UNION WAGE STRATEGIES AND INTERNATIONAL TRADE

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Abstract

In this paper, we analyse the relationship between wage outcomes and the nature of international trade and economic integration when labour markets are unionised and a homogeneous product market is characterised by intra-industry trade. We characterise the full set of possible trade regimes for different combinations of wages and derive unions' wage reaction functions. We show that a union's choice between a high and a low-wage strategy will depend on the value of trade costs. We find that: (i) compared to a non-union setting, unions reduce the prohibitive trade cost and that (ii) this rules out trade in that region of trade costs over which, in the non-union model, welfare falls as trade costs fall, (iii) in any trade equilibrium, falling trade costs lead monopoly unions to set higher wages, (iv) there is a range of trade costs for which equilibrium is non-existent and (v) the characterisation of the union wage-setting game as a Prisoners' Dilemma, and hence the incentives for international union coordination of wage demands, depend upon the extent of trade costs.

JEL Classification No.: F 15, J 5, L 13.

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1. Introduction

Micro-econometric analysis has established that the nature of product market competition is a crucial determinant of wage outcomes generally (see, for example, Dickens and Katz (1987)), and, more specifically, of the capacity of a trade union to raise wages above non-union levels (see, for example, Stewart (1990)). Similarly, the economic forces associated with internationalisation is increasingly seen as influencing both the level and the variance of wage outcomes (see Freeman and Katz (1995)). Despite the growing body of empirical evidence on these issues, there is still a relative paucity of theoretical analysis which considers wage determination in the context of product markets which are both international and oligopolistic.[1]

A number of recent papers have developed models of international trade in which the impact of increased economic integration on union-bargained wages can be analysed (see, for example, Driffill and van der Ploeg (1993, 1995), Danthine and Hunt (1994), Corneo (1995) and Naylor (1997)). Naylor (1997) represents a development of the standard reciprocal dumping model of international trade associated with Brander (1981), Brander and Krugman (1983) and Brander and Spencer (1988) (see also Mezzetti and Dinopoulos (1991) and Santoni (1996)) to capture the case of unionisation in more than one country. Naylor (1997) assumes that tariff or other trade costs are sufficiently low as to ensure the existence of intra-industry trade and proceeds to find that reductions in these trade costs will, somewhat surprisingly, lead unions to set higher wages. In the current paper, we develop a more

[1] Dowrick (1989) is one of the first attempts to consider union-oligopoly bargaining.

general model of strategic behaviour by trade unions in the context of international trade. This enables us to consider the simultaneous determination of labour market and international trade equilibria for unrestricted tariff values. We also compare these equilibria with those associated with a non-unionised environment.

The paper can be thought of as applying the analysis of multimarket oligopoly developed by Bulow, Geanakoplos and Klemperer (1985) to the setting of integrating unionised oligopolies in an international environment. In a seminal paper, Davidson (1988) analyses the strategic interactions between unions in oligopolistic markets and, specifically, focuses on a comparison of the effects of different bargaining structures. Padilla, Bentolila and Dolado (1996) extend the analysis to consider the case of asymmetries in union bargaining across firms, investigating the effects of changes in various labour and product market variables. In our paper, in contrast, we are concerned with the effects of changes in the costs of trading *between* markets, which we take as a proxy for the extent of economic integration. In our model, the product market is characterised by strategic substitutes whilst union-set wages are strategic complements, *whatever the nature of the trade regime.*

A further motivation for the current paper is that it fills the gap between the model developed in Naylor (1997) and the class of models associated with Huizinga (1993) and Sørensen (1994). In the latter, economic integration is considered as a discontinuous process in which two initially separate autarkic economies become wholly integrated into one large economy.[2] In other words, it is as if integration

[2] This is also true of the interesting model developed by Wes (1996), where firm mobility is also modelled.

reduces tariff costs from some prohibitively high level to zero in one jump. Instead, in the current paper we are able to explain what determines the prohibitive level of the tariff, how this varies across unionised and non-unionised settings and what characterises labour market equilibria for all values of the tariff in the interval between zero and the prohibitive level.

The layout of the rest of the paper is as follows. Section 2 outlines the formal 2-stage model in which rival unions set wages prior to firms choosing output. We derive the Stage 2 labour demand functions and show how the possible trade regimes vary with the combination of wage outcomes. In Section 3, we model the problem facing each union as a choice between a low and a high-wage strategy and in Section 4 we show that the union's optimal choice of strategy depends on the value of trade costs. Section 5 considers the two unions' strategies simultaneously, derives the possible Cournot-Nash equilibria and examines their properties. In Section 6, we compare the welfare implications of trade and integration under union and non-union settings. In Section 7, we consider the Prisoners' Dilemma nature of the wage-setting game and show that the union's incentives to form international agreements on wage-setting to prevent underbidding depend on the extent of trade costs. Section 8 closes the paper with a summary and suggestions for further work.

2. Intra-industry trade and labour demands

The formal analysis is based on the reciprocal dumping or 'cross-hauling' model of intra-industry trade. In each of two identical countries (A and B) there is one domestic firm (Firm 1 and Firm 2, respectively) producing a non-differentiated commodity. Each firm regards each country as a separate market and there is Cournot competition in both markets. There is a constant tariff cost of t per unit of the commodity exported. Each firm confronts a monopoly trade union (Union 1 and Union 2, respectively) which represents all the workers employed by its respective firm and has the objective of rent-maximisation with no influence over employment.

There are two stages to the game. In Stage 1, each union chooses a wage taking as given the wage set by the rival union, and taking account of the employer's labour demand function. In Stage 2, each firm sets output taking as given the output of the rival firm. In each country there is a linear product demand function. In Country A this is given by $p^a = a - b(X^a)$, where $X^a = x_1^a + x_2^a$, whilst in Country B: $p^b = a - b(X^b)$, where $X^b = x_1^b + x_2^b$ and x_i^j represents output by Firm i for sale in Country j. We proceed by backward induction: first solving for the firms' choices in Stage 2 before turning to analyse union strategies in Stage 1.

Stage 2 *The firms' output choices*

It is straightforward to derive the reaction functions which describe Cournot behaviour in the product market. Given linear product demand functions and given wages of w_1 and w_2 for the two firms' workers, the Cournot output reaction functions of the profit-maximising firms are just the first-order conditions for profit-maximisation:

$$x_1^a = \frac{a - w_1}{2b} - \frac{x_2^a}{2} \tag{1}$$

$$x_1^b = \frac{a - w_1 - t}{2b} - \frac{x_2^b}{2} \tag{2}$$

$$x_2^a = \frac{a - w_2 - t}{2b} - \frac{x_1^a}{2} \tag{3}$$

$$x_2^b = \frac{a - w_2}{2b} - \frac{x_1^b}{2} \tag{4}$$

for $x_i^j \geq 0, \forall \ i, j$. Solving (1) - (4) simultaneously, we are able to re-write these reaction functions in terms of the wages of the two groups of workers:

$$x_1^a = \frac{1}{3b}\left[a - 2w_1 + w_2 + t\right] \tag{5}$$

$$x_1^b = \frac{1}{3b}\left[a - 2w_1 + w_2 - 2t\right] \tag{6}$$

$$x_2^a = \frac{1}{3b}\left[a - 2w_2 + w_1 - 2t\right] \tag{7}$$

$$x_2^b = \frac{1}{3b}\left[a - 2w_2 + w_1 + t\right] \tag{8}$$

Equations (5) to (8) determine the conditions under which each firm is able to capture a share of each market. These are that:

$$x_1^a > 0 \text{ iff } w_1 < \frac{1}{2}[a + w_2 + t] \tag{9}$$

$$x_1^b > 0 \text{ iff } w_1 < \frac{1}{2}[a + w_2 - 2t] \tag{10}$$

$$x_2^a > 0 \text{ iff } w_2 < \frac{1}{2}[a + w_1 - 2t] \tag{11}$$

$$x_2^b > 0 \text{ iff } w_2 < \frac{1}{2}[a + w_1 + t] \tag{12}$$

The boundaries between the different possible trade regimes implied by conditions (9) through (12) are depicted in Figure 1.

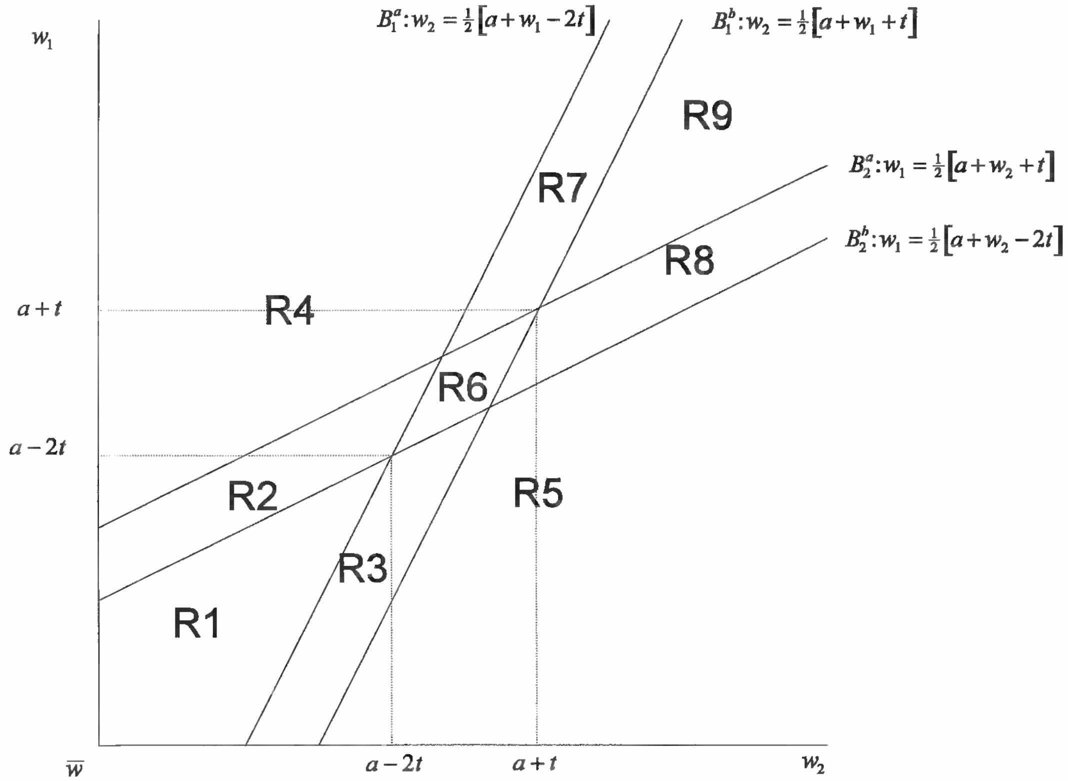

Figure 1

There are six qualitatively different possible regions, three of which involve trade. In Region 1 (R1), $x_1^a, x_1^b, x_2^a, x_2^b$ are all positive. This is the region associated with values of wages sufficiently low and similar as to permit reciprocal dumping or intra-industry trade. The upper vertex of this region represents the point at which trade just ceases in each direction: from inequalities (10) and (11) it can be seen that this is when $w_1 = w_2 = a - 2t$. As t falls, this region expands in w_1, w_2-space.

In Region 2 (Region 3 is analogous with Country and Firm identites transposed), w_1 is so high, given w_2 and t, that Firm 1 cannot export. Nevertheless, w_1 is sufficiently low within R2 that, although there are imports from Country B, Firm 1 retains a share of its domestic market. In Region 4 (R5 is analogous), in contrast, w_1 is so high that Firm 2 establishes a monopoly in both markets.

R1, R2 (R3) and R4 (R5) comprise the three types of Region involving trade. In Region 6, in contrast, w_1 and w_2 are so high, and sufficiently similar, that there is no trade. In Region 7 (R8 is analogous) both w_1 and w_2 are so high that there is neither production nor consumption in Country A, given t. w_2 is sufficiently low, however, that Firm 1 is able to produce for its home market. In Region 9, there is no production or consumption in either market: w_1 and w_2 are both so high as to preclude economic activity given the structure of the product markets. Finally, we notice both from Figure 1 and from the inequalities (9) through (12) that if $t = 0$ then only R1, R4, R5 and R9 exist.

The labour demand function which Union 1 faces will depend on which of the nine regions obtains, and hence on t as well as on both w_1 and w_2. Union 1 will never set a wage which condemns Firm 1 to R4, R7 or R9 as demand for Union 1 labour is zero in each of these cases. Consider each of the other possible regions.

(i) *Region 1* In this region, w_1 and w_2 are such that $x_i^j \geq 0, \forall \ i, j$. Hence demand for Union 1 labour is given by the sum of (5) and (6):

$$X_1 = x_1^a + x_1^b = \frac{1}{3b}[2a - 4w_1 + 2w_2 - t] \qquad (13)$$

(ii) *Region 2* Here, w_1 and w_2 are such that $x_1^b = 0$. Hence, demand for Union 1 labour is given by (5).

(iii) *Region 3* w_1 and w_2 are such that $x_2^a = 0$. Hence, demand for Union 1 labour is given by the sum of (1), with $x_2^a = 0$, and (6). That is,

$$X_1 = \frac{1}{6b}[5a - 7w_1 + 2w_2 - 4t] \qquad (14)$$

At the boundary between R1 and R3, (13) and (14) are satisfied simultaneously and hence:

$$w_1 = -a + 2w_2 + 2t \qquad (15)$$

which is, of course, consistent with (8) and (12).

(iv) *Region 5* w_1 and w_2 are such that both $x_2^a = 0$ and $x_2^b = 0$: Firm 2 is priced out of both markets. Demand for Union 1 labour is given by the sum of (1), with $x_2^a = 0$, and (2), with $x_2^b = 0$. That is,

$$X_1 = \frac{1}{2b}[2a - 2w_1 - t] \tag{16}$$

At the boundary between R3 and R5, (14) and (16) are satisfied simultaneously and hence:

$$w_1 = -a + 2w_2 - t \tag{17}$$

which is, of course, consistent with (7) and (11).

(v) *Region 6* w_1 and w_2 are such that $x_1^b = 0$ and $x_2^a = 0$. Hence, demand for Union 1 labour is given by (1) for $x_2^a = 0$. That is,

$$x_1^a = \frac{1}{2b}[a - w_1] \tag{18}$$

At the boundary between R2 and R6, (5) and (18) are satisfied simultaneously and hence:

$$w_1 = -a + 2w_2 + 2t \tag{19}$$

which is, of course, consistent with (8) and (12).

(vi) *Region 8* w_1 and w_2 are such that $x_1^b = 0$, $x_2^a = 0$ and $x_2^b = 0$. Hence, demand for Union 1 labour is again given by (18).

Figure 2 shows a possible arrangement of these labour demand relations, for given t and w_2.

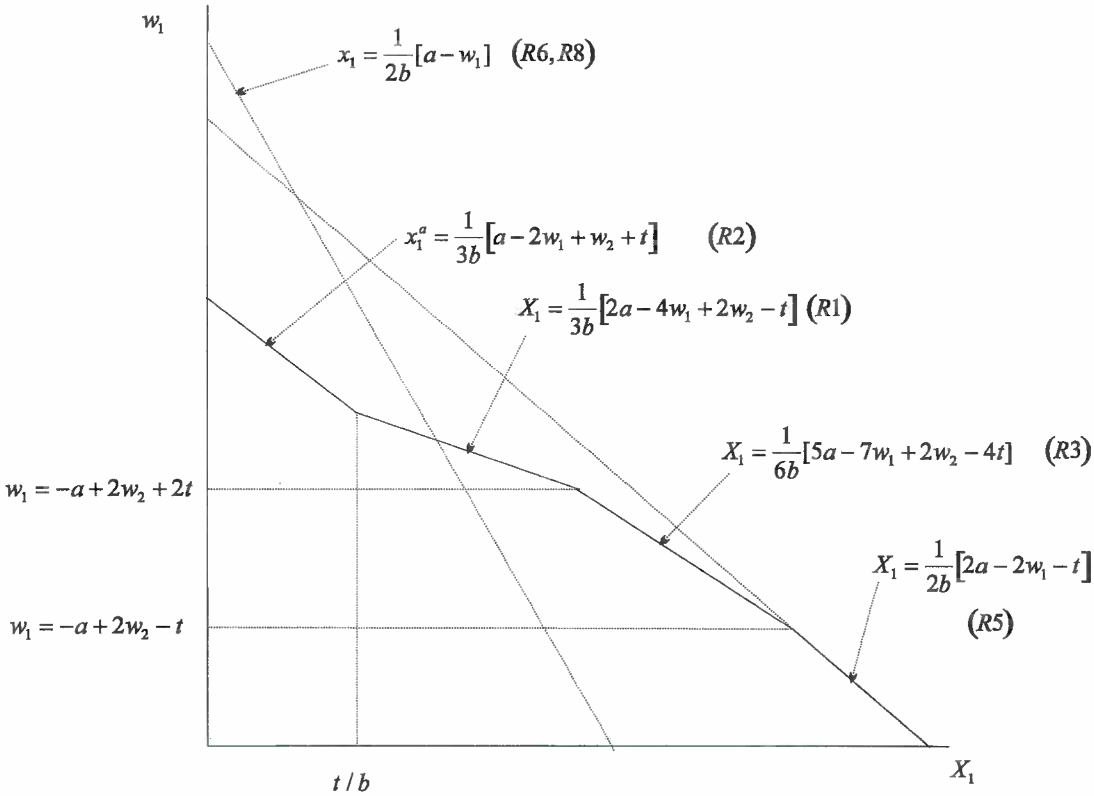

Figure 2

Thus far, this analysis of Stage 2 tells us nothing about the existence, location or properties of any equilibria once we take account of the strategic behaviour of trade unions. We turn now to the analysis of Stage 1 union strategy formation.

3. Stage 1: Union wage-strategy formation

We can model each union as making a choice between two alternative strategies. The first is a low-wage strategy in which Union 1 chooses a wage such that both x_1^a and x_1^b are strictly positive. In terms of Figure 1, this strategy produces outcomes which lie in one of the regions R1, R3 or R5. The alternative high-wage strategy involves the union setting a wage which precludes the possibility of competing in the foreign market: $x_1^a > 0$, $x_1^b = 0$. Such a strategy by Union 1 produces outcomes lying in R2, R6 or R8.[1]

Our analysis proceeds as follows. First, we derive Union 1's optimal wage choice under the low-wage strategy. This generates a (low-wage) reaction function for Union 1, labelled R_1^L. Second, we derive the analogous (high-wage) reaction function, R_1^H, conditional on the selection of a high-wage strategy by Union 1. Then, for each w_2, we compare R_1^L and R_1^H for the level of utility they yield for Union 1. It turns out that whether R_1^L or R_1^H yields the higher utility depends on the value of t. This is shown in Section 4. Thus, for every possible value of t we are able to determine the union's optimal choice of strategy and its associated wage level and hence how these change with both t and w_2. In Section 5 of the paper, we bring together this analysis for both unions, and hence consider the possible Nash equilibrium outcomes of the model, and how these, and their properties, vary with t.

[1] We notice that Union 1 will never choose w_1 such that the outcome will lie in R4, R7 or R9.

3.1 The low-wage strategy

Under a low-wage strategy Union 1 chooses a wage such that, given w_2 and t, Firm 1 is able to compete in both the domestic and foreign markets: that is, in one of regions R1, R3 or R5. Hence demand for Union 1 labour will be given by either (13), (14) or (16). Each of these labour demand equations shifts with both w_2 and t. In order to derive Union 1's wage-reaction function with respect to the wage set by Union 2, we consider how labour demands shift with w_2 for given t. Figure 3 represents these shifts in the relevant labour demands, and considers the associated set of possible union optima.

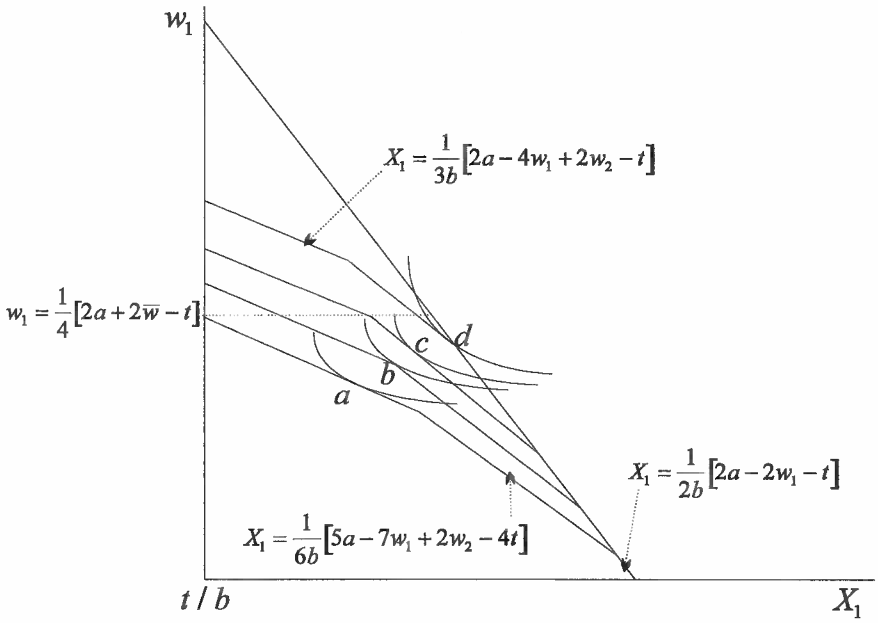

Figure 3

When w_2 is sufficiently low, Union 1 will optimise at 'a' in Figure 3, subject to labour demand equation (13), putting the outcome in R1. As w_2 increases Union 1 responds by raising w_1 according to a reaction function given by the interior solution for union utility maximisation on (13) at 'a'. We can show that there comes a critical w_2, however, which induces Union 1 to optimise at the corner solution, point 'b' in Figure 3. Within a critical range, increases in w_2 then cause w_1 to change along the boundary between R1 and R3, described by the corner solution. As w_2 increases beyond this range, the solution moves initially on to interior optima in R3 on (14), such as at point 'c' in the figure, and then to corner solutions of (14) and (16). Once w_1 has reached the value $w_1 = \frac{1}{4}[2a + 2\overline{w} - t]$, further increases in w_2 will not affect w_1. The outcome is now in R5. We proceed to demonstrate these results, which are then represented in Figure 4.

3.1.1 In R1, labour demand is given by (13). Union 1's optimising wage will be:

$$w_1 = \arg\max\left\{\frac{1}{3b}(w_1 - \overline{w})[2a - 4w_1 + 2w_2 - t]\right\}$$

=> $$w_1 = \frac{1}{8}[2a + 2w_2 + 4\overline{w} - t] \qquad (20)$$

=> $$U_1 = \frac{1}{48b}[2a + 2w_2 - 4\overline{w} - t]^2 \qquad (21)$$

Thus, (20) defines the low-wage reaction function of Union 1 in R1, where Union 2 is setting a low wage.

3.1.2 As w_2 rises, there comes a point at which the interior optimum, given by (20), coincides with the intersection of (13) and (14) - indicated at 'b' in Figure 3. At this value of w_2, both (15) and (20) are satisfied simultaneously. That is,

$$w_2 = \frac{1}{14}[10a + 4\overline{w} - 17t] \tag{22}$$

Hence, as w_2 rises above this level, the low-wage reaction function of Union 1 is given by (15). It remains the case that this segment of the reaction function moves along the boundary between R1 and R3 until w_2 rises so high that the intersection of (13) and (14) coincides with the interior optimum on (14).

3.1.3 The interior solution on (14) is described by:

$$w_1 = \arg\max\left\{\frac{1}{6b}(w_1 - \overline{w})[5a - 7w_1 + 2w_2 - 4t]\right\}$$

=> $$w_1 = \frac{1}{14}[5a + 2w_2 + 7\overline{w} - 4t] \tag{23}$$

=> $$U_1 = \frac{1}{84b}[5a + 2w_2 - 7\overline{w} - 4t]^2 \tag{24}$$

(23) describes Union 1's reaction function in R3 when w_2 rises above that critical level at which (15) and (23) are satisfied simultaneously. That is,

$$w_2 = \frac{1}{26}[19a + 7\overline{w} + 10t] \tag{25}$$

3.1.4 The interior solution given by (23), as indicated by point 'c' in Figure 3, obtains until w_2 is so high that (23) coincides with the corner solution - point 'd' in the figure - where (14) and (16) intersect. This level of w_2 arises when (23) and (17) are satisfied simultaneously. That is,

$$w_2 = \frac{1}{26}[19a + 7\overline{w} + 10t] \tag{26}$$

For w_2 in excess of this, the reaction function is given by (17): Union 1 reacts to a rising w_2 by raising w_1 along the boundary between R3 and R5 so as to keep Firm 1 just unable to compete in its domestic market.

3.1.5 The corner solution given by (17) describes Union 1's reaction function up to the value of w_2 at which (17) coincides with the interior optimum on (16). That is,

$$w_2 = \frac{1}{8}[6a + 2\overline{w} - 3t] \tag{27}$$

As w_2 rises above this level, Union 1's reaction function is given by the interior solution on (16). That is,

$$w_1 = \arg\max\left\{U_1 = (w_1 - \overline{w})\left[\frac{1}{2b}[2a - 2w_1 - t]\right]\right\}$$

Hence,

$$w_1 = \frac{1}{4}[2a + 2\overline{w} - t] \tag{28}$$

As w_2 continues to rise, Union 1's optimal choice of wage does not change: the outcome is in R5 where Firm 1 has a monopoly over both markets.

We can now summarise the entire low-wage reaction strategy of Union 1, as depicted in Figure 4.

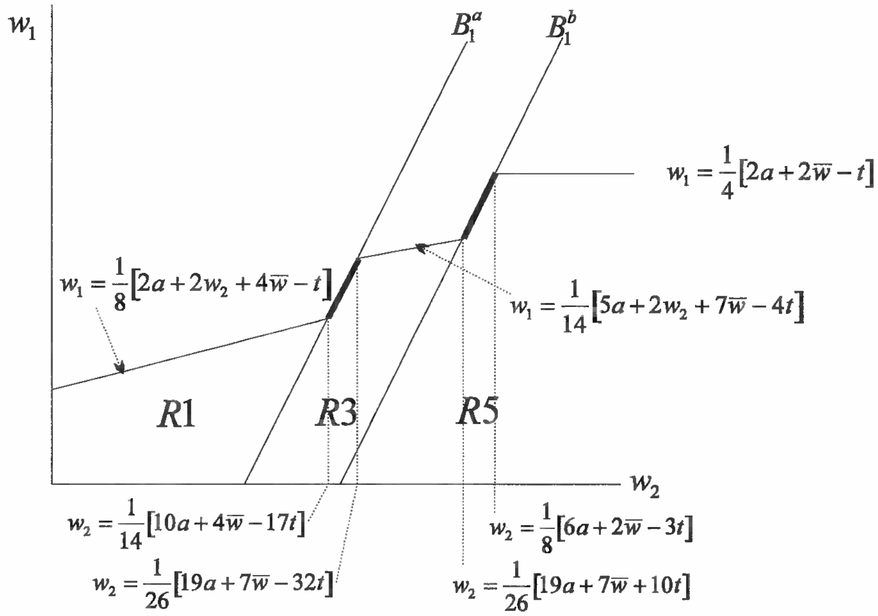

Figure 4

We now turn to examine the alternative high-wage strategy for Union 1.

3.2 High-wage strategy

Under a high-wage strategy, Union 1 is concerned exclusively with selling to the home market.[2] As we shall explain in the next Section, whether or not this strategy dominates the low-wage strategy will depend upon the value of t : that is, on the costs associated with trade.

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2 This is the situation implicitly assumed in Brander and Spencer (1988).

With the high-wage strategy, the union chooses its wage subject to either the labour demand curve of R2, given by (5), or that of R6 and R8, given by (18). The problem is described graphically in Figure 5, for given t.

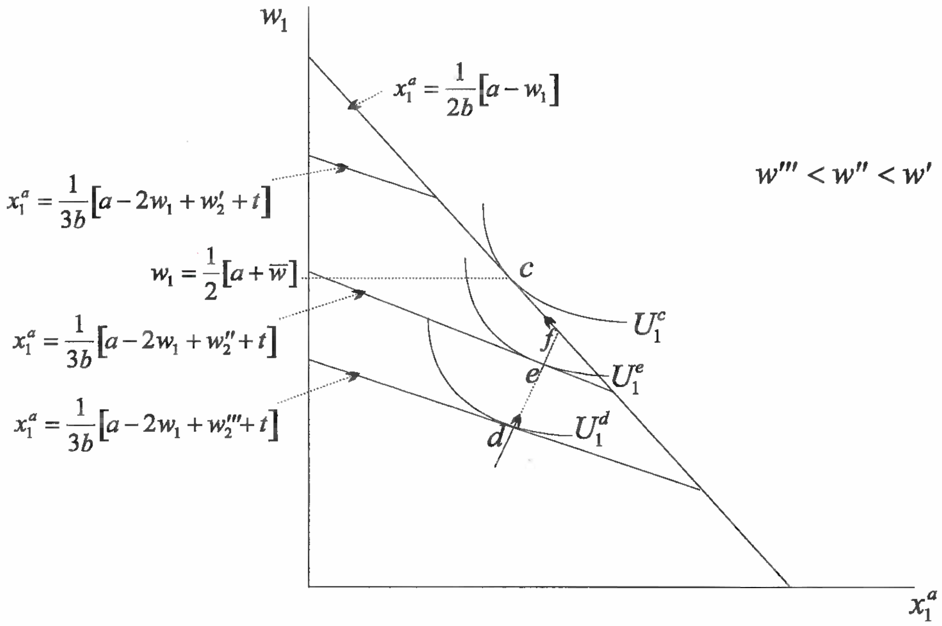

Figure 5

When w_2 is sufficiently low, for example at w_2''' in Figure 5, Union 1 will optimise at 'd', where it is subject to labour demand equation (5) in R2. As w_2 rises, Union 1 responds by raising its wage according to a reaction function given by the interior solution for utility maximisation on (5): plotting the locus of points such as 'd', 'e' and 'f' in the figure. There comes a critical value of w_2 at which this interior solution on (5) coincides with the intersection of (5) and (18): as at 'f' in Figure 5. Within a critical range, increases in w_2 then cause w_1 to change along the boundary between R2 and R6, described by the corner solution. Once w_1 has reached the value $w_1 = \frac{1}{2}[a + \overline{w}]$, further increases in w_2 will not affect w_1. The outcome is now in R6 and Union 1 is maximising utility subject to (18): it has a domestic monopoly in

Country A. We proceed to demonstrate these results, which are then represented in Figure 6.

3.2.1 In R2, labour demand is given by (5). Union 1's optimising wage will be:

$$w_1 = \arg\max\left\{U_1 = \frac{1}{3b}[w_1 - \overline{w}][a - 2w_1 + w_2 + t]\right\}$$

Hence, it follows that Union 1's reaction to Union 2 setting low values of w_2 is given by:

$$w_1 = \frac{1}{4}[a + w_2 + 2\overline{w} + t] \tag{29}$$

=>
$$U_1 = \frac{1}{24b}[a + w_2 - 2\overline{w} + t]^2 \tag{30}$$

Thus, (29) defines the high-wage reaction function of Union 1 in R2, where Union 2 is setting a low wage.

3.2.2 As w_2 rises, there comes a point at which the interior optimum, given by (29), coincides with the intersection of (5) and (18). At this value of w_2, both (19) and (29) are satisfied simultaneously. That is,

$$w_2 = \frac{1}{7}[5a + 2\overline{w} - 7t] \tag{31}$$

Hence, as w_2 rises above this level, the high-wage reaction function of Union 1 is given by (19). Thus the reaction function coincides with the boundary between R2 and R6. This obtains until w_2 rises sufficiently that the intersection of (5) and (18) coincides with the interior optimum on (18).

3.2.3 The interior solution on (18) is described by:

$$w_1 = \arg\max\left\{\frac{1}{2b}(w_1 - \overline{w})[a - w_1]\right\}$$

$$\Rightarrow \qquad w_1 = \frac{1}{2}[a + \overline{w}] \qquad (32)$$

Thus, (32) describes Union 1's reaction function in R6 when w_2 rises above that critical level at which (19) and (32) are satisfied simultaneously. That is,

$$w_2 = \frac{1}{4}[3a + \overline{w} - 4t] \qquad (33)$$

It follows that the high-wage strategy for Union 1 can be summarised as in Figure 6.

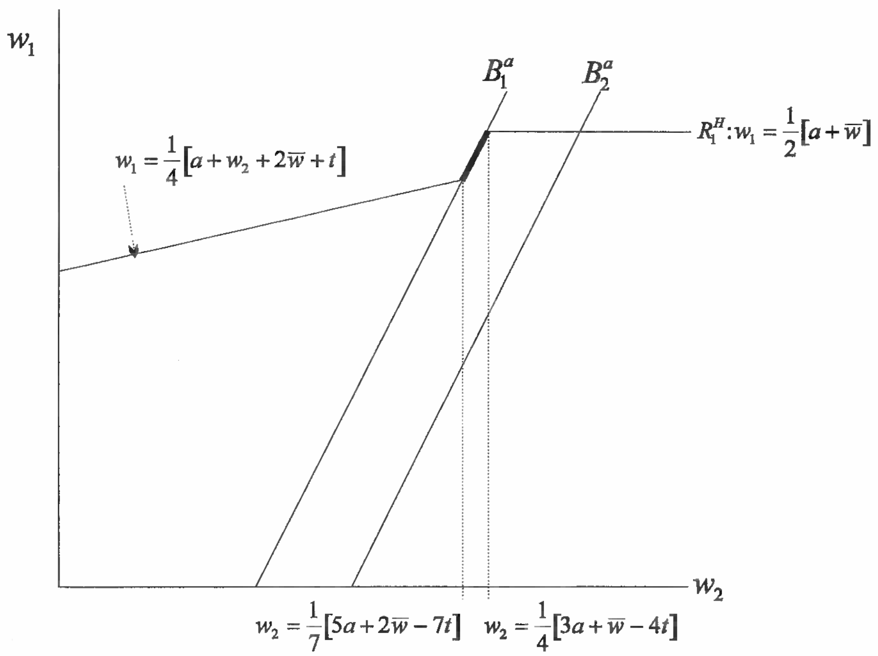

Figure 6

In this Section, then, we have derived both the low- and high-wage reaction functions of Union 1 and seen how each depends upon the various parameters of the model. We are now able to analyse the Union's choice over the two strategies and to show how this depends, in particular, on both w_2 and t.

4. Strategy selection

In Figure 7 we show the boundary conditions and Union 1's two reaction functions. We also exploit (28) from which it is clear that the union will never set a wage in excess of $\frac{[a+\overline{w}]}{2}$.

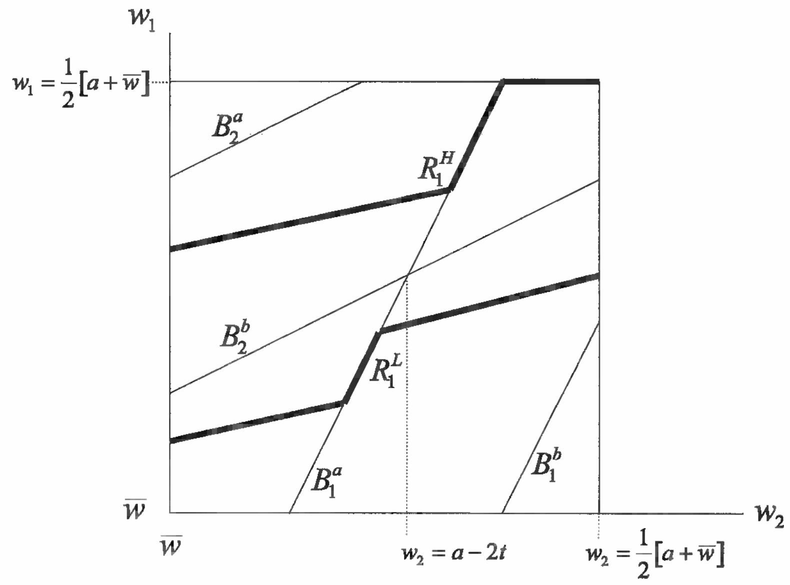

Figure 7

Consider initially the choice between R_1^H and R_1^L for low values of w_2, such that R_1^H is given by (29) in R2, and R_1^L by (20) in R1. The utility, U_1^H, associated with R_1^H is given by (30):

$$U_1^H = \frac{1}{24b}\left[a + w_2 - 2\overline{w} + t\right]^2$$

Similarly, the utility, U_1^L, associated with R_1^L for this range of w_2 is given by (21):

$$U_1^L = \frac{1}{48b}\left[2a + 2w_2 - 4\overline{w} - t\right]^2$$

Comparison of (30) and (21) reveals that Union 1 will prefer the low-wage to the high-wage strategy iff:

$$w_2 \geq -a + 2\overline{w} + \left[\frac{1+\sqrt{2}}{2-\sqrt{2}}\right]t \tag{34}$$

For w_2 less than this, Union 1 makes no attempt to set a wage to enable Firm 1 to penetrate Market B but instead follows the high-wage strategy. As w_2 rises to satisfy condition (34), Union 1 switches to the low-wage strategy. We define as the *switching wage*, the value of w_2 which just satisfies (34) with equality. It is clear from (34) that the Union's choice of strategy depends upon the value of t: the higher is t the greater is the value of w_2 which is necessary to induce the switch to the low-wage strategy. We capture this in Proposition 1.

Proposition 1 The switching wage is increasing in t. Hence, as t rises the value of w_2 needed to induce Union 1 to switch from R1 to R2 increases.

From (34) it follows that:

$$\frac{dw_2}{dt} = \left[\frac{1+\sqrt{2}}{2-\sqrt{2}}\right] > 0 \tag{35}$$

This describes the choice of Union 1 over R1 and R2. Before considering the union's choice over other possible alternative regions, we turn to the simultaneous analysis of the two unions' reaction functions. This enables us to describe the possible equilibria of the model.

5. Cournot-Nash Equilibria

In Figure 8, we represent the reaction functions of both unions simultaneously. We depict the case in which t is sufficiently low that the switching wage is less than the value of the wage at which the (low-wage) reaction functions of the two unions intersect in R1. The relevant segments of the two low-wage reaction functions are given by (20) for Union 1 and, analogously, by:

$$w_2 = \frac{1}{8}[2a - 4w_1 + 2\overline{w} - t] \tag{36}$$

for Union 2.

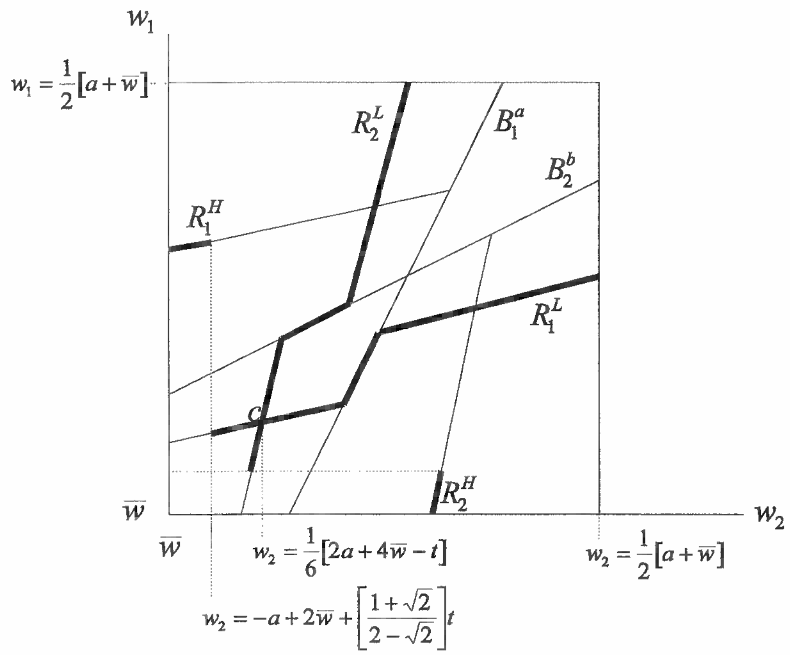

Figure 8

Point ‘c’ in the figure represents a Cournot-Nash equilibrium as each union is optimally on its low-wage reaction function. At this equilibrium, (20) and (36) are satisfied simultaneously and hence,

$$w_1 = w_2 = \frac{1}{6}[2a + 4\overline{w} - t] \tag{37}$$

This yields Proposition 2.

Proposition 2 The equilibrium wage in R1, in which each union optimally plays a low-wage strategy, falls as t rises.

This follows from (37), as it is clear that in equilibrium:

$$\frac{dw_1}{dt} = \frac{dw_2}{dt} = -\frac{1}{6} < 0 \tag{38}$$

The clear implication of this is that in an R1 equilibrium, the equilibrium wage increases as economic integration reduces the costs associated with trade.

As is clear from Figure 8, the equilibrium characterised by (37) obtains only if the equilibrium wage is greater than or equal to the switching wage. This requires that the equilibrium wage defined by (37) is not less than the switching wage implied by (34). The condition for this is given in Proposition 3.

Proposition 3 The low-wage equilibrium in R1 obtains if and only if $t \le 0.311[a - \overline{w}]$.

There is a critical value of t at which the switching wage and the equilibrium low-wage coincide. This t is given by:

$$t = \frac{8\left[2 - \sqrt{2}\right]}{8 + 5\sqrt{2}}\left[a - \overline{w}\right] \tag{39}$$

or, approximately, $t = 0.311[a - \overline{w}]$. For t less than or equal to this, each union will play the low-wage strategy and the outcome will be in R1, given by (37). It then follows that:

Proposition 4 For $t > 0.311[a - \overline{w}]$, there is a range of t for which equilibrium does not exist.[4]

For t marginally in excess of $0.311[a - \overline{w}]$, equilibrium defined by (37) does not obtain as each union would respond to the rival union's choice of such a wage by switching to a high-wage strategy. When one of the union's switches to a high-wage, the other raises its wage under a revised low-wage strategy. The switching union is then likely to switch back to a low-wage strategy, but not one consistent with equilibrium. The process does not converge. Figure 9 depicts a situation in which equilibrium does not exist: the dominant reaction functions do not intersect.

[4] In this paper, we consider only pure strategy equilibria.

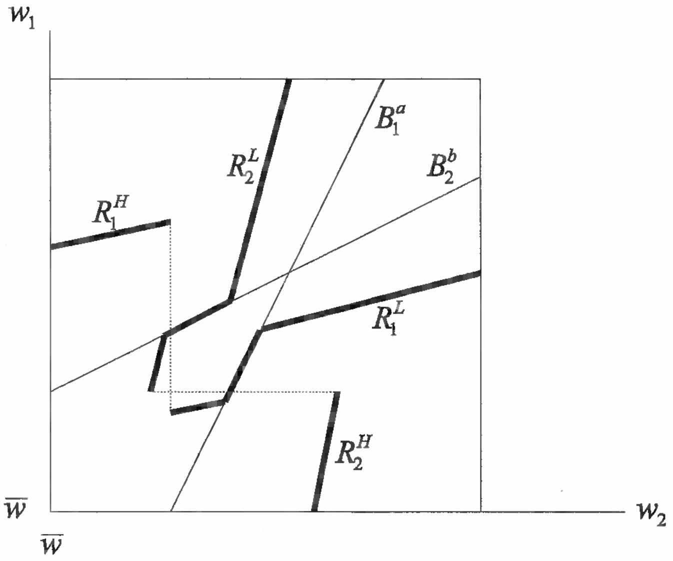

Figure 9

As t rises above the critical value defined by (39), there is no intersection between R_1^L and R_2^L to the right of the switching point described by (34). Thus, $t = 0.311[a - \overline{w}]$ marks the critical level of t above which symmetric intra-industry trade or reciprocal dumping will not occur. Indeed, the two unions' dominant reaction function segments are entirely without intersection for some range of t in excess of this critical level. From the figure, it would appear that there are potential asymmetric equilibria where, for example, the dominant segments R_1^H and R_2^L might intersect. It turns out, however, that there are no such equilibria. Instead, further equilibria exist only in R6 when t has risen sufficiently high as to induce each union to play the high-wage strategy associated with (18). This value of t is derived under Proposition 5.

Proposition 5 For $t \geq 0.354[a - \overline{w}]$, there will be a symmetric no-trade equilibrium in R6 with both unions setting wages equal to $[a + \overline{w}]/2$.

For this no-trade equilibrium to hold, t must be sufficiently high for Union 1, for example, to prefer the high wage of (18) in R6 to the low-wage strategy of (23) in R3, in response to the high wage of Union 2. To see this, suppose Union 2 is setting the high wage of $[a+\overline{w}]/2$. We are looking for the critical value of t such that $U_1^H = U_1^L$, where U_1^H is the utility to Union 1 of responding with $w_1 = w_2 = \frac{1}{2}[a+\overline{w}]$ whilst U_1^L is the utility of responding with (23). Hence,

$$U_1^H = [w_1 - \overline{w}]x_1^a = [w_1 - \overline{w}]\left[\frac{a-\overline{w}}{2b}\right] = \frac{1}{8b}[a-\overline{w}]^2 \qquad (40)$$

and U_1^L is as given by (24), with $w_2 = \frac{1}{2}[a+\overline{w}]$. Hence,

$$U_1^L = \frac{1}{42b}[3(a-\overline{w}) - 2t]^2 \qquad (41)$$

Thus, $U_1^H = U_1^L$ iff:

$$U_1^H = U_1^L = \frac{1}{42b}[3(a-\overline{w}) - 2t]^2 = \frac{1}{8b}[a-\overline{w}]^2$$

=> $$t = \frac{6-\sqrt{21}}{4}[a-\overline{w}] \qquad (42)$$

or, approximately, $t = 0.354[a-\overline{w}]$.

Hence, the non-existence result obtains for t in the interval $0.311(a-\overline{w}) < t < 0.354(a-\overline{w})$. We define the value of t in (42) as the *prohibitive level* of trade costs associated with equilibria characterised by an absence of trade.

It is interesting to compare this prohibitive level with that obtaining in a non-union setting. With reference to Figure 1, it is clear that symmetric trade outcomes lie on the 45° line between the origin, ($\overline{w}$, $\overline{w}$), and the intersection of B_1^a and B_2^b, ($a-2t$, $a-2t$). The origin, of course, defines the non-union outcome, $w_1 = w_2 = \overline{w}$. As t rises, $a-2t$ falls and the point of intersection of the two boundaries moves down the locus towards the origin: R1 collapses as t increases. Only when $a-2t < \overline{w}$ is it the case that R1 no longer contains the non-union equilibrium. Hence,

$$t^n = \frac{1}{2}[a - \overline{w}] \tag{43}$$

is the prohibitive level of t in the non-unionised setting. This establishes Proposition 6.

Proposition 6 Unionised markets are associated with a reduction in the prohibitive level of t: reciprocal intra-industry trade is less likely in the presence of unions.

Under unionised labour markets, the prohibitive level of t is given by (42). This is less than that obtaining in a non-union setting:

$$t = \frac{6-\sqrt{21}}{4}[a - \overline{w}] < t^n = \frac{1}{2}[a - \overline{w}] \tag{44}$$

Thus, we have found that there are two ranges of t which yield equilibrium in the unionised setting. The first, with $t \leq 0.311[a - \overline{w}]$, produces outcomes in R1 in which each union plays a low-wage strategy and the equilibrium is characterised by reciprocal international trade. The equilibrium wage depends negatively on t, as is shown in (38). Hence, increased economic integration induces monopoly unions to set higher wages. The second range of t values, consistent with equilibrium in R6, is given by $t \geq 0.354[a-\overline{w}]$, for which no trade occurs and with each union following a high-wage strategy of setting $w_1 = w_2 = \frac{1}{2}[a+\overline{w}]$.

We now turn to consider the welfare implications of trade in the unionised model compared to those in the standard model where unions are absent.

6. Unions and the inefficiency of trade

In the standard intra-industry trade model without unions, it is well-known that when trade costs are initially high a fall in t will have the apparently paradoxical effect of reducing welfare. This is because although Cournot duopolists have an incentive to engage in reciprocal dumping, such trade is welfare-reducing when t is sufficiently close to the prohibitive level.

Proposition 7 In the non-union setting, welfare declines as t falls for $t > 0.364[a-\overline{w}]$.

In the absence of unions, with $w_1 = w_2 = \overline{w}$, consumer surplus is given by:

$$CS_1 = \frac{1}{2}[a-p^a][X^a] \qquad (45)$$

and producer surplus by:

$$PS_1 = [p^a - \overline{w}][X^a] - tx_1^b \tag{46}$$

in equilibrium, where x_1^b and X^a can be derived from (1) through (3). Thus, welfare is given by:

$$W_1 = CS_1 + PS_1 = \frac{1}{18b}\{[2(a-\overline{w})-t][4(a-\overline{w})+t] - 6t[(a-\overline{w})-2t]\} \tag{47}$$

Hence,

$$\frac{dW}{dt} = \frac{2}{9b}[11t - 4(a-\overline{w})] = 0 \tag{48}$$

=> $$\frac{dW}{dt} > 0 \text{ iff } t > \frac{8}{22}(a-\overline{w})$$

or $t > 0.364(a-\overline{w})$, approximately. QED.

Proposition 8 Unions preclude the possibility of welfare-damaging intra-industry trade.

In the absence of unions, reductions in trade costs in the interval $0.364(a-\overline{w}) < t \leq 0.5(a-\overline{w})$ cause a reduction in welfare. In the presence of unions, trade does not occur over this interval, as the prohibitive level of t, given by (42), falls below this interval. This establishes the Proposition.

Furthermore, in the interval, $0 \leq t \leq 0.311(a-\overline{w})$, for which intra-industry trade occurs in the presence of unions, it can be shown that reductions in t are welfare-enhancing (see Naylor (1996)). Thus, in an equilibrium unionised setting, falling t always raises welfare. The optimal (supra-national) tariff is zero.

7. Unions and the Prisoners' Dilemma

Whether or not the Nash equilibrium in low-wages Pareto-dominates the collusive outcome for the unions depends on t. The low-wage strategy yields utility to Union 1 given by (21). In equilibrium, this is:

$$U_1^L = \frac{1}{27b}\left[2(a-\overline{w})-t\right]^2 \tag{49}$$

Conversely, under collusion, each union will set a wage of $[a+\overline{w}]/2$ in R6. Union 1, for example, will face demand given by (18). It follows that U_1^H is given by:

$$U_1^H = \frac{1}{8b}\left[a-\overline{w}\right]^2 \tag{50}$$

From (49) and (50), it follows that the collusive outcome yields higher utility than the Nash equilibrium if:

$$t > \left[2-\sqrt{\frac{27}{8}}\right]\left[a-\overline{w}\right] \tag{51}$$

or $t > 0.163[a-\overline{w}]$, approximately. This establishes Proposition 7:

Proposition 7 In the interval $0.163[a-\overline{w}] < t \leq 0.311[a-\overline{w}]$, the problem facing the unions is characterised by the properties of the Prisoners' Dilemma: the Cournot-Nash equilibrium is Pareto-dominated by the collusive outcome.

Hence, one would expect that there will be a strong incentive for unions to form an international agreement, colluding over a high-wage strategy for this range of t, and hence avoiding utility-reducing underbidding. As $t < 0.163[a - \overline{w}]$, however, unions are better off forming independent, decentralised wage agreements.

In Figure 10, we summarise the relationship between t and the labour market equilibria. $t = 0.5[a - \overline{w}]$ shows the prohibitive level of t for the non-union setting.

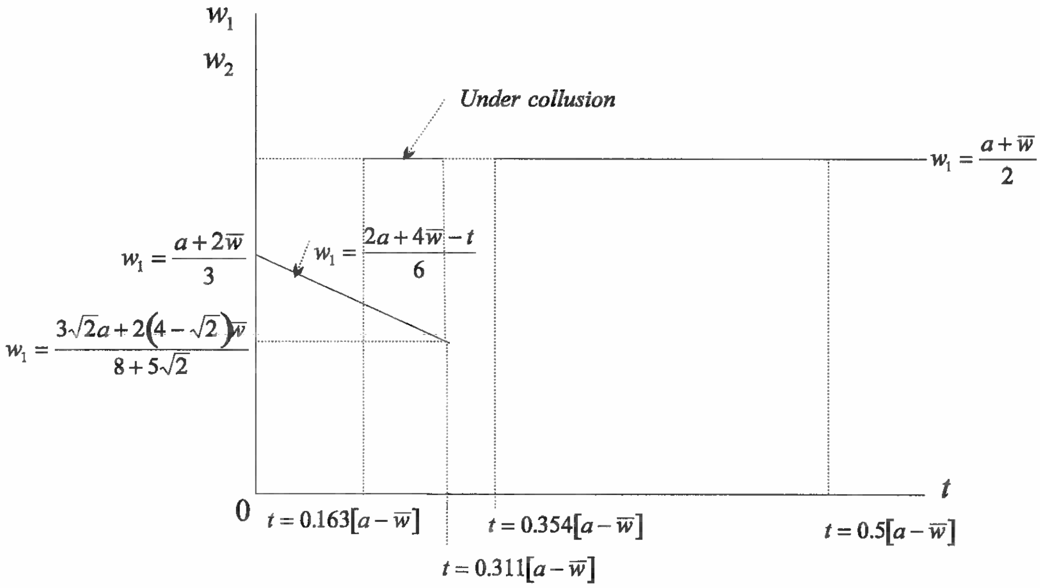

Figure 10

8. Summary and conclusions

In this paper, we have developed a framework in which to explore the relationship between wage outcomes and the nature of international trade. We have characterised the full set of possible trade regimes for different combinations of wages: as represented in Figure 1. We have also considered the possible wage strategies of rival unions and shown how a union's choice of wage strategy will depend on the value of trade costs. Finally, we have examined the possible Nash equilibria associated with the unions' strategy choices and derived a number of results. Our main findings are the following.

In a non-union setting, Cournot-Nash behaviour in the product market will generate intra-industry trade, or reciprocal dumping, for $t < 0.5(a - \overline{w})$. As $t \geq 0.5(a - \overline{w})$, costs associated with trade are prohibitively high and there is no trade in equilibrium. In the union model developed in this paper, with Nash equilibrium in both the product and labour markets, the prohibitive level of t at which trade no longer characterises is $t = 0.354(a - \overline{w})$. Hence, the prohibitive level of trade costs is lower in the unionised setting: no-trade equilibria are more likely under unions.

In the non-union setting, any $t < 0.5(a - \overline{w})$, the prohibitive level, will induce intra-industry trade. In the unionised framework, this is not so: it is not sufficient that t is less than the prohibitive level, rather, t must be less than $t = 0.311(a - \overline{w})$ for reciprocal trade to characterise the equilibrium. In the interval $0.311(a - \overline{w}) < t < 0.354(a - \overline{w})$, equilibrium is non-existent. When $t \leq 0.311(a - \overline{w})$, further reductions in t, representing increased product market integration, lead monopoly unions to set higher wages, and hence their utility is unambiguously rising as t falls.

For values of t in the interval $0 \leq t < 0.163(a - \overline{w})$, the Cournot-Nash reciprocal trade equilibrium Pareto-dominates the collusive-union outcome in which both unions set the (domestic) monopoly wage: t is sufficiently low that unions - *jointly* - stand to gain by accommodating international trade. However, in the interval $0.163(a - \overline{w}) \leq t \leq 0.311(a - \overline{w})$, the game between the unions has the characteristics of the Prisoners' Dilemma: the collusive outcome Pareto-dominates the Nash equilibrium and hence trade equilibria will be vulnerable to international union collusion.

In the absence of unions, intra-industry trade is welfare-enhancing only if $t < 0.364(a - \overline{w})$. If, instead, $0.364(a - \overline{w}) < t < 0.5(a - \overline{w})$, equilibrium intra-industry-trade will occur but will be welfare-reducing, with reductions in t further eroding welfare. With unions these welfare-damaging equilibria are removed: trade does not exist in equilibrium for this interval of t. Indeed, it can be shown that in the presence of unions reductions in t are welfare-augmenting over all equilibria.

In future work, it would be interesting to develop the model in various further directions. First, we have considered a two-stage game in which trade costs, t, are taken as given and independent of the direction of trade. It could be assumed instead that t is chosen separately by each domestic government, t_1 not necessarily equal to t_2, in a three-stage game, prior to wage-setting. We have not followed this route in the current paper as our context is one in which t, to the extent that it is a policy variable, is pre-set by international agreement. Second, the Stage 1 reaction functions we derive assume monopoly unions. It would be interesting to consider the case of the more general right-to-manage model of wage bargaining. Finally, we have considered the perfectly symmetric case. It would be of value to relax the assumption of symmetry, especially in the case of the reservation wage, $\overline{w}$, and examine how this affects the possible Nash equilibria.

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