker, then this will reduce the marginal revenue product of labour and so reduce the wage for all other workers in the firm. Firms with individual bargaining have a strategic incentive to hire more workers than unionised firms. Similarly, when firms face a low probability of becoming unionised they will hire more workers than when firms face a high probability. Suppose that in the economy the rate of union density was below its equilibrium value. This would mean more workers are employed per firm than in equilibrium. For a given level of supply of the good, increasing the number of workers for a firm causes marginal revenue to decrease more than average revenue per worker. As union bargained wages are

a function of average revenue, and individually bargained wages are a function of marginal revenue, the increase in the difference between marginal revenue and average revenue causes union membership to be more attractive. Union density will rise, and average level of workers per firm will fall until equilibrium is achieved.

Different types of firms may pay different wages. The value for workers of having a job depends on the type of firm they are working for. The value to a worker of being employed depends on the wage they will receive this period, the discounted value of the their state next period, and whether they face any cost as a result of being a member of a union. The expected value to workers of being employed in the Cournot sector is

$$W_i^X = \mu W_i^U + (1-\mu) W_i^I,$$

which is the weighted average of being employed in a firm with union bargaining or individual bargaining. The value of being employed with a union contract is

$$W_i^U = w_i^U + \beta \left(\lambda U_i' + (1-\lambda) W_i^{X\prime}\right) - aP\left(X_{ic}, Y_{ic}\right),$$

where w_i^U is the wage received under union bargaining, U_i' is the value of being unemployed next period, β is the discount rate, λ is the exogenous probability that the worker will separate from the firm at the end of this period, and a is the real cost of being in a trade union. a can be thought of as union dues or the cost of attending union meetings. The value of unemployment is in nominal terms so it was necessary to multiply a by the price index $P\left(X_c, Y_c\right)$. The origin of the index is outlined in the next section. The value to a worker of being employed when wages are determined by individual bargaining is

$$W_i^I = w_i^I + \beta \left(\lambda U_i' + (1-\lambda) W_i^{X\prime}\right),$$

where w_i^I is the wage under individual bargaining. As can be seen the value this period depends on the discounted probablility of being unemployed next period and the discounted probability of continuing to work in a Cournot sector firm. The worker does not know if the Cournot sector firm will continue to bargain wages individually next period or if it will unionise. In the competitively traded good sector the value of being employed is

$$W_i^Y = w_i^Y + \beta \left(\lambda U_i' + (1-\lambda) W_i^{Y\prime}\right),$$

where w_i^Y is the wage in the competitively traded good sector.

If a worker is unemployed he does not participate in the product market. They do gain some utility, z, which is the income a worker receives from non-market

activities. This can be considered home production which the agent does not sell on the market. The value of unemployment is

$$U_i = zP\left(X_{ic}, Y_{ic}\right) + \beta\left(\left(1 - \theta_i q(\theta_i)\right) U_i' + \theta_i q(\theta_i) E\left(W_i'\right)\right). \tag{3}$$

$\theta_i q(\theta_i)$ is the probability that a worker finds a job this period. The value of unemployment is in nominal terms so it was necessary to multiply z by the price index $P\left(X_{ic}, Y_{ic}\right)$. As a worker does not know what type of firm he will work for next, $E\left(W_i'\right)$ is simply a weighted average of the values of being employed in the various types of firms and is given by

$$E\left(W_i'\right) = \frac{\bar{v}_i^Y}{v_i} W_i^{Y\prime} + \frac{\bar{v}_i^X}{v_i} W_i^{X\prime},$$

where v_i is the total number of vacancies in country i, $\bar{v}_i^Y$ are the total number of vacancies posted in country i in the Y sector and $\bar{v}_i^X$ is the total number of vacancies posted by firms in the X sector.

3.2 Product market

Two homogeneous goods, X and Y , are produced in the economy. Good Y is the numeraire competitively traded good and is internationally mobile without any cost of transportation. Due to the symmetry of the countries good Y will not be traded in equilibrium. The X sector is characterised by Cournot competition. There are transportation costs if the Cournot good is shipped internationally. In the Cournot sector a firm negotiates with workers when bargaining wages either individually or collectively. Labour is used in production in both sectors, however resources are only used in the competitively traded good sector. It is useful to think of Y as a good which uses the resource land. The utility of the representative consumer is shown by the Cobb-Douglas function $U_i = X_{ic}^{\delta} Y_{ic}^{1-\delta}$, where X_{ic} is the total amount of good X consumed in country i, and

$$X_{ic} = nX_{i,i} + n \sum_{\substack{j=1 \\ j \neq i}}^{m} X_{j,i}, \tag{4}$$

where n is the number of national firms based in each country. $X_{i,i}$ is the amount of the Cournot good produced by a country i based national firm for the the market of country i. The first subscript index is for the country of origin of the firm, and the second is for where the good is sold. Therefore $X_{j,i}$ is the amount of X produced by a country j based firm and exported to country i.

It is assumed that unemployed workers do not participate in the goods market. Using the budget constraint that national income equals national expenditure,

$M_i = P(X_{ic}) X_{ic} + Y_{ic}$, where $P(X_{ic})$ is the price of the Cournot good in country i and M_i is national income of country i, we get the product demands

$$X_{ic} = \frac{\delta M_i}{P(X_{ic})}, \; Y_{ic} = (1-\delta) M_i. \tag{5}$$

The indirect demand equation for X_{ic} is given by

$$P(X_{ic}) = \frac{\delta M_i}{X_{ic}}. \tag{6}$$

By definition as numeraire, the price of good Y is equal to 1. The price index for the economy is defined as

$$P(X_{ic}, Y_{ic}) = P(X_{ic})^{\delta}.$$

This was calculated by inserting equation (5) into the utility function, which gave an indirect utility function in terms of prices and nominal income, and then rescaling.

3.2.1 Competitively traded good sector firms

In the competitively traded good sector firms are small, with one worker per firm. Therefore the mass of workers, L_i^Y , and the mass of firms in the competitively traded good sector are identical. Competitively traded good sector firms consider themselves too small to affect the market. The firms use resources and one unit of labour. The amount of resources used by an individual firm is given by $\hat{R}_i$. As the resource is freely traded and not subject to any frictions, all the resource will be used each period, so $R_i = L_{iY} \hat{R}_i$. It is free to trade the competitively traded good internationally. Competitively traded good sector firms only have one worker. There are no competitively traded good sector MNEs. The value this period of a filled job to an entrepreneur in the competitively traded good sector is given as

$$J_i^Y = y_i - w_i^Y - r_i \hat{R}_i + \beta (1-\lambda) J_i^{Y\prime}, \tag{7}$$

where we have the production technology $y_i = \hat{R}_i^{1-\alpha}$, and r_i is the rental rate of resources in country i, w_i^Y is the wage and λ is the exogenous probability that the job-worker pair will separate. As firms in this sector are price takers the revenue labour product function is linear. Maximising the above for $\hat{R}_i$ and using the fact that all firms in the competitively traded good sector act symmetrically, we get that

$$r_i = (1-\alpha) \left(\frac{L_i^Y}{R_i} \right)^{\alpha}. \tag{8}$$

Similarly, the total amount of the competitively traded good produced in the economy can be given as

$$Y_i = \left(L_i^Y\right)^{\alpha} R_i^{1-\alpha}. \tag{9}$$

The value of posting a vacancy in the competitively traded good sector is

$$V_i^Y = -\phi P\left(X_{ic}, Y_{ic}\right) + (1-\eta)\,\beta\left(q\left(\theta_i\right) J_i^{Y\prime} + \left(1 - q\left(\theta_i\right)\right) V_i'\right), \tag{10}$$

where ϕ is the cost of posting a vacancy and $q\left(\theta_i\right)$ is the probability that the firm will fill the vacancy. When a firm decides to post a vacancy they take θ_i as given. η is the exogenous probability that the firm will cease to exist. As a firm is deemed to exist from the moment it posts a vacancy there is a possibility that the firm will expire before it even manages to hire a worker.

Due to the free entry condition $V_i^Y \leq 0$. In the steady state this holds with equality where there is a positive number of competitively traded good sector firms operating in country i. Due to the nature of the Cobb-Douglas production function, in the steady state there will always be a positive number of Y sector firms operating in country i whenever $R_i > 0$. This, combined with equation (10) leads to

$$J_i^{Y\ \prime} \leq \frac{\phi P\left(X_{ic}, Y_{ic}\right)}{(1-\eta)\,\beta q\left(\theta_i\right)} \tag{11}$$

with equality in the steady state if $R_i > 0$. This is simply the cost of filling a vacancy divided by the discount factor and probability that the firm will continue to exist next period. Firms have a value due to the barrier to entry caused by labour market frictions.

3.2.2 Cournot sector firms

Good X is a homogeneous good and firms producing good X act according to Cournot competition, taking the competitively traded good as numeraire. Cournot sector firms are aware of their effect on the price of X but take the actions of the other firms as given. It is costly for Cournot firms to enter the market. Firms must pay for a production licence, b, which is paid to some members of the economy (how it is distributed is irrelevant as agents are risk neutral). There is a cost τ associated with transporting Cournot good internationally. Technology in the Cournot sector is constant returns to scale. It takes one worker to produce each unit of the good. Firms in the Cournot sector are large and hire a continuum of workers. As a continuum of workers is hired we can use the law of large numbers. Therefore the probability that a worker separates from the firm can be interpreted as the proportion of workers separating from the firm at the end of the period. Though Cournot sector firms consider they are large enough to affect

the price of the Cournot good, they do not account for any effect they may have on the labour market, on national income or the price index of the economy as a whole. Firms in the Cournot sector will negotiate wages according to either union bargaining or individual bargaining. Firms do not know if next period they will face union bargaining or individual bargaining. They only know the probability μ' that union bargaining will take place. When firms become aware that they face union bargaining it may be optimal for them to lay off some workers. To avoid this complication it is assumed that firms cannot adjust the number of workers downward until the next period. This is realistic if one assumes that firms must give a minimum notice of one period before laying off workers.

The timing of activities in the Cournot sector is as follows. Due to labour market frictions the firm must search for workers to fill its vacancies. This is done in the period before they start to work for the firm. The firm does not know if next period these workers will form a trade union but it does know the probability that this will happen. If the value of being a member of a union is greater than the value of bargaining individually then the probability will be one. If the value of joining a union is less than that of bargaining individually then the value will be zero. If however the value of being a union member is equal to the value of bargaining individually then the probability will be a mixed strategy Nash equilibrium. If workers form into a union all the workers in the firm join. Workers have some means, such as a closed shop agreement, to ensure there is no free riding of trade union membership. Firms have an optimal number of hirings which depends on the probability that workers will unionise. At the beginning of the next period the workers either unionise or do not. They will only unionise if the value of trade union membership is greater than or equal to the value of bargaining individually with the firm. Wage negotiations then follow. If workers bargain individually then during negotiations the worker can only threaten to withdraw his labour. The firm can treat each worker as the marginal worker. The firm can threaten to sack the worker and production can continue with the other workers. However, if workers form into a union then they can threaten to all withdraw their labour simultaneously. In this case the firm will sack all the workers and no production will take place this period. The firm does not expire completely however. It has already paid some set up cost and will not wish to lose the value of this. The firm will post vacancies to hire more workers for the next period. Assuming wage bargaining has been successful (which in equilibrium it always is) the firm produces the good and decides the level of vacancies to be filled for the next period, taking into account the probability that next period the workers may form a trade union.

I will now outline the problem facing Cournot sector firms. The value of a firm

in the Cournot sector is

$$V(H_i) = \max_{v, X_{ij}} \left\{ \begin{array}{c} P(X_{ic}) X_{i,i} + \sum_{\substack{j=1 \\ j \neq i}}^{m} P(X_{jc}) X_{i,j} - \left(\mu w_i^U(H_i) + (1-\mu) w_i^I(H_i)\right) H_i \\ -\phi P(X_{ic}, Y_{ic}) v^X + (1-\eta) \beta V(H_i') \end{array} \right\}, \tag{12}$$

subject to the price of the good

$$P(X_{ic}) = \frac{\delta M_i}{X_{ic}}, \ i = 1, 2, ...m,$$

the law of motion for hiring workers

$$H_i' = \left(1 - \widetilde{\lambda}\right) H_i + q(\theta_i) v, \tag{13}$$

and that production is constrained by the number of workers presently hired by the firm

$$H_i = X_{i,i} + (1+\tau) \sum_{\substack{j=1 \\ j \neq i}}^{m} X_{i,j}, \tag{14}$$

where $w_i^U(H_i)$ is the wage if union bargaining takes place and $w_i^I(H_i)$ is the wage if wage bargaining takes place, v is the mass of vacancies posted by the firm, $X_{i,i}$ is the amount of the Cournot good supplied by the firm in its home country and $X_{i,j}$ is the amount of the Cournot good supplied to country j. At the beginning of the period the firm does not know whether or not a union will form, it only knows the probability μ that a union will form. So the value of a firm at the beginning of the period is simply the revenue of this period minus the expected wage and cost of posting vacancies plus the discounted value of the firm next period. The constraint shown in equation (14) shows workers either produce for the home market or are engaged in the production and transport of the good to the foreign market. The first order conditions for $X_{i,i}$ and $X_{i,j}$ lead to

$$\frac{\delta M_i (X_{ic} - X_{i,i})}{X_{ic}^2} = \frac{\delta M_j (X_{jc} - X_{i,j})}{(1+\tau) X_{jc}^2}. \tag{15}$$

which is also marginal revenue per worker. Using the first order conditions, equation (4), and the fact that all countries are symmetric we get the amount that the firms supplies to their domestic market as

$$X_{i,i} = \frac{H_i (1 + \tau n (m-1))}{1 + (m-1)\left((1+\tau)^2 - n\tau^2\right)},$$

and to each foreign country as

$$X_{i,j} = \frac{H_i (1 - \tau (n-1))}{1 + (m-1)\left((1+\tau)^2 - n\tau^2\right)}.$$

Whenever transport costs are positive (and the number of Cournot firms are not less than one) firms will supply more to their home market than to the market of any other country.

Also, combining the envelope condition and the first order condition for vacancies we get

$$\frac{\delta\left(X_{ic}-X_{i,i}\right)M_i}{X_{ic}^2}+\phi P\left(X_{ic},Y_{ic}\right)\frac{\left(1-\widetilde{\lambda}\right)}{q\left(\theta_i\right)}-\mu\left(w_i^U\left(H_i\right)+H\frac{\partial w_i^U\left(H_i\right)}{\partial H_i}\right)$$
$$-\left(1-\mu\right)\left(w_i^I\left(H_i\right)+H_i\frac{\partial w_i^I\left(H_i\right)}{\partial H_i}\right)=\frac{\phi P\left(X_{ic},Y_{ic}\right)}{q\left(\theta_i\right)\beta\left(1-\eta\right)}$$

where $\frac{\delta(X_{ic}-X_{i,i})M_i}{X_{ic}^2}$ is the marginal revenue gained by hiring one extra worker. $\frac{\phi P(X_{ic},Y_{ic})}{q(\theta_i)}$ is the cost of replacing an existing worker and $\widetilde{\lambda}$ is the exogenous probability that this worker will separate from the firm. $\frac{\partial w_i^U(H_i)}{\partial H_i}$ and $\frac{\partial w_i^I(H_i)}{\partial H_i}$ are the strategic hiring effects. Due to the nature of Cournot competition, hiring one extra worker will lower the wage for all other workers. As with individual bargaining the wage is a function of marginal rather than average revenue, the strategic hiring effect is stronger when a firm faces individual bargaining. As the firm does not know whether a union will form next period the firm chooses the level of workers such that the cost of hiring workers is equal to the discounted revenue minus expect wage and expected strategic hiring effect.

It is costly for Cournot sector firms to enter the market. There is a set up cost b. The value of entering the market is

$$V\left(0\right)=\max_{v}\left\{-\phi P\left(X_{ic},Y_{ic}\right)v+\left(1-\eta\right)\beta V\left(H_i'\right)\right\}-bP\left(X_{ic},Y_{ic}\right), \qquad (16)$$

subject to the law of motion for hiring workers

$$H'=q\left(\theta_i\right)v.$$

Due to the free entry condition $V\left(0\right)=0$. From this we can get the steady state value of a firm in the X sector as

$$V\left(H_i'\right)=\frac{\phi P\left(X_{ic},Y_{ic}\right)H_i'}{q\left(\theta_i\right)\beta\left(1-\eta\right)}+\frac{bP\left(X_{ic},Y_{ic}\right)}{\beta\left(1-\eta\right)}.$$

The firm has a value due to the barrier to entry caused by labour market frictions, and also due to the cost of a production licence, b.

3.3 Wage bargaining

When bargaining wages, workers would like to maximise their surplus of being employed $W_i^k - U_i,\ k = Y, I, U$. Due to the cumbersome nature of the equations, it is useful to substitute out all the elements agents take as give during the wage bargain. These are taken as given as agents either consider themselves too small to affect these variables or can not commit to future variables. Setting $W_i^k = U_i$, and rearranging for wages, we get a variable that only includes variables taken as given by agents. ω_i^k can be defined as a reservation wage which summarises the labour market effects on the wage bargain. As wages are renegotiated each period it can be benefitial for a worker to accept a low wage this period in anticipation of bargaining a higher wage next period (though this never happens in equilibrium). Thus for the competitively traded good sector we define

$$\omega_i^Y = zP\left(X_{ic}, Y_{ic}\right) + \beta\left(\left(1 - \theta_i q(\theta_i) - \lambda\right) U_i{}' + \theta_i q(\theta_i) E\left(W_i'\right) - (1-\lambda) W_i^{Y\prime}\right), \quad (17)$$

for X sector firms with individual bargaining as

$$\omega_i^I = zP\left(X_{ic}, Y_{ic}\right) + \beta\left(\left(1 - \theta_i q(\theta_i) - \lambda\right) U_i{}' + \theta_i q(\theta_i) E\left(W_i'\right) - (1-\lambda) W_i^{X\prime}\right), \quad (18)$$

and for firms with union bargaining as

$$\begin{aligned} \omega_i^U &= zP\left(X_{ic}, Y_{ic}\right) + \beta\left(\left(1 - \theta_i q(\theta_i) - \lambda\right) U_i{}' + \theta_i q(\theta_i) E\left(W_i'\right) - (1-\lambda) W_i^{X\prime}\right) && (19) \\ &\quad + aP\left(X_{ic}, Y_{ic}\right). && (20) \end{aligned}$$

As can be seen equation (17) and equation (18) are quite similar. The reservation wage for all workers is increasing in the value of unemployment and the average wage for the economy. However it is decreasing in the value of working in the same job next period. This is due to workers being willing to accept a low wage this period in anticipation of gaining a higher wage next period. The reservation wage for unionsied workers equation (19) is identical to that of workers who bargain individually with the exception of the term for union dues, $aP\left(X_{ic}, Y_{ic}\right)$. This is as union members are interested in their wage net of union dues rather than their gross wage. As there are no frictions in joining a union unionised workers and workers who bargain their wage individually actually both receive the same wage net of union dues. From the reservation wage equations it is easy to show that

$$W_i^k - U_i = w_i^k - \omega_i^k,\ k = Y, I, U. \quad (21)$$

Using this substitution is useful, though it in no away affects the results of the model.

3.3.1 Bargaining in the competitively traded good sector

As is standard in the literature wages are negotiated through Nash bargaining. The Nash product takes the form

$$\max_{w_i^Y} \left\{ \left[W_i^Y - U_i \right]^{\gamma} \left[J_i^Y \right]^{1-\gamma} \right\},$$

where γ is the bargaining power of workers. This leads to

$$\gamma J_i^Y = (1-\gamma) \left[W_i^Y - U_i \right]. \tag{22}$$

Using equations (7), (11), and (21) we get the wage for the Y sector,

$$w_i^Y = \gamma \left(\alpha \left(\frac{R_i}{L_i^Y} \right)^{1-\alpha} + \phi P \left(X_{ic}, Y_{ic} \right) \frac{\left(1 - \tilde{\lambda} \right)}{q\left(\theta_i \right)} \right) + (1-\gamma)\, \omega_i^Y. \tag{23}$$

This is simply a weighted average of the production of the worker plus the cost of replacing the worker, and the reservation wage.

3.3.2 Bargaining in Cournot sector firms

Cournot sector firms are large, and bargaining is either conducted by a union representing the workers or wages are bargained by each worker individually. I will first outline the case of union bargaining. If negotiations break down all the workers are sacked, which combined with the free entry condition, means that the outside option for the firm is zero. The union wishes to maximise the surplus of the value of employment over unemployment for the members of the union. If negotiations break down the firm does not shut down completely (then it would lose the money it spent on a set up cost). Wages are found by maximising the Nash product

$$\max_{w_i^U} \left\{ \left[H_i \left(W_i^U - U_i \right) \right]^{\gamma} \left[V\left(H_i \right) - V\left(0 \right) \right]^{1-\gamma} \right\},$$

which leads to

$$H_i \left(1 - \gamma \right) \left[W_i^U - U_i \right] = \gamma \left(V\left(H_i \right) - V\left(0 \right) \right). \tag{24}$$

Defining $REV_i = P\left(X_{ic} \right) X_{i,i} + \sum_{\substack{j=1 \\ j \neq i}}^{m} P\left(X_{jc} \right) X_{i,j}$, and substituting in equations (12) and (21) into equation (24) we get

$$w_i^U = \gamma \left(\frac{REV_i}{H_i} + \phi P \left(X_{ic}, Y_{ic} \right) \frac{\left(1 - \tilde{\lambda} \right)}{q\left(\theta_i \right)} \right) + (1-\gamma)\, \omega_i^U. \tag{25}$$

To get the wage net of union dues, this wage equation can be rewritten as

$$w_i^U - aP\left(X_{ic}, Y_{ic}\right) = \gamma\left(\frac{REV_i}{H_i} + \phi P\left(X_{ic}, Y_{ic}\right)\frac{\left(1-\tilde{\lambda}\right)}{q\left(\theta_i\right)}\right) + \left(1-\gamma\right)\omega_i^I.$$

It is useful at this point to know that from this we get

$$\frac{\partial\, w_i^U}{\partial\, H_i} = \frac{\gamma}{H_i^2}\left[-REV_i + H_i\frac{\partial\, REV_i}{\partial\, H_i}\right], \tag{26}$$

which is used in the envelope condition for X sector firms.

Calculating wages in the case of individual bargaining is slightly more complicated. During wage bargaining the firm negotiates with the marginal worker, so the marginal value of a worker is

$$\frac{\partial V\left(H_i\right)}{\partial H_i} = \frac{\partial\, REV_i}{\partial\, H_i} + \frac{\left(1-\widetilde{\lambda}\right)}{q\left(\theta_i\right)} - \left(w_i^I\left(H_i\right) + H_i\frac{\partial w_i^I\left(H_i\right)}{\partial H_i}\right).$$

The term $\frac{\partial w_i^I(H_i)}{\partial H_i}$ appears as non-simultaneous bargaining is used (similar to Stole and Zwiebel, 1996). If bargaining breaks down and the worker separates from the firm, then the wage is renegotiated with all the other workers. This term does not appear in the case of union bargaining as if negotiations break down all the workers separate from the firm, and there are no workers left with which to renegotiate wages with.

The Nash product for individual bargaining is

$$\max_{w_i^I}\left\{\left[W_i^I - U_i\right]^{\gamma}\left[\frac{\partial V\left(H_i\right)}{\partial H_i}\right]^{1-\gamma}\right\},$$

which leads to

$$w_i^I\left(H_i\right) = \gamma\left(-H_i\frac{\partial w^I\left(H_i\right)}{\partial H_i} + \frac{\partial\, REV_i}{\partial\, H_i} + \phi P\left(X_{ic}, Y_{ic}\right)\frac{\left(1-\tilde{\lambda}\right)}{q\left(\theta_i\right)}\right) + \left(1-\gamma\right)\omega_i^I.$$

This wage is a weighted average of the net benefit of the match and the reservation wage. The net benefit of the match is the strategic effect of having an extra worker when negotiating wages with the other workers at the firm, the marginal revenue of

the worker, and the cost of replacing the worker. Solving this differential equation and substitution for $\frac{\partial\ REV_i}{\partial\ H_i}$ we get

$$w_i^I\left(H_i\right) = H_i^{-\frac{1}{\gamma}} \int H_i^{\frac{1-\gamma}{\gamma}} \frac{\delta M_i\left(X_{ic} - X_{i,i}\right)}{X_{ic}^2} dH_i + \gamma\phi P\left(X_{ic}, Y_{ic}\right) \frac{\left(1-\tilde{\lambda}\right)}{q\left(\theta_i\right)} + \left(1-\gamma\right)\omega_i^I.$$

When we integrate we must remember that H_i has an affect on X_{ic}. We can rewrite X_{ic} as $X_{ic} = \left(X_{ic} - X_{i,i}\right) + X_{i,i}$. Due to the assumptions of Cournot competition, the firm takes $\left(X_{ic} - X_{i,i}\right)$ as given. Using this, equation (14), equation (15) and the fact that countries are symmetrical, we can write

$$w^I\left(H\right) = H_i^{-\frac{1}{\gamma}} \int \frac{H_i^{\frac{1-\gamma}{\gamma}} \delta M_i\left(X_{ic} - X_{i,i}\right)}{\left(X_{ic} - X_{i,i} + \frac{H_i - (1+\tau)(m-1)(X_{ic} - X_{i,i} - (X_{jc} - X_{i,j}))}{1+(1+\tau)(m-1)}\right)^2} dH_i$$
$$+ \gamma\phi P\left(X_{ic}, Y_{ic}\right) \frac{\left(1-\tilde{\lambda}\right)}{q\left(\theta_i\right)} + \left(1-\gamma\right)\omega_i^I.$$

It is also useful to show $\frac{\partial w_i^I(H_i)}{\partial H_i} = -\frac{H_i^{-\frac{(1+\gamma)}{\gamma}}}{\gamma} \int \frac{H_i^{\frac{1-\gamma}{\gamma}} \delta M_i(X_{ic} - X_{i,i})}{\left(X_{ic} - X_{i,i} + \frac{H_i - (1+\tau)(m-1)\left(X_{ic} - X_{i,i} - \left(X_{jc} - X_{i,j}\right)\right)}{1+(1+\tau)(m-1)}\right)^2} dH_i +$ $\frac{\delta M_i(X_{ic} - X_{i,i})}{HcX_{ic}^2}$.

3.4 Equilibrium

In this section the equilibrium is outlined. The model is solved for the steady state. It should be noted that the model must be solved numerically. In the steady state the number of workers working for each type of firm is constant. As the probability that a worker will lose a job is λ, each period $\lambda\left(nH_i + L_i^Y\right)$ jobs must be replaced. As the probability that a firm will fill a vacancy this period is $q\left(\theta_i\right)$ we get the total number of vacancies posted this period as

$$v_i = \frac{\lambda\left(nH_i + L_i^Y\right)}{q\left(\theta_i\right)}. \tag{27}$$

As $nH_i + L_i^Y$ is simply employment, the level of unemployment is given by

$$u_i = L_i - \left(nH_i + L_i^Y\right) \tag{28}$$

Rearranging equation (27) and then inserting this and equation (28) into equation (2) we get

$$\theta_i = \left(\frac{\lambda\left(L_i^Y + nH_i\right)}{s\left(L_i - \left(L_i^Y + nH_i\right)\right)}\right)^{\frac{1}{(1-\rho)}}. \tag{29}$$

Using equations (1), (28), and (29) we can write

$$v_i = \theta_i \left(L_i - \left(nH_i + L_i^Y \right) \right).$$

National income is given by

$$M_i = R_i^{1-\alpha} \left(L_i^Y \right)^{\alpha} + nREV_i, \tag{30}$$

which is the sum of the competitively traded good produced, and the total output of the Cournot sector firms in country i. It is assumed that the costs of posting a vacancy are part of the national income of the country where the firm is located, so there is no need to subtract this from these firms' revenues in order to calculate national income.

4 Results

Due to the heterogeneity of nations in trade blocs a calibration of the model is not appropriate. Instead a simulation was undertaken, targeting some key variables of the European economies. A table of the parameters used is given in Table 1. The wages in the model are presented in terms of the competitively traded good. It must be remembered however that the price of the Cournot good may vary. In order to make a valid comparison of wages all nominal values have been divided by the price index $P(X_{ic}, Y_{ic})$. Figure 3 helps to summarise the results of the model.

Table 1: Parameter values

L	R	α	β	γ	δ	η	$\tilde{\lambda}$	ρ	ϕ	s	z	a	b
$1,000,000$	$4,500,000$	0.5	$\frac{10000}{10033}$	.5	0.5	.008	.01	.5	.25	.18	0.3	0.15	$2,500,000$

Comparing Figure 3 to Figure 1 shows how increasing the number of countries in a trade bloc can first increase union density and then it decreases as competition intensifies. It should be noted however that the X axis in Figure 1 shows years, while the X axis in Figure 3 shows the number of countries in the trade bloc. For $\tau = .24$, with the number of countries in a trade bloc being two or three, all workers in the Cournot sector are unionised. A mixed strategy Nash equilibrium was found for the other solutions. For $\tau = .26$, with the number of countries in a trade bloc between two and five, all workers in the Cournot sector are unionised, and for $\tau = .30$, with the number of countries in a trade bloc between two and ten, all workers in the Cournot sector are unionised. As can be seen, when a country moves from autarky to trading with one other country there is an initial jump in union density. This is due to workers moving from producing the Cournot

good to transporting the Cournot good. Due to rent chasing by Cournot firms the output of the Cournot good actually decreases as workers are diverted to transportation. This causes the difference between average revenue and marginal revenue to increase, leading to an increase in unionisation. In this model trade union density will never reach 100 per cent as there is never an incentive for workers in the one worker per firm competitively traded good sector to join a union. As the number of countries in the trade bloc increases the increase in competition leads to a fall in the difference between average revenue and marginal revenue for Cournot firms. This causes a decrease in union density. As the number of countries goes to infinity the marginal effect of an increase in the size of the trade bloc on union density goes to zero. Transport costs have an effect on union density. It would be expected that higher transport costs protect firms from international competition, which leads to higher union density, and this has been found to be the case. The continuing increase in density after moving from autarky to more countries in the trade bloc is due to increased employment by Cournot firms of both transport and production workers.

As can be seen from Figure 4 the wage premium has remained largely stable, though it has decreased slightly. The value of the wage premium is within the range of estimates in the literature. The value of the wage premium is determined largely by the cost of union membership, a. The decrease is due to the differing fortunes of firms in the Cournot sector and competitively traded good sector. Though the difference between union wages and non-union wages in the Cournot sector is constant, the increase in competition affects the Cournot sector more than the competitively traded good sector. This leads to a small relative improvement to wages in the competitively traded good sector, and it is this which causes the small decline in the union wage premium.

The model also explains why the direction of union wages need not be linked to the direction of union density. Comparing Figure 5 with Figure 3 and Figure 4 shows how the union real wage can move in the opposite direction to union density and the union wage premium. When there is a low number of countries in the trade bloc the real wage falls. This is as workers are being diverted to transporting the Cournot good rather than producing the Cournot good, causing the price to rise. This lowers the real wage. As more countries join the trade bloc the effect of greater competition dominates over the effect of diverting workers to transporting the good. The real wage is increasing due to a decline in markups in the Cournot sector as competition causes the average revenue and marginal revenue of firms to converge. However this same convergence of average and marginal revenue is what causes the decline in trade union density.

As can be seen from Figure 6 the model also partially replicates the rise and

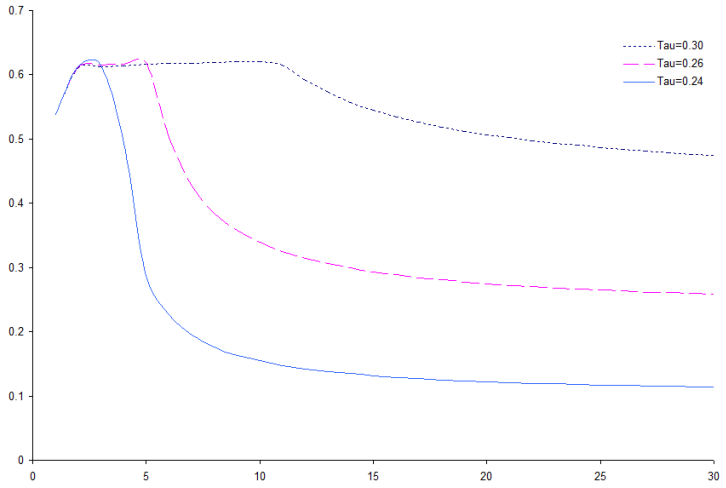

Figure 3: Results: Trade union density for an increasing size of trade bloc.

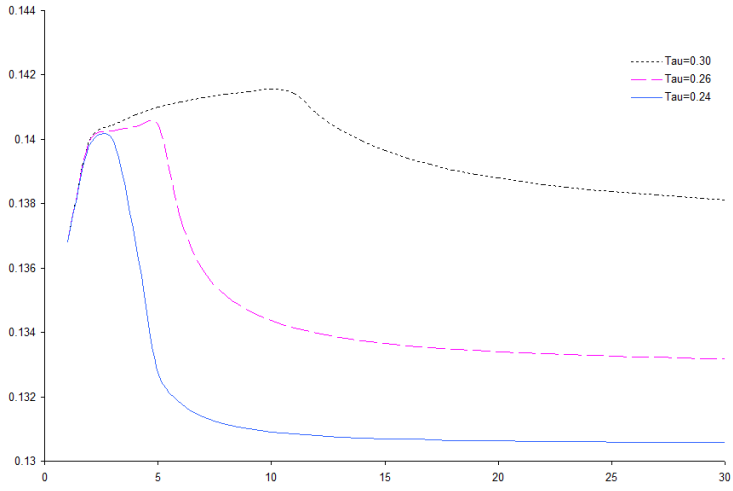

Figure 4: Results: Trade union premium for an increasing size of trade bloc

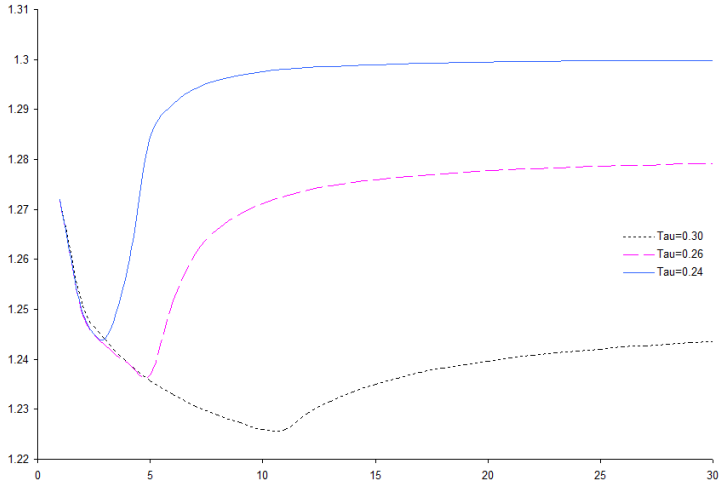

Figure 5: Results: Real wage of trade union members for an increasing size of trade bloc.

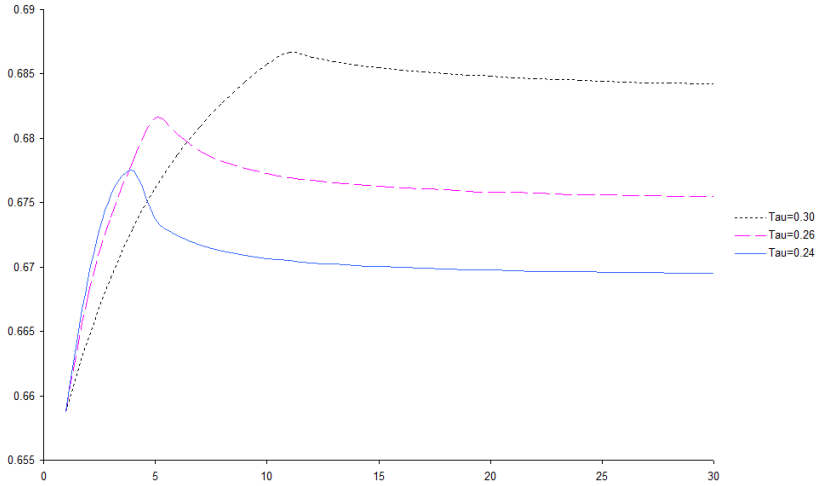

Figure 6: Results: Labour share of income for an increasing size of trade bloc.

fall of the labour share of income as seen in the data (European Communities, 2007). This rise and decline coincides with the movements in trade union density. Also, diverting workers from the competitively traded sector increases the resource labour ratio, which serves to lower the share of income that goes to the owner of the resource. Though the model matches the data qualitatively it can account only partially for the decrease in the labour share of income. This is only to be expected from the model that does not include capital as a factor of production. Finally, the simulated results for unemployment are shown in Figure 7. It is found that increasing international openness leads to an decrease in unemployment. This is partially due to employers being willing to employ more workers if there is a smaller probability of workers forming a union. This model does not capture the unemployment dynamics of the European economics. This is due to the model being solved for the steady state. Any unemployment caused by the economy moving from one steady state to another is not captured.

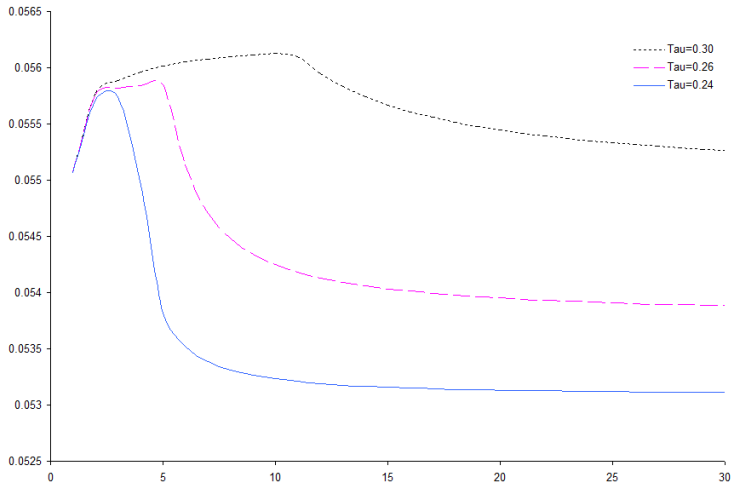

Figure 7: Results: Unemployment rate for an increasing size of trade bloc.

5 Conclusion

Given the international decline in trade union density, it is possible that the cause of the decline is increasing internationalisation. In this paper, international product market competition is put forward as a cause for the decrease in union density. This is as the narrowing of the difference between average revenue and marginal revenue which is caused by increased competition reduces the advantage of being a trade union member, as trade union wages are a function of average revenue. It

is found that increasing the number of countries in a trade bloc initially increases but then decreases the level of trade union density. This initial increase is caused by rent seeking firms transferring workers to transporting rather than producing the good, causing an initial fall in production, and therefore competition, of the good. It is also found that movements in the union wage can be in the opposite direction to trade union density and the trade union wage premium.

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