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Open Shop Unions and International Trade Liberalisation

by

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Abstract

This paper extends the international oligopoly model to the situation of bargaining with an open shop union. Within this setting, we are able to investigate the implications of different levels of union density for both the equilibrium trade regime and wages. We then use this model to examine the response of wages to product market integration in the presence of different levels of union density. We find that, with intermediate levels of union density, wages need neither to fall monotonically as trade liberalisation occurs, nor indeed to fall in absolute terms as an economy moves from autarky to free trade.

JEL classification: F15, J5, L13

Keywords: Bargaining, open shop unions, trade liberalisation

Outline

Non-Technical Summary

In spite of its potential benefits to consumers across the globe, the liberalisation of international trade is still viewed with apprehension by many. In developed countries, policy concerns are particularly focused on the interaction between international trade and labour markets. In this context, the role played by labour market institutions such as trade unions is central. Labour unions often blame trade liberalisation for the deterioration of both the wage and the employment prospects of their members. Conversely, firms frequently point to trade unions as a major obstacle to their international competitiveness.

Initial theoretical analyses appeared to bear out the concerns of organised labour. Huizinga (1993) and Sørensen (1993) both showed, within a symmetric unionised duopoly setting, that the wage level is lower under free trade than under autarky. Naylor (1998, 1999) argues, however, that the conclusion that trade liberalisation leads to wage reductions is a special, rather than a general, case and results from a comparison of polar ends of the possible range of trade regimes. Modelling the process of integration as a *marginal* reduction in trade costs, Naylor arrives at the striking conclusion that, within a context of two-way trade, liberalisation leads monopoly unions to set higher wages. Note however that, wages under free trade are always lower than those under autarky.

A common feature of the existing literature is that bargaining is eschewed in favour of the monopoly union model. The papers also embody the implicit assumption that the union is a 'closed shop', with 100% level of membership. Thus, in the event of a strike, the firm is unable to continue production. In reality 'open shop' arrangements, where the union is recognised for bargaining purposes but membership is not compulsory, are the dominant form of union organisation in the OECD. Although the implications of intermediate levels of union density for labour market outcomes have been examined in a closed economy context (Naylor and Cripps (1993), Naylor and Rauum (1993) and Barth et al. (2000)) the existing literature lacks an international dimension.

The current paper seeks to extend the existing international oligopoly model by applying the open shop assumption to an open economy context. The incorporation of intermediate forms of union density has several consequences for the model developed. Firstly, the fall back position of firms is no longer zero in the event of a strike, as firms may continue to operate with the non-union workers that they employ. This will impact on wage outcomes. Thus, this extension is more naturally handled within a bargaining framework. Secondly, since the firm continues to operate in the event of a strike, the possibility exists that trade will impact on the wage outcome via this route, even if no trade exists in equilibrium. This serves to generate additional trade regimes and a richer range of wage profiles than are present under monopoly union models. In particular, we find that, with intermediate levels of union density, wages need neither to fall monotonically as trade liberalisation occurs, nor indeed to fall in absolute terms as an economy moves from autarky to free trade.

1 Introduction

With the proliferation of international economic arrangements associated with NAFTA, EU and the WTO, restrictions to international trade have been progressively removed and economies have become more closely integrated. In spite of its potential benefits to consumers across the globe, the liberalisation of international trade is still viewed with apprehension by many. In developed countries, policy concerns are particularly focused on the interaction between international trade and labour markets. In this context, the role played by labour market institutions such as trade unions is central. Labour unions often blame trade liberalisation for the deterioration of both the wage and the employment prospects of their members. Conversely, firms frequently point to trade unions as a major obstacle to their international competitiveness.

Initial theoretical analyses appeared to bear out the concerns of organised labour. Huizinga (1993) and Sørensen (1993) both showed, within a unionised duopoly setting, that the wage level is lower under free trade than under autarky. This is because, although market expansion as a result of trade liberalisation causes wages to rise, this is more than offset by the increased product market competition which serves to moderate wages.

Naylor (1998, 1999) argues however that the conclusion that trade liberalisation leads to wage reductions is a special, rather than a general, case and results from a comparison of polar ends of the possible range of trade regimes. To show this, Naylor (1998) adopts a model of international oligopoly in which a monopoly union sets the wage in each country with the firms subsequently having the right to manage with regard to the setting of employment. He then considers the process of integration as a *marginal* reduction in trade costs. In the context of symmetrical countries, he argues that the movement from autarky to two-way trade is triggered when the unions in the two countries find it optimal to abandon their previous high wage strategies, and instead lower their wage demands in order to allow their firms to compete internationally. This causes a discontinuity in the wage level, as union demands are adjusted downwards. However the union gains from the rapid expansion in employment that results. As trade costs are reduced further, Naylor (1998) arrives at the striking conclusion that, within a context of two-way trade, liberalisation induces greater employment levels which leads the monopoly unions to set higher wages. In two-way trade, the market expansion effect dominates the market discipline effect. Note however that wages under free trade are always lower than those under autarky. The wage fall, as the union discretely moves from a high wage strategy to a low wage strategy, outweighs any subsequent expansion in wages.

Various extensions of Naylor's results have been made. Munch and Skaksen (2002) distinguish between fixed and variable trade costs when both labour markets are unionised. They conclude that while a fall in fixed trade costs leads to an unambiguous fall in wages, the implication of a reduction in variable costs is ambiguous.

Piperakis et al. (2003), unlike Naylor (1998), allow for asymmetry between the countries. They show that if the market size of the two countries differs widely, a reduction in trade costs can lead to decreases in wages, employment and welfare in the country with the larger market. This is because the larger economy has less to gain, relatively speaking, from the market expansion effect.

The paper of Lommerud et al. (2003) also has asymmetrical countries. Indeed, they assume that one country is unionised whilst the other one is not.[1] Although this model generates qualitatively similar results to Naylor (1998) for two-way trade, a much wider range of trade regimes is possible. Under autarky, all trade is prevented by the level of trade costs, and wages are set in isolation in each country. However, as trade costs fall, the ability of organised labour to obtain higher wages in the unionised country will be limited by the possibility that firms from the low wage (non-unionised country) will begin to export. This leads to what Lommerud et al. (2003) call the *import deterrence* regime. If liberalisation continues, eventually trade costs will fall to such an extent that trade begins and the foreign firm starts to export. One-way trade continues until trade costs fall to a level such that the unions find it in their best interests to adopt a low wage strategy in order to induce the domestic firm to export as well. Hence, as in Naylor, there is a discontinuity as two-way trade begins, and wages fall discretely. However, as trade costs fall further market expansion causes wages to rise. As with the preceding papers, wages are shown to be higher in autarky compared with free trade (or indeed one-way) trade.[2]

Within this framework Lommerud et al. (2003) then examine how wage setting impacts on the location decisions of multinational firms. They argue that if the firm has plants located in both countries then this would serve to simplify the wage schedules, since the union no longer gains by adopting a low wage strategy in order to induce its plant to export. Thus

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[1] Brander and Spencer (1988) develop a model in which a unionised domestic firm competes against a foreign firm that operates in a perfectly competitive labour market, with the home country wage being the outcome of a Nash bargain between the union and the firm. Tariff protection permits the union to bargain higher wages.

[2] In Naylor (1998) the market expansion effect is stronger as the wages of the unions in each country are strategic complements.

wages fall continuously from autarky to free trade. More generally, the option of locating abroad serves to weaken the position of the union.

A common feature of the literature reviewed above is that bargaining is eschewed in favour of the monopoly union model. The papers also embody the implicit assumption that the union is a 'closed shop' trade union with 100% level of membership. Thus, in the event of a strike, the firm is unable to continue production. In reality 'open shop' arrangements, where the union is recognised for bargaining purposes but membership is not compulsory, are the dominant form of union organisation in the OECD (see, for example, Gregg and Naylor (1993), Metcalf (2003), Visser (2003)). Although the implications of intermediate levels of union density for labour market outcomes have been examined in a closed economy context (Naylor and Cripps (1993), Naylor and Rauum (1993) and Barth et al. (2000)) the existing literature lacks an international dimension.

The current paper seeks to extend the existing international oligopoly model by applying the open shop assumption to an open economy context. We adopt a model in which wages are explicitly the outcome of a union-firm bargain.[3] Within this setting, we are then able to investigate the implications of different levels of union density for both the equilibrium trade regime and wages. We then use this model to examine the response of wages to product market integration in the presence of different levels of union density. This generates a wider set of trade regimes than is present in Naylor (1998) and Lommerud et al. (2003) and a richer response of wages to trade liberalisation. Indeed, within the framework developed, wage levels may be higher under free trade than under autarky.

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[3] The monopoly union is often used as a 'suitable simplification' in the case of a closed shop union. In the context of an open shop union we prefer a bargaining approach (see Naylor and Cripps (1993), pp. 1612).

The remainder of the paper is organised as follows. Section 2 presents the basic model set-up and model solution. Section 3 then analyses the impact of reductions in trade costs on wages, for different levels of union density. Section 4 extends the model to situations in which a minimum level of membership is necessary before the union impacts on wages. Section 5 concludes.

2 The Theoretical Model

2.1 Basic Setup

We assume that there are two countries, domestic and foreign, denoted, respectively, by (i, j). In each country one firm operates, producing a homogeneous commodity. We assume the sector of interest is small relative to the rest of the economy.

Output is produced in a constant returns to scale process, with labour as the only input and one unit of labour being required to produce one unit of final product. We further assume that inverse demand functions in the two countries are symmetric and given by:

$$p_i = a - b(x_{ii} + x_{ji}) \qquad (1)$$

$$p_j = a - b(x_{jj} + x_{ij}). \qquad (2)$$

Where, $a, b > 0$, p_i is the price in the home country, p_j is the price in the foreign country and x_{ii} and x_{ij} denote, respectively, the sales of the firm located in country i to markets i and j.

We assume that each producer views each country as a separate market and that there is a constant trade cost of t per unit of commodity exported. Competition in the two markets is characterised as Cournot.

In terms of the labour market, we assume that there is a single union that represents the workers of the domestic sector. However, an open shop exists, and union density (μ) can vary between 0 and 1.

In the foreign country, the labour market is assumed to be perfectly competitive, and wages are set at their market clearing level $\left(w_j = w_j^C\right)$. For simplicity we assume that the competitive wage is equal in the two countries $\left(w_i^C = w_j^C = w^C\right)$, and furthermore that $w^C = 0$.[4]

We consider a dynamic setting, modelled as a sequence of contract periods. In each contract period, the model can be described as a two-stage game. In Stage 1 the domestic firm and the union bargain over wages through a decentralised Nash bargaining process, for a given level of union density. In Stage 2, the domestic and foreign producers decide on their level of production, and hence employment, taking as given the wage of the other firm and taking into consideration their firm's labour demand schedule.

In order to solve the model analytically, we proceed by backwards induction. We begin by examining Stage 2 and examining the optimal production decisions of the firms. Once these are known we can examine Stage 1, and solve for the steady-state wage level that results from the wage bargain.

[4] Section 4 below is devoted to analysing the case of $w^C > 0$.

2.2 Solving for Production

Given the assumptions of the model, the profit functions of the producers located in countries i and j are given by:

$$\pi_i = [a - b(x_{ii} + x_{ji}) - w_i]x_{ii} + [a - b(x_{jj} + x_{ij}) - w_i - t]x_{ij} \tag{3}$$

$$\pi_j = [a - b(x_{jj} + x_{ij})]x_{jj} + [a - b(x_{ii} + x_{ji}) - t]x_{ji}\,. \tag{4}$$

We adopt the right-to-manage assumption and assume that the firm is allowed to set employment to maximise profits given the bargained wage.[5] Solving the first order conditions for profit maximisation yields:

$$x_{ii} = \frac{a - w_i}{2b} - \frac{1}{2}x_{ji} \tag{5}$$

$$x_{ij} = \frac{a - w_i - t}{2b} - \frac{1}{2}x_{jj} \tag{6}$$

$$x_{ji} = \frac{a - t}{2b} - \frac{1}{2}x_{ii} \tag{7}$$

$$x_{jj} = \frac{a}{2b} - \frac{1}{2}x_{ij}\,. \tag{8}$$

In order to obtain the equilibrium levels of output for each firm in each market, we can solve (5)–(8). Given the constraint that all production quantities have to be non-negative, this yields the following solutions for equilibrium sales:

$$x_{ii}, x_{ji} = \begin{cases} (1/3b)(a - 2w_i + t),\ (1/3b)(a + w_i - 2t) & \text{if} \quad t < (1/2)(a + w_i) \\ (1/2b)(a - w_i),0 & \text{if} \quad t \geq (1/2)(a + w_i) \end{cases} \tag{9}$$

$$x_{jj}, x_{ij} = \begin{cases} (1/2b)a\,,0 & \text{if} \quad t \geq (1/2)a - w_i \\ (1/3b)(a + t + w_i),(1/3b)(a - 2t - 2w_i) & \text{if} \quad t < (1/2)a - w_i \end{cases}. \tag{10}$$

[5] This assumption is also made in Naylor and Cripps (1993), Naylor and Raaum (1993) and Barth et al. (2000).

2.3 Solving the wage bargain

We assume that the domestic firm is unionised and pays all of its workers, whether they are members of the union or not, the same bargained wage, $w_i = w^B$, which must be non-negative.[6] The wage paid in each contract period is modelled as the outcome of a Nash bargain between the union and the firm:

$$w^B = \arg\max_{w_i} \left[\left(u_i - u_i^s \right) \left(\pi_i - \pi_i^s \right) \right]. \tag{11}$$

Here, u_i is the utility level of the union, u_i^s is the disagreement payoff of the union and π_i^s is disagreement payoff of the firm. For simplicity we assume that the objective of the union is to maximise wages[7], and so by implication, u_i^s is the wage in event of a strike. The strike pay is assumed to be exogenous, and it is set equal to zero without further loss of generality.[8] Hence:

$$w^B = \arg\max_{w_i} \left[w_i \left(\pi_i - \pi_i^s \right) \right]. \tag{12}$$

Within this framework, we assume that the level of union membership has an impact on the outcome of the bargain via its impact on π_i^s, by determining the number of workers

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[6] Thus we are assuming that the union wage effect is a pure public good. For empirical evidence supporting this assumption see Barth et al. (2000). Using matched employer-employee data for Norway, these authors found evidence that when controlling for the level of union density in the establishment, the individual membership status ceases to have any significant effect on the wage.

[7] This might also be justified in situations in which the representative union member is protected against redundancy by a seniority rule or insulated from layoffs by a sufficiently high turnover (see Oswald, 1985).

[8] While the *absolute* size of the strike pay does not matter for any of the main results, some results derived in the following depend on the fact that by setting to zero both outside options open to the worker (the strike pay and the competitive wage), we have assumed them to be equal. We will relax this assumption in section 4 below.

that the firm is able to employ in the event of disagreement with the union. The essential mechanism of this modelling approach is that greater union membership increases the effectiveness of industrial action. Higher union density means that more workers are likely to take part in actions that reduce the firm's payoff during a disagreement.[9]

As in Naylor and Cripps (1993) and Naylor and Raaum (1993), we assume that in the event of a strike the firm is able to employ only the fraction of its workers who are not union members, under the terms of the contract negotiated in the previous period. Hence, the domestic firm's total sales under a strike are equal to the production that the firm is able to realise with the non union workers, at the wage rate negotiated in the previous contract period ($\overline{w_i}$). Therefore, when the domestic firm only supplies the home market, its sales under a strike are given by:

$$x_{ii}^s = (1-\mu)\overline{x_{ii}}, \tag{13}$$

where μ is union density, and $\overline{x_{ii}}$ is the level of employment of the domestic firm in the previous contract period (that is, the domestic firm's profit maximising level of employment at the wage rate $\overline{w_i}$). When the domestic firm sells in both home and foreign markets, a strike would impose the following constraint on its total sales:

$$x_{ii}^s + x_{ij}^s = (1-\mu)\left(\overline{x_{ii}} + \overline{x_{ij}}\right), \tag{14}$$

where $\overline{x_{ij}}$ is the predetermined level of employment used to produce goods for the foreign market. As in Naylor and Cripps (1993) and Naylor and Raaum (1993), we make the

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[9] In previous international trade models with unionised labour, wages are either settled by a monopoly union (see, for example, Naylor (1998, 1999), Munch and Skaksen (2002), Piperakis et al. (2003) and Lommerud et al. (2003)) or through a Nash bargain between the union and the firm, under the assumption that the firm's disagreement payoff is equal to zero (see, for example, Brander and Spencer (1988)).

assumption that the firm is myopic and neglects the impact of its current employment decisions on future wage negotiations.

Since the firm's level of profit is given by (3), π_i^s is given by:

$$\pi_i^s = \left[a - b\left(x_{ii}^s + x_{ji}^{\ s}\right) - \overline{w_i}\right]x_{ii}^s + \left[a - b\left(x_{jj}^{\ s} + x_{ij}^s\right) - \overline{w_i} - t\right]x_{ij}^s, \qquad (15)$$

where $\left(x_{ii}^{\ s}, x_{ij}^{\ s}, x_{jj}^{\ s}, x_{ji}^{\ s}\right)$ denote the sales of each firm to each market during a strike in country i, and $\overline{w_i}$ represents the predetermined level of wages.

The following three sub-sections present the outcome of the wage bargain described in (12) for each possible trade regime. These results will in turn enable us to express the boundaries between each of the trade regimes, which in their general form given in (9) and (10) involve the endogenous wage rate, in terms of the model parameters.

a. Nash bargaining with no international trade in equilibrium

In the absence of international trade, the domestic firm's agreement profits are given by (3) with $x_{ij} = x_{ji} = 0$. When looking at the disagreement profits, we have to distinguish between the case where a strike would induce the foreign firm to start exporting and the case where this would not happen.

From (9) and (13), the domestic firm's production in the event of a strike is given by $x_{ii}^s = (1-\mu)\left(a - \overline{w_i}\right)/2b$, and substituting this result into the reaction function (7) yields:

$$x_{ji}^s = \frac{a(1+\mu) + \overline{w_i}(1-\mu) - 2t}{4b}. \qquad (16)$$

This gives firm j's exports in the event of a strike in country i, conditional upon them being positive. Straightforward rearranging shows that we have $x_{ij}^s \geq 0$ if

$$t \leq \frac{a(1+\mu)+\overline{w_i}(1-\mu)}{2}. \qquad (17)$$

Hence, (17) gives the threshold level of trade costs below which it is profitable for the foreign firm to start exporting during the conflict, thereby exploiting the reduction in domestic firm's supply occasioned by the strike.

For t below this threshold, disagreement profits are given by (15) with $x_{ij}^s = 0$ and x_{ji}^s given by (16). We label this the *import threat* case. Even though there is no trade in equilibrium, the possibility of trade impacts on the outcome of the bargain via the firm's disagreement payoff. For t above the threshold given by (17), disagreement payoffs are given by (15) with $x_{ij}^s = x_{ji}^s = 0$. We label this the *true autarky* situation, as high trade costs preclude any impact of the foreign firm on the domestic firm's conflict payoff, and therefore on the outcome of the Nash bargain.

We can now proceed to analyse the wage bargaining outcome. We start with the *true autarky* situation. After substituting and simplifying, the Nash bargaining problem can be written as

$$w_{autarky}^B = \arg\max_{w_i} \left[w_i \left(\frac{a^2\mu^2 + \overline{w_i}(\mu^2-1) + w_i^2 - 2a\left(\overline{w_i}(\mu^2-1)+w_i\right)}{4b} \right) \right],$$

and the outcome satisfies the first order condition

$$\frac{a^2\mu^2 + \overline{w_i}^2\left(\mu^2-1\right) + 3w_i^2 - 2a\left(\overline{w_i}\left(\mu^2-1\right)+2w_i\right)}{4b} = 0,$$

which implies, in steady state when $w_i = \overline{w_i}$, that

$$w_{autarky}^B = \frac{a\mu^2}{\mu^2+2}. \qquad (18)$$

Consider now the *import threat* case. Solving as above, we find the steady-state bargained wage:

$$w^{B}_{import\ threat} = \frac{a\left(1+\mu^{2}\right)-2t\left(1-\mu\right)}{\mu\left(\mu+2\right)+3}. \tag{19}$$

Note at this juncture that the threat of imports only impacts on wages for levels of union density less than unity. When union membership is full, the domestic firm's strike profits are not affected by a potential expansion of foreign production since the domestic firm is forced to shut down in the event of a strike. Substituting either (18) or (19) into (17) gives the threshold level of transport cost that separates the *true autarky* and the *import threat* case as a function of the model parameters:

$$t^{(1)} = \frac{\mu\left(\mu+1\right)+1}{\mu^{2}+2}a. \tag{20}$$

At the opposite end of the *import threat* regime, the lowest level of trade cost at which the foreign firm would not export in equilibrium, given the wage level in (19), are found by substituting $w^{B}_{import\ threat}$ into the boundary condition $t = \left(1/2\right)\left(w_i + a\right)$. This gives:

$$t^{(2)} = \frac{\mu\left(\mu+1\right)+2}{\mu\left(\mu+1\right)+4}a. \tag{21}$$

b. Nash bargaining under one-way trade

Consider now the case of one-way trade in which the domestic firm produces for its own market and the foreign firm sells to both home and foreign markets. From (9) and (13), firm *i*'s sales to its home market in the event of a strike are given by $x_{ii}^{s} = \left(1-\mu\right)\left(a-2\overline{w_i}+t\right)/3b$. In contrast to the no-trade equilibria considered previously, a strike under one-way trade would always induce a reaction by the foreign firm since the exports of the foreign firm are negatively related to the sales of the domestic firm.

After substituting x_{ii}^{s} in (7) and simplifying, firm *j*'s exports in the event of a strike in country *i* are given by:

$$x_{ji}^{s} = \frac{a(\mu+2) + 2\overline{w_i}(1-\mu) - t(4-\mu)}{6b}. \quad (22)$$

Solving the Nash bargaining problem, we find the steady-state bargained wage under one-way trade is:

$$w_{one-way}^{B} = \frac{(a+t)(\mu+1)\mu}{2\mu(\mu+1)+8}. \quad (23)$$

We can find the level of trade cost below which there are exports by the foreign firm to the domestic market in equilibrium by substituting (23) into the boundary condition $t = (1/2)(w_i + a)$, yielding:

$$t^{(3)} = \frac{3\mu(\mu+1)+8}{3\mu(\mu+1)+16}a. \quad (24)$$

Comparing $t^{(3)}$ and $t^{(2)}$, it is straightforward to show that the former is strictly smaller than the latter for positive levels of union membership. Hence, for trade cost levels between these two boundaries wages are set according to

$$w^{D} = 2t - a, \quad (25)$$

thereby preventing imports in equilibrium. Following Lommerud et al. (2003), we call this the *import deterrence* regime.

On the other hand, the boundary between the one-way trade regime and the two-way trade regime is found by substituting (23) into $t = (1/2)a - w_i$. This gives:

$$t^{(4)} = \frac{4}{3\mu(\mu+1)+8}a. \quad (26)$$

c. *Nash bargaining with two-way trade in equilibrium*

Under two-way trade, both the domestic firm's home sales (x_{ii}^s) and exports (x_{ij}^s) are affected in the event of a strike. This implies that the foreign firm's sales in both its home and overseas market are affected likewise.

Given the assumptions of the model, the total sales of the domestic firm in the event of a strike are equal to the total output that the firm would be able to realise with the non-striking workers, at the predetermined wage rate $\overline{w_i}$:

$$x_{ii}^s + x_{ij}^s = (1-\mu)(\overline{x_{ii}} + \overline{x_{ij}}) = (1-\mu)\frac{2a - 4\overline{w_i} - t}{3b}. \qquad (27)$$

Taking this constraint into account, the domestic firm allocates output across markets in a profit maximising way. Using (27), (15), (7) and (8), we find

$$x_{ii}^s = (1-\mu)\frac{a - 2\overline{w_i} + t\dfrac{\mu+2}{2(1-\mu)}}{3b} \qquad (28)$$

and

$$x_{ij}^s = (1-\mu)\frac{a - 2\overline{w_i} - 2t\dfrac{4-\mu}{4(1-\mu)}}{3b}, \qquad (29)$$

showing, by comparison with (9) and (10), that in the event of a strike the home firm would cut exports more than proportionally and domestic sales less than proportionally. The threshold level of trade costs below which x_{ij}^s is strictly positive is given by:

$$t = \frac{2(1-\mu)(a - 2\overline{w_i})}{4-\mu}. \qquad (30)$$

For trade costs above this level, all the production of the non-striking workers would be used to supply the home market, giving

$$x_{ii}^s = (1-\mu)\frac{2a - 4\overline{w_i} - t}{3b}, \qquad (31)$$

and $x_{ij}^{s} = 0$. Therefore, starting from an initial situation of two-way trade, a strike would lead the domestic firm to stop exporting. We label this the *two-way/ full export withdraw* situation. In this case, we find the export level of the foreign firm as

$$x_{ji}^{s} = \frac{a(2\mu+1)+4\overline{w}_i(1-\mu)-t(\mu+2)}{6b}, \tag{32}$$

and after substituting and solving in analogy to the procedure laid out earlier we find the steady state bargained wage as:

$$w_{two-way/few}^{B} = \frac{4a(\mu(2\mu-1)+3)-t(\mu(4\mu-11)+15)-\sqrt{64a^2-16at(9\mu-5)-t^2(\mu(63\mu+18)+335)}}{8(\mu(2\mu-1)+5)}. \tag{33}$$

It is easily checked that substituting (33) into $t=(1/2)a-w_i$ yields $t^{(4)}$ as given in (26). On the other hand, substituting (33) into (30) gives the threshold level of trade cost as a function of the model parameters. We get:

$$t^{(5)} = \frac{8(1-\mu)}{\mu(3\mu-1)+16}a, \tag{34}$$

which is strictly smaller than $t^{(4)}$ for $0<\mu\leq 1$. Hence, for each positive level of unionisation there exists a range of trade costs that would lead the home firm to stop exporting in the case of a strike.

For trade costs below $t^{(5)}$, the home firm would export even in the event of a strike. We label this the *two-way/partial export withdraw* situation, as a strike would lead the domestic firm to cut exports more than proportionally (29) and domestic sales less than proportionally (28). In this scenario, the foreign firm's sales to its two markets would be given by

$$x_{ji}^{s} = \frac{2a(2+\mu)+4\overline{w}_i(1-\mu)-t(\mu+8)}{12b} \tag{35}$$

and

$$x_{jj}^{s} = \frac{2a(2+\mu) + 4\overline{w_i}(1-\mu) + t(4-\mu)}{12b}, \qquad (36)$$

respectively. This implies a steady-state bargained wage of

$$w_{two-way/pew}^{B} = \frac{(2a-t)\mu(\mu+1)}{4(\mu(\mu+1)+4)}. \qquad (37)$$

2.4 Discussion

It is helpful for expositional purposes to summarise the results from the above section diagrammatically. Figure 1 plots the critical level of trade costs that separates each trade regime ($t^{(1)}$, $t^{(2)}$, $t^{(3)}$, $t^{(4)}$ and $t^{(5)}$) against the level of union density (μ). From (20), (21), (24), (26) and (34), it can be easily checked that: $t^{(1)} > t^{(2)} > t^{(3)} > t^{(4)} > t^{(5)}$ if $\mu > 0$.

As can be seen, when union density is zero then there is no asymmetry between the countries and the only possible trade regimes are autarky or two-way trade. When $\mu > 0$, the possibility of asymmetric trade regimes exists. For given levels of $\mu < 1$, decreases in t will move the equilibrium from *true autarky*, to *import threat*, to *import deterrence*, to one-way trade, to *two-way/full export withdraw* and finally to *two-way/partial export withdraw*. It can be seen that whilst $t^{(1)}$, $t^{(2)}$ and $t^{(3)}$ are increasing in union density, $t^{(4)}$ and $t^{(5)}$ are decreasing in union density. The intuition for this is straightforward: On the one hand, in all regimes the bargained wages are increasing in union density.[10] On the other hand, the boundaries between the trade regimes depend on the difference in the two firms' marginal

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[10] This is immediate for the regimes of *true autarky*, one-way trade and *two-way/partial export withdraw*, respectively. See Appendices 1 and 2 for a proof that it is true in the *import threat* regime and under *two-way/full export withdraw* as well.

cost (including trade cost) of serving the respective market. This implies that with increasing union density higher trade costs are needed in order to prevent the foreign firm from serving the home market, explaining the positive slope of $t^{(1)}$, $t^{(2)}$ and $t^{(3)}$. However, lower trade costs are needed to make the domestic firm competitive in the foreign market, explaining the negative slope of $t^{(4)}$ and $t^{(5)}$.

3 The Impact of Integration on Wages

Now that we have described the trade regimes that can prevail in equilibrium for given levels of trade costs and union density, we are able to examine the impact of trade liberalisation on wages. We plot these changes in Figure 2.

Consider the impact of moving from a position of true autarky to a situation of free international trade: From (18) we know that in *true autarky*, that is when $t > t^{(1)}$, the wage does not change with economic integration. If $t > t^{(1)}$, the foreign firm is unable to export in equilibrium and the unionised firm's profits are not affected by changes in trade costs. Furthermore, trade costs are high enough to prevent the foreign firm's exports even in the case of a strike in the domestic country. Thus, neither the unionised firm's profits nor its conflict payoff are affected by product market integration, and consequently the same is true for the Nash wage.

Lowering trade costs below $t^{(1)}$ will result in increasing Nash equilibrium wages, as we can see from (19) that the *import threat* wage will increase as trade costs fall. The reason for this result is that (holding wages constant) whilst profits remain unaffected by economic integration (since there is still no trade in equilibrium), the prospect of imports in the event of a strike negatively affects the firm's conflict payoff through its effect on the domestic price.[11] Therefore, when trade costs fall below $t^{(1)}$, the profit differential $\pi_i - \pi_i^s$ increases, and, hence, so does the bargained wage. The lower the trade costs, the higher would be the amount of imports in the event of a strike, and hence the higher is the bargained wage.

An exception to this logic is in the case of full membership ($\mu = 1$), when lowering trade costs below $t^{(1)}$ has no impact on the bargained wage. Since there is still no international trade in equilibrium, the domestic firm's profits are not affected by economic integration and are equal to those in autarky. Furthermore, with full membership the firm's conflict payoff is equal to that under autarky (equal to zero in both cases). Thus, when $\mu = 1$, the Nash bargained wage under the threat of imports is equal to the autarky wage, and is not affected by product market integration.

When $t^{(2)} > t > t^{(3)}$ we have the case of deterred imports and the wage is given by (25). Thus, the wage level is sensitive to the prospect of trade and decreases as the level of trade costs falls. When $t^{(3)} > t \geq t^{(4)}$, we are in a situation of one-way trade, and as we can see from (23) the bargained wage decreases as t falls.

When $t^{(4)} > t > t^{(5)}$, we have the *two-way/full export withdraw* regime, and the wage is given by (33). In this regime, the wage function is strictly convex and its response to reductions in trade costs depends on the level of union density. If union density is relatively high ($\mu > 2/3$), the wage rate changes non-monotonically with t: The wage initially decreases as trade costs fall and then eventually rises for lower values of trade costs. Conversely, when union density is relatively low ($\mu \leq 2/3$), the wage decreases with product market

[11] With the introduction of imports in the event of a strike in country *i* the domestic price would necessarily fall.

integration in the full range of trade costs consistent with this regime. Appendix 3 offers a proof of this proposition.

Finally, lowering trade costs below $t^{(5)}$, we have the *two-way/partial export withdraw* regime. In this case, as we can see from (37), the wage unambiguously increases as trade costs fall.

Two points of particular interest are evident from Figure 2. Firstly, the wage rate under two-way trade is always smaller than that under one-way trade. Secondly, for sufficiently small levels of union density, the bargained wage is lower under autarky than under free trade (that is, two-way trade with zero trade costs). From (18) and (37) we know that:

$$w^B_{autarky} = \frac{a\mu^2}{\mu^2+2}, \text{ and } w^B_{two-way/pew}\Big|_{t=0} = \frac{\mu(\mu+1)a}{2\mu(\mu+1)+8}.$$

Hence,

$$w^B_{autarky} = w^B_{two-way/pew}\Big|_{t=0} \text{ if } \mu = 0 \text{ or } \mu = 0.312041 .$$

Straightforward computations show that both $w^B_{autarky}$ and $w^B_{two-way/pew}\Big|_{t=0}$ are weakly increasing in μ, and furthermore we have:

i) $$\left.\frac{\partial w^B_{two-way/pew}\big|_{t=0}}{\partial\mu}\right|_{\mu=0} > \left.\frac{\partial w^B_{autarky}}{\partial\mu}\right|_{\mu=0} = 0;$$

ii) $$\left.\frac{\partial w^B_{autarky}}{\partial\mu}\right|_{\mu=0.312041} > \left.\frac{\partial w^B_{two-way/pew}\big|_{t=0}}{\partial\mu}\right|_{\mu=0.312041} > 0.$$

Hence, given continuity of $w^B_{autarky}$ and $w^B_{two-way/pew}\Big|_{t=0}$ in μ, we have $w^B_{autarky} > w^B_{two-way/pew}\Big|_{t=0}$ ($w^B_{autarky} < w^B_{two-way/pew}\Big|_{t=0}$) if $\mu > 0.312041$ ($\mu < 0.312041$).

We can gain some intuition for these results by noting that when $\mu = 0$, the bargained wage is zero under either trade regime because, with zero union membership, the firm does not lose anything in case of a strike. However when $\mu > 0$ then the wage levels may diverge. Under autarky, increasing μ from 0 has only a second-order effect on the disagreement payoff. On the other hand, there is a first order negative effect on the disagreement payoff under free (two-way) trade due to both the induced increase in foreign firm's exports to the home market and the induced fall in the domestic firm's exports. Therefore, for sufficiently small union densities, the profit differential $\pi_i - \pi_i^s$ (and therefore the wage) is smaller under autarky than under free trade. At the opposite extreme of $\mu = 1$ however, $\pi_i - \pi_i^s$ is larger under autarky than under free trade. This follows from the fact that, with full union membership, the disagreement payoff is zero in either trade regime while in the absence of a strike the profit is higher under autarky than under free trade. Together, this implies that, at some intermediate level of density, profit differentials and therefore wage rates are equal between regimes ($\mu = 0.312041$).

4 A Binding Union Membership Constraint

Up until this point we have excluded by assumption the possibility that unions are too weak to negotiate wages above the competitive level. We did this by setting the strike pay equal to the competitive wage. However, Naylor and Cripps (1993) show in a closed economy context that, whenever the competitive wage is higher than the strike pay, a strictly positive minimum union membership is needed to lift the wages above the worker's outside option. The same is true in the present open economy context. It can be readily shown that for strictly positive levels of w^C (and with strike pay still being normalised to zero), the minimum union membership becomes strictly positive in all trade regimes.

With $w^C > 0$, the profit function for the foreign firm is:

$$\pi_j = \left[a - b(x_{jj} + x_{ij}) - w^C\right]x_{jj} + \left[a - b(x_{ii} + x_{ji}) - t - w^C\right]x_{ji}. \tag{4'}$$

Under the assumption that the union is able to increase wages above the competitive level, the boundaries between the trade regimes are given by:

$$t^{(1)} = \frac{\mu(\mu+1)+1}{\mu^2+2}a - w^C \tag{23'}$$

$$t^{(2)} = \frac{a(\mu(\mu+1)+2) - (1-\mu)w^C}{\mu(\mu+1)+4} \tag{24'}$$

$$t^{(3)} = \frac{3\mu(\mu+1)+8}{3\mu(\mu+1)+16}a - w^C \tag{28'}$$

$$t^{(4)} = \frac{4\left(a + w^C\right)}{3\mu(1+\mu)+8} \tag{30'}$$

$$t^{(5)} = \frac{8(1-\mu)\left(a + w^C\right)}{\mu(3\mu-1)+16}. \tag{34'}$$

Note that these boundaries will not be relevant if t and μ are such that the bargained wage would be smaller than w^C.[12] In this case, $t^{(2)} = t^{(4)} = (1/2)\left(a - w^C\right)$ is the unique boundary between the two possible trade regimes in equilibrium: no international trade and two-way trade.

The new situation when $w^C > 0$ is most easily analysed with the help of Figure 3. This shows the new boundaries between the trade regimes in (t, μ)-space. With a competitive wage greater than zero, $t^{(1)}$, $t^{(2)}$ and $t^{(3)}$ shift downwards relative to the case of $w^C = 0$

[12] The explicit formulation for the equilibrium wages in each of the regimes is derived in Appendix 4. Using these expressions, one can show that the bargained wage tends to zero (the strike pay) as union density tends to zero. As the strike pay is smaller than the competitive wage, there is now some level of union density above which the union must rise in order to increase the wages above the competitive level.

considered in the previous section, while $t^{(4)}$ and $t^{(5)}$ shifts upwards. This is because an increase in w^C *ceteris paribus* makes the home firm more competitive. Hence, it can keep the foreign firm out of its home market even if trade costs are lower, and can serve the foreign market when trade costs are higher.

The locus $[d\,e\,f\,g\,h\,i]$ separates the combinations of t and μ for which the union is able to bargain a wage greater than w^C (to the right of the locus) from those for which it is to weak and where $w_i = w^C$ (to the left of this locus). The locus is derived analytically for each of the regimes by setting the respective equilibrium wage equal to w^C and solving for t or μ. Three different regions may now be distinguished.

In Region 1 (R1), the model collapses to the standard reciprocal dumping model of Brander (1981). This is the region associated with the values of union density ($0 \le \mu \le \mu^*$) for which, independently of the trade cost, the union can never raise the wages above the competitive level. Within this region the equilibrium trade regime will be either no international trade if $t \ge (1/2)(a - w^C)$ or two-way trade if $t < (1/2)(a - w^C)$.

In Region 3 (R3) the level of union density ($\mu^{**} \le \mu \le 1$) is such that the union is always able to raise the wages above the competitive level. For each level of union density, the level of the trade cost will determine the equilibrium trade regime. This segment corresponds with the model in the previous section.

Within Region 2 (R2) ($\mu^* \le \mu \le \mu^{**}$) a richer configuration of outcomes is possible, since the competitive wage will sometimes act as a binding constraint on the bargain. Consider for instance a situation in which μ is such that we are positioned on the left of the segment $[d\ e]$. For sufficiently high trade costs ($t \geq t^{(1)}$) *true autarky* will prevail and the union will not be able to raise the wages above the competitive level ($w_i = w^C$). When trade costs fall below $t^{(1)}$, the threat of imports leads to an increase in the bargained wage. However, the *import threat* bargained wage will only be higher than the competitive wage (and therefore the wage actually paid by the unionised firm) when trade costs fall below the segment $[f\ e]$. When this happens, the wage increases above the competitive level as trade costs fall. This situation will prevail until trades costs fall below $t^{(2)}$. The firm will then start to pay a lower wage in order to deter imports, and wages will decrease with further economic integration. If μ is such that we are positioned to the left of point g, then the wage collapses to w^C as soon as the segment $[f\ g]$ is reached. Two-way trade will then be the equilibrium trade regime, and further reductions in t have no impact on the wage ($w_i = w^C$). If μ is such that we are positioned on the right of point g, the equilibrium trade regime will be one-way trade if $t^{(4)} \leq t < t^{(3)}$ and *two-way/full export withdraw* if $t < t^{(4)}$. Under the latter case, further reductions in the trade cost lead the bargained wage to fall, until the competitive level is reached (at $[g\ h]$).

Finally if μ is such that we are positioned on the right of the segment $[d\ e]$, then the union membership constraint only becomes binding at some level of trade cost below $t^{(4)}$, when we are in the *two-way/full export withdraw* situation. For the combinations of t and μ located above and right of the segment $[g\ h]$, the union is always able to raise the wages above w^C. By contrast, below and to the left of this segment the firm pays the competitive wage. When trade costs fall below $t^{(5)}$, the bargained wage will only increase above the competitive level in the *two-way/partial export withdraw* regime when the segment $[h\ i]$ is reached (which only occurs when μ is close to μ^{**}). In this case, the union is able to raise the wages above w^C, and the wage rises further as trade costs fall to zero.

5. Concluding Comments

In this paper we develop a model of international oligopoly in which workers are represented by open shop trade unions. We then examine the impact of different levels of union density and trade costs for the equilibrium trade regime and use the model to examine the response of wages to product market integration.

The incorporation of intermediate forms of union density has several consequences for the model developed. Firstly, the fall back position of firms is no longer zero in the event of a strike, as firms may continue to operate with the non-union workers that they employ. This will impact on wage outcomes. Thus, whilst Naylor (1998) and Lommerud et al. (2003) adopt a monopoly union framework, this extension is more naturally handled within a bargaining framework. Secondly, since the firm continues to operate in the event of a strike, the possibility exists that trade will impact on the wage outcome via this route, even if no trade exists in equilibrium. This serves to generate additional trade regimes compared to those found in Lommerud et al. (2003).

Both of these features help to provide a richer range of wage profiles than are present under monopoly union models. Of particular interest in this regard is the *import threat* regime. In this situation, trade does not occur in equilibrium. However, the threat that the foreign firm will export to meet the shortfall in product supply in the event of a strike acts as an additional discipline on the firm and serves to help the union in the bargain. Thus, within this range, we can observe unionised wages rising with trade liberalisation. This serves to extend Naylor's (1998) argument that unionised wages may not fall monotonically with marginal reductions in trade costs, with the novelty of this result being in the mechanism by which it operates, namely via reductions in the firm's disagreement payoff.

The results of this paper also contrast with the earlier literature by indicating that, with intermediate levels of union density, wages may be higher under free trade than under autarky. At low levels of density the union is only able to capture a small proportion of the relatively large surplus under autarky. Its position under free trade is stronger. Although the surplus to be bargained over is smaller, a strike not only causes disruption to production but also elicits a competitive response from the overseas firm. This reduces the firm's strike profits further and serves to bolster the position of the union. Hence, in a model with intermediate levels of union density, wages need neither to fall monotonically as trade liberalisation occurs, nor indeed to fall in absolute terms as an economy moves from autarky to free trade.

Figure 1: The Boundaries between Trade Regimes in (t, μ)–Space

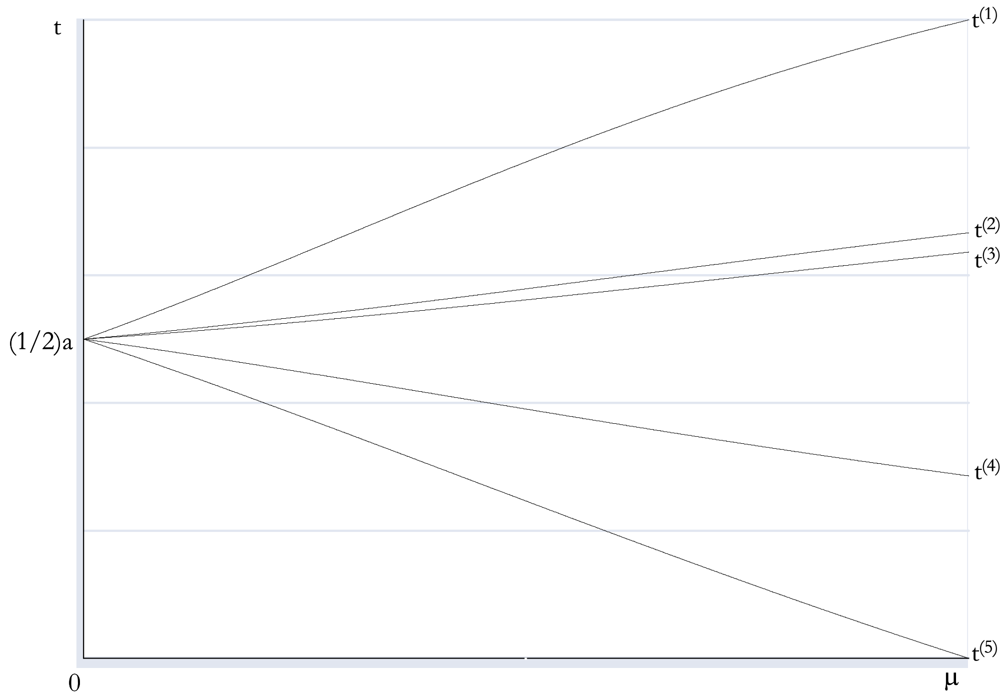


Figure 2: The Impact of Trade Liberalisation on Wages

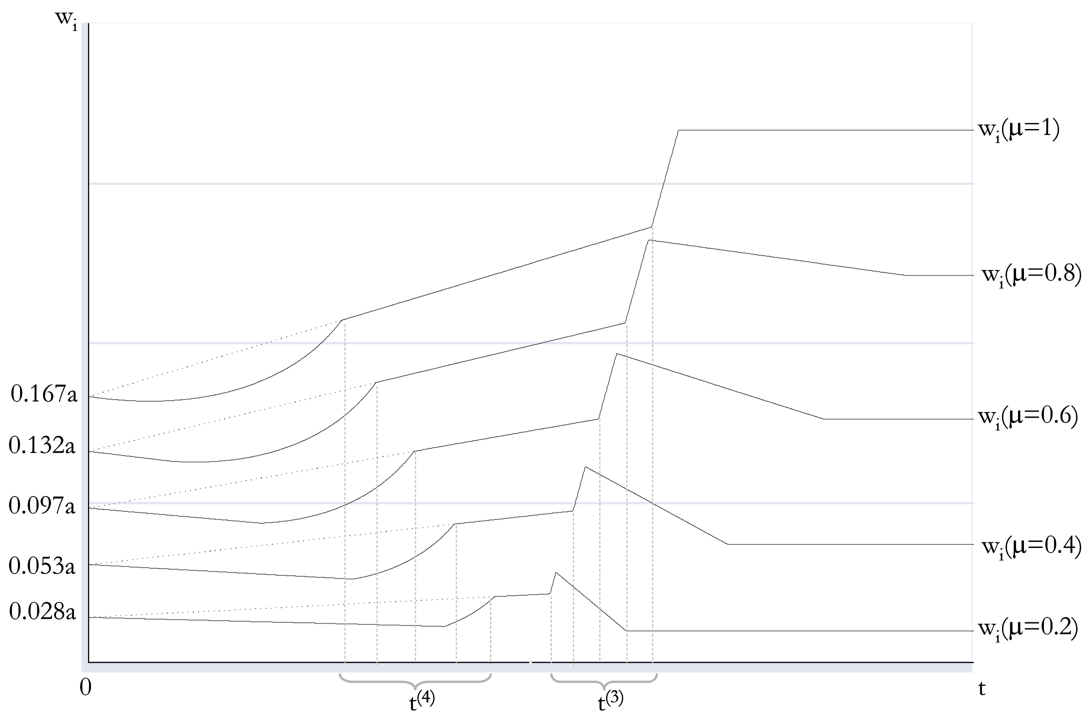
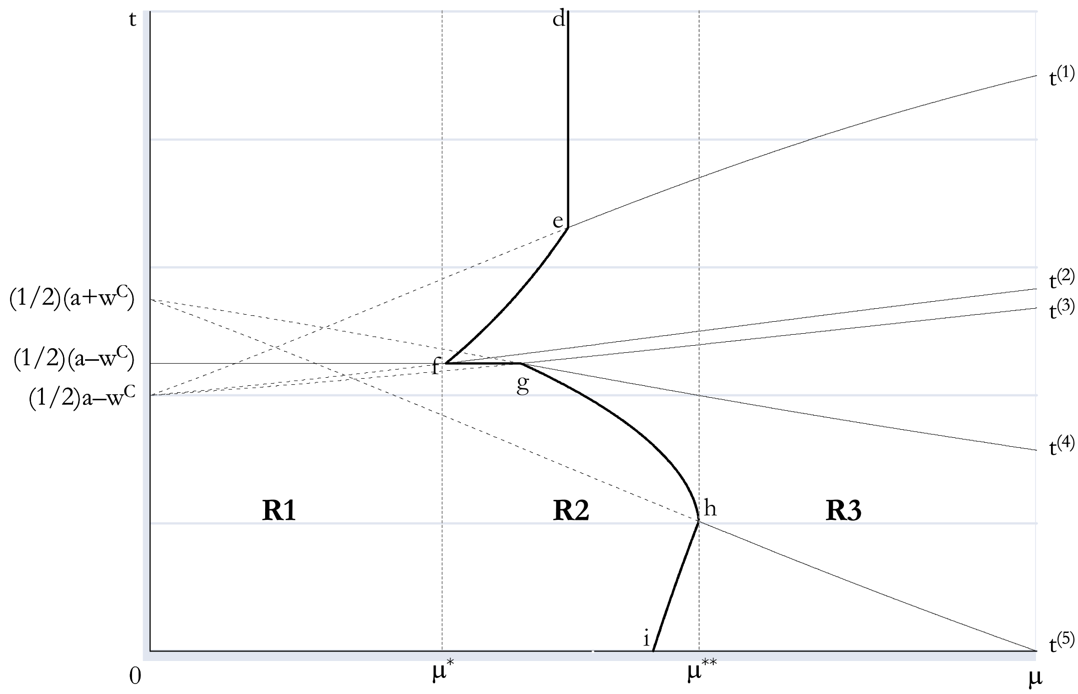


Figure 3: The Boundaries between Trade Regimes with a Binding Union Membership Constraint in (t, μ)–Space



Appendix

1 Implications of the level of union density for the *import threat* wage

In section 2.4 of the main text we argue that in the *import threat* situation higher union density raises the bargained wage for a given level of trade costs. Partial differentiation of (19) with respect to μ yields:

$$\frac{\partial w_{import\ threat}^{B}}{\partial \mu}=\frac{2t(5+\mu(2-\mu))-2a(1-\mu(\mu+2))}{(\mu(\mu+2)+3)^{2}}. \tag{A.1}$$

(A.1) is strictly positive whenever $\mu \geq \sqrt{2}-1$. For lower values of union density, (A.1) is only positive when t is high enough relative to a. That, however, is always guaranteed for the range of trade costs under which the *import threat* regime occurs in equilibrium ($t^{(1)} > t > t^{(2)}$). As shown below, (A.1) is always positive when evaluated at the inferior limit of the interval of trade costs consistent with the imports threat case ($t = t^{(2)}$):

$$\left.\frac{\partial w_{import\ threat}^{B}}{\partial \mu}\right|_{t=t^{(2)}}=\frac{4a(\mu+2)}{(\mu(\mu+1)+4)(\mu(\mu+2)+3)}>0.$$

Therefore, we can conclude that the same necessarily happens for the full range of trade costs consistent with the *import threat* case.

2 Implications of the level of union density for the *two-way/full export withdraw* wage

In section 2.4 of the main text we argue that under the *two-way/full export withdraw* regime higher union density raises the bargained wage, for a given level of trade costs. To prove this one needs to differentiate (33) with respect to μ. This yields:

$$\frac{\partial w^{B}_{two-way/few}}{\partial \mu} = \frac{4a(4\mu-1)+t(11-8\mu)+\dfrac{9t(8a+t(1+7\mu))}{\sqrt{64a^2-16at(9\mu-5)-t^2(9\mu(7\mu+2)+335)}}}{8(\mu(2\mu-1)+5)} +$$

$$+\frac{(4\mu-1)\left[4a(\mu(1-2\mu)-3)+t(\mu(4\mu-11)+15)+\sqrt{64a^2-16at(9\mu-5)-t^2(9\mu(7\mu+2)+335)}\right]}{8(\mu(2\mu-1)+5)^2}. \quad \text{(A.2)}$$

In order restrict the analysis to the relevant range of trade costs, we can substitute t in (A.2) by $\alpha t^{(4)} + (1-\alpha)t^{(5)}$, where α is a parameter that can take any value between 0 and 1. After substitution, it can be shown that $\left.\frac{\partial w^{B}_{two-way/few}}{\partial \mu}\right|_{t=\alpha t^{(4)}+(1-\alpha)t^{(5)}} > 0$. This is illustrated in Figure A.1, which shows the behaviour of this partial derivative in (μ, α)-space.

The algebraic proof of this result is here presented for the two extreme values of the interval of trade costs consistent with the *two-way/full export withdraw* case[13] (that is, for $\alpha = 1$ and $\alpha = 0$):

$$\left.\frac{\partial w^{B}_{two-way/few}}{\partial \mu}\right|_{t=t^{(4)}} = \frac{6a(1+2\mu)}{24+\mu(6\mu^3+3\mu^2+22\mu+1)} > 0$$

$$\left.\frac{\partial w^{B}_{two-way/few}}{\partial \mu}\right|_{t=t^{(5)}} = \frac{2a(2+\mu)}{(1+\mu)(16+\mu(3\mu-1))} > 0.$$

3 Impact of trade liberalisation on the *two-way/full export withdraw* wage

In section 3 of the main text we argue that in the *two-way/full export withdraw* case the wage function is strictly convex in the level of trade costs. Additionally we argue that when union density is relatively high ($\mu > 2/3$), the wage rate changes non-monotonically with t: The

[13] Proof for intermediate values of α is available upon request.

wage initially decreases as trade costs fall and then eventually rises for lower values of trade costs. Finally, we argue that for levels of lower union density ($\mu \leq 2/3$) the wage decreases in the full range of trade costs consistent with this trade regime.

When $\mu > 2/3$ the *two-way/full export withdraw* wage:

i) Decreases with trade liberalisation for sufficiently high levels of trade costs ($t^{(4)} > t > t^{\circ}$);

ii) Reaches its the minimum level when $t = t^{\circ}$;

iii) Increases with trade liberalisation for sufficiently low levels of trade costs ($t^{\circ} > t > t^{(5)}$).

Where,

$$t^{\circ} = \frac{8\left[70 - 151\mu + 50\mu^2 - 9\mu^3 + 3\sqrt{14 - \mu(5-\mu)}(15 - \mu(11 - 4\mu))\right]}{(14 - \mu(5-\mu))(9\mu(7\mu + 2) + 335)} a . \quad \text{(A.3)}$$

Proof proceeds by differentiation of (33) with respect to the level of trade costs:

$$\frac{\partial w^B_{two-way/few}}{\partial t} = \frac{\dfrac{8a(9\mu - 5) + t(335 + 9\mu(7\mu + 2))}{\sqrt{64a^2 - 16at(9\mu - 5) - t^2(335 + 9\mu(7\mu + 2))}} - 15 + \mu(11 - 4\mu)}{8(\mu(2\mu - 1) + 5)} . \quad \text{(A.4)}$$

When $t = t^{(4)}$, the wage function has a positive slope:

$$\left.\frac{\partial w^B_{two-way/few}}{\partial t}\right|_{t = t^{(4)}} = \frac{2 + \mu(5 - \mu)}{6 - 2\mu(1 - \mu)} > 0 .$$

When $t = t^{\circ}$, (A.4) is equal to zero:

$$\left.\frac{\partial w^B_{two-way/few}}{\partial t}\right|_{t = t^{\circ}} = 0 .$$

When $t = t^{(5)}$ and $\mu > 2/3$, the wage function has a negative slope:

$$\left.\frac{\partial w^B_{two-way/few}}{\partial t}\right|_{t = t^{(5)}} = \frac{2 - 3\mu}{6(\mu + 1)} .$$

When $\mu \leq 2/3$, the *two-way/full export withdraw* wage decreases with product market integration in the full range of trade costs consistent with this trade regime ($t^{(4)} > t > t^{(5)}$). It can be easily checked that:

i) $t^{(5)} = t^{\circ}$ and $\left.\frac{\partial w^{B}_{two-way}}{\partial t}\right|_{t=t^{(5)}} = 0$ if $\mu = 2/3$;

ii) $t^{(5)} > t^{\circ}$ and $\left.\frac{\partial w^{B}_{two-way}}{\partial t}\right|_{t=t^{(5)}} > 0$ if $\mu < 2/3$.

In order to prove convexity of the wage function in trade costs we compute the second partial derivative of the *two-way/full export withdraw* wage with respect to the level of trade costs. This is given by:

$$\frac{\partial^2 w^{B}_{two-way/few}}{\partial t^2} = \frac{576a^2}{\left[64a^2 + 16at(5-9\mu) - t^2(9\mu(7\mu+2)+335)\right]^{3/2}}. \qquad \text{(A.5)}$$

In order restrict the analysis to the relevant range of trade costs, we can substitute t in (A.5) by $\alpha t^{(4)} + (1-\alpha)t^{(5)}$, where α is a parameter that can take any value between 0 and 1. After substitution, it can be shown that $\left.\frac{\partial^2 w^{B}_{two-way/few}}{\partial t^2}\right|_{t=\alpha t^{(4)}+(1-\alpha)t^{(5)}} > 0$. This is illustrated in Figure A.2, which shows the behaviour of that second partial derivative in (μ, α)-space.

The algebraic proof of this result for the two extreme values of the interval of trade costs consistent with this trade regime (that is, $\alpha = 1$ and $\alpha = 0$)[14] is presented below:

[14] Proof for other values of α is available upon request.

$$\left.\frac{\partial^2 w^B_{two-way/few}}{\partial t^2}\right|_{t=t^{(4)}} = \frac{(3\mu(\mu+1)+8)^3}{648a(1+\mu)^3} > 0$$

$$\left.\frac{\partial^2 w^B_{two-way/few}}{\partial t^2}\right|_{t=t^{(5)}} = \frac{(\mu(3\mu-1)+16)^3}{648a(1+\mu)^3} > 0 .$$

4 The outcome of the wage bargaining with a strictly positive competitive wage

In section 4 of the main text we use the outcomes of the wage bargaining with a positive competitive wage to derive the boundaries between trade regimes and the minimum level of union density above which the union must rise in order to increase wages above the competitive level. When $w^C > 0$ the outcome of the wage bargaining for each trade regime is given by:

$$w^B_{autarky} = \frac{a\mu^2}{\mu^2+2} \tag{A.6}$$

$$w^B_{import\ \ threat} = \frac{a(\mu^2+1) - 2(t+w^C)(1-\mu)}{\mu(\mu+2)+3} \tag{A.7}$$

$$w^B_{one-way} = \frac{\mu(\mu+1)(a+t+w^C)}{2(\mu(\mu+1)+4)} \tag{A.8}$$

$$w^B_{two-way/few} = \frac{4a(\mu(2\mu-1)+3) - t(\mu(4\mu-11)+15) + 4(\mu(2\mu-1)+3)w^C}{8(\mu(2\mu-1)+5)} +$$

$$+\frac{\sqrt{64\left(a^2+w^{C^2}\right) - 16a(9t\mu-5t-8w^C) - t^2(9\mu(7\mu+2)+335) - 16t(9\mu-5)w^C}}{8(\mu(1-2\mu)-5)} \tag{A.9}$$

$$w^B_{two-way/pew} = \frac{(2(a+w^C)-t)\mu(\mu+1)}{4(\mu(\mu+1)+4)} \tag{A.10}$$

Furthermore, with a strictly positive competitive wage, there is an *import deterrence* regime in the transition between the *import threat* case and one-way trade. This is given by:

$$w^D = 2t + 2w^C - a . \tag{A.11}$$

Using (A.6)-(A.10), it can be checked that, in all three trade regimes the bargained wage is increasing in union density and tends to zero as union density tends to zero.

As the strike pay is smaller than the competitive wage, there is now some minimum level of union density above which the union must rise in order to increase wages above the competitive level. This minimum level is derived analytically for each trade regime by setting the respective equilibrium wage equal to w^C and solving for μ. That yields:

$$\mu_{autarky}^{\min} = \sqrt{\frac{2w^C}{a - w^C}} \tag{A.12}$$

$$\mu_{import\ threat}^{\min} = \frac{\sqrt{4t^2 - 4\left(a - 2t - 5w^C\right)\left(a - w^C\right)} - 2t}{2\left(a - w^C\right)} \tag{A.13}$$

$$\mu_{one-way}^{\min} = \frac{1}{2}\left(\sqrt{\frac{a + 31w^C + t}{a - w^C + t}} - 1\right) \tag{A.14}$$

$$\mu_{two-way\,/\,few}^{\min} = \frac{\left(2a - 2w^C - t\right)\left(a - 5t - 2w^C\right)}{2\left(2w^C + t - 2a\right)^2} +$$

$$+\frac{\sqrt{\left(2w^C + t - 2a\right)\left(34at - 7a^2 - 31t^2 + 78aw^C - 66tw^C - 71w^{C^2}\right)}}{2\left(2w^C + t - 2a\right)^2} \tag{A.15}$$

$$\mu_{two-way\,/\,pew}^{\min} = \frac{1}{2}\left(\frac{2a + 62w^C - t}{\sqrt{\left(2a - 2w^C - t\right)\left(2a + 62w^C - t\right)}} - 1\right). \tag{A.16}$$

Similarly, the *import deterrence* wage cannot be lower than the competitive wage, and therefore we can define a level of trade costs above which the wage is above the competitive level:

$$t_{\min}^D = \frac{a - w^C}{2}. \tag{A.17}$$

Notice that the union membership constraint under one-way trade ($\mu_{one-way}^{\min}$) is never binding in equilibrium. Within the region where one-way trade is the equilibrium trade regime (that is, on the right of point g in Figure 3), the combinations of μ and t for which $w^{B}_{one-way} = w^{C}$ are always positioned below $t^{(4)}$, the boundary of trade costs between one-way trade and the *two-way/full export withdraw* trade regime. Under one-way trade, a reduction in the level of trade costs always leads to a fall in the bargained wage. As the bargained wage decreases, the difference between the domestic and foreign firm's marginal costs also falls. For this reason, before the wage reaches the competitive level, the domestic firm will start to export. From then onwards the equilibrium trade regime is two-way trade, and the one-way trade union membership constraint is no longer relevant. Hence, the locus $[d\,e\,f\,g\,h\,i]$ is traced out by (A.12), (A.13), (A.15), (A.16) and (A.17).

μ

Figure A.1: Derivative of the *two-way/full export withdraw* wage with respect to μ in $(t,\ \mu)$-Space

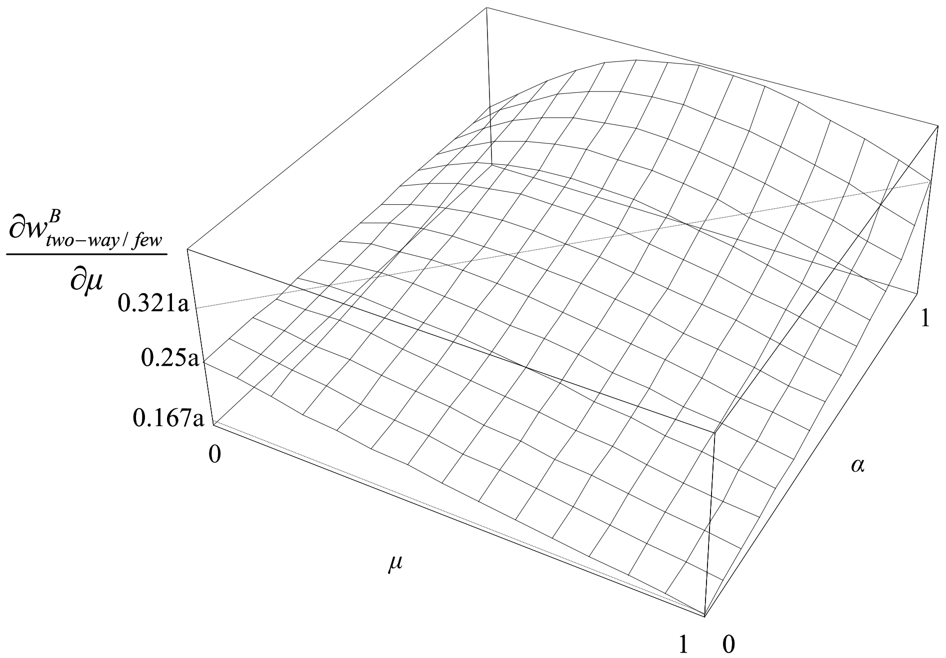
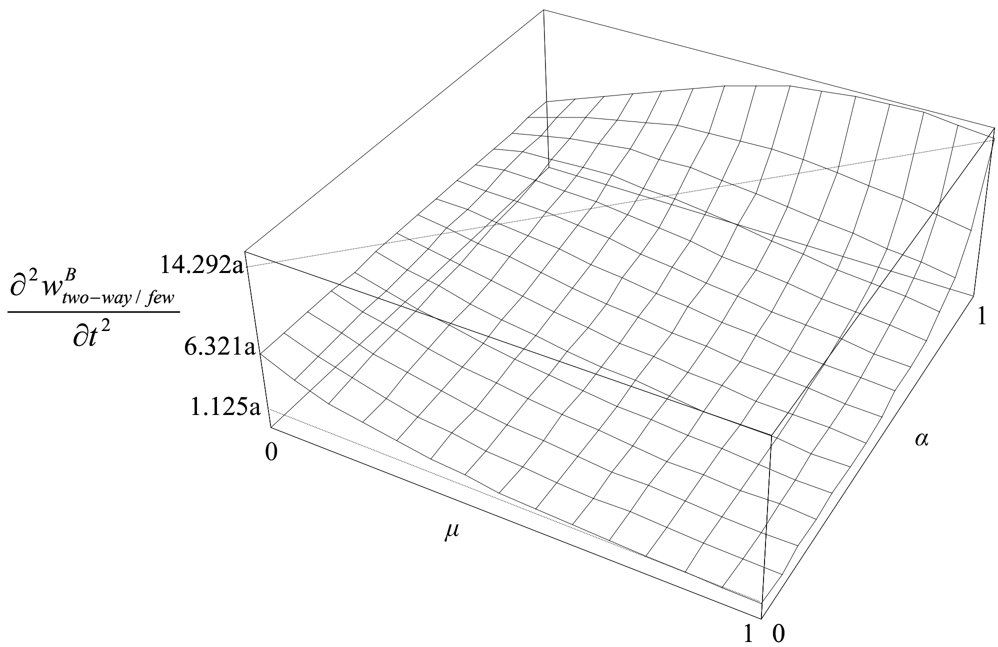


Figure A.2: Second derivative of the *two-way/full export withdraw* wage with respect to t in $(t,\ \mu)$-Space



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