UNIONIZED OLIGOPOLY, TRADE LIBERALIZATION AND LOCATION CHOICE

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Abstract

In a two-country reciprocal dumping model, with one country unionized, we analyze how wage setting and firm location are influenced by trade liberalization. We show that trade liberalization can induce FDI, which is at odds with conventional theoretical wisdom and cannot happen in a corresponding model without unionization. FDI is undertaken partly to win a distributional battle with unionized labor, and the incentives to invest abroad can be too large seen from a welfare point of view.

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1 Introduction

Closer international economic integration is perhaps one of the most important societal trends in the last half of the twentieth century. Increased specialization, larger scales of production and harsher competitive pressures are likely to benefit consumers across the globe. Still, the globalization of our economies is viewed with scepticism and fear by many. Will trade liberalization mean the end to decent pay and job security? Will wages be set in Beijing, to quote Freeman (1995)? Or will the good jobs disappear to non-unionized foreign countries with more lax labor regulations, with "a great sucking sound", as Ross Perot so famously put it? In short; does globalization give capital the upper hand, either leading to job losses or to a depression of wages? Borjas and Ramey (1995) argue that increased trade can reduce the possibility for blue-collar workers to extract rents from their firm, and that this can help explaining the rising wage inequality in the United States - and find empirical support for their view. This type of empirical studies is an important back-drop for the present work.

Of course, if "globalization" is taken to mean that firms and their workers totally lose any market power they might have had, this is bound to hurt unionized workers. But globalization can be given less extreme interpretations. Here we study an international oligopoly where international transport costs are reduced, but the number of active firms remains the same. This has been a popular model in the theoretical literature that studies how unionized labor might fare in the face of globalization, as we shortly shall review. The main novelty here is to allow for capital flight, which we think captures an important aspect of reality. We allow for two different types of foreign direct investment (FDI). The less dramatic case is when a firm chooses to serve a non-unionized foreign market from a plant built in that country rather than through exports. The more radical option is to move all the activities of a firm to this non-unionized economy, including production for the former home market.

It borders on the trivial to note that high union wages creates incentives for capital flight (of either form). It is perhaps a more subtle point that we show that economic integration – in the sense that the marginal trade cost is reduced – can strengthen the incentive to capital flight. Common wisdom, though, is that lower transport costs favor the export solution over FDI, as exports become cheaper when the trade cost drops. Foreign direct investments have been gaining in importance in world economic relations in recent decades. At the same time there has been a strong momentum towards trade liberalization. This is an apparent puzzle. The usual explanation is that this is the interplay of opposing forces: Trade liberalization points at

more exports, but "something else" (as the fixed costs of establishing foreign plants going down in parallel with the marginal trade cost) leads the firms to undertake more FDI [see, e.g., Markusen and Venables (1998)]. Our point is that in an international unionized oligopoly model it can be explained how economic integration in the sense that marginal trade costs are lowered in itself can cause FDI.[1]

In general terms, our results also support the notion that the problem with unions and economic integration is "sucking sound" job losses rather than Beijing wages. If all union sector jobs disappear due to a full move of the firm abroad, it is a rather academic question if one should refer to this as a loss of jobs or a drop in wages. However, when FDI signifies that the foreign country is served by a new-built plant abroad, wages for the remaining unionized workers are shown actually to go up: The cost saving potential from the firm's side is that they are fewer.

We also want to highlight the result that trade liberalization can lead to a drop in national welfare. Unionized workers lose, and the possible gains for other groups are not always large enough to outweigh this. One key reason for this is that the combination of strong unions and trade liberalization can lead the firm to invest real resources in FDI just to win a distributional battle with the union. It also enters the picture that trade liberalization can lead to profit shifting from owners of firms in a unionized economy to owners of firms in non-unionized economies.

A growing body of research studies theoretical models of international unionized oligopoly.[2] In turn, a subset of these papers study the impact of reduced trade barriers in an international unionized oligopoly framework. The papers that perhaps are closest to our own work are Naylor (1998, 1999). Naylor uses a linear demand international unionized oligopoly model, just as

[1] The only empirical study which, to our knowledge, tests on a disaggregate level the relationship between trade costs on the one hand and exports/FDI on the other, does not support the standard theoretical prediction. Feinberg, Keane and Bognanno (1998) test how MNCs and their affiliates responded to US-Canada tariff reductions. They find that tariff reductions led to more foreign direct investment rather than more exports. See also Hanson (1998), which surveys the existing literature on the effect of NAFTA on industry location. The broad picture suggests that trade liberalization triggers relocation of firms.

[2] A seminal paper is Brander and Spencer (1988). Their main focus is on how unions influence optimal strategic trade policy. Also Dowrick (1989) includes a trade union model where oligopoly rents are the source of union power. Mezzetti and Dinopoulos (1991) and Bughin and Vannini (1995) investigate the interrelationship between unionism and a firm's choice between serving a foreign market through exports or by investing abroad. In a different set-up, Zhao (1995) studies unionized international oligopoly and cross-hauling foreign direct investment. Straume (2001) studies the scope for collusion among firms and unions in an international oligopoly situation. However, none of these studies addresses how closer economic integration affects outcomes in unionized oligopolies.

we do. Monopoly unions set wages, but employment determination is left to the discretion of the firm, again just as in our model. A key point in Naylor's analysis is that in many popular models of wage determination, wage claims are governed by the elasticity of labor demand rather than firms' profitability. When trade costs are lowered, there will be harsher competition among the participants in an international oligopoly, but the output of the firms will go up, which in his framework (for a situation with two-way trade between the countries initially) implies that labor demand becomes less elastic. So while firms suffer a profit loss, unions will choose to set higher wages.[3] Because of the output expansion, employment nevertheless goes up, so unionized labor wins on both counts. This is undeniably a more rosy account of the impact of trade liberalization on the situation of unionized labor than the popular notions that for example are expressed in the above Ross Perot quote. The present paper extends Naylor's reasoning by allowing for foreign direct investment. Precisely because of the tendency to wage increases after trade liberalization that Naylor points out, trade liberalization gives firm an increased incentive to capital flight, which is not the case in a corresponding model without unions. Another difference between our framework and that of Naylor is that whereas he studies trade liberalization between two unionized countries, we study a situation with one unionized and one non-unionized country. Intuitively, FDI triggered by union-set wages should be more relevant when union strength differs considerably between the two economies.[4]

In our model as in Naylor's work, economic integration is pictured as a marginal decrease of the trade cost that is incurred when goods are delivered from one country to the other. Driffil and van der Ploeg (1993, 1995) study economic integration in a similar way, but apply a model of monopolistic, rather than oligopolistic competition.[5] Alternatively, Sørensen (1993, 1994) and Huizinga (1994) compare autarky with full integration.[6] It can be argued

[3] This inverse relationship between trade costs and wages is also found in Driffil and van der Ploeg (1995). It is consistent with some empirical findings from US manufacturing industries [see Gaston and Trefler (1994) and Lovely and Richardson (1998)].

[4] Of course, both our assumption of non-unionized labor in the foreign country and Naylor's assumption of equally powerful unions should be seen as benchmark cases. Even among countries that are rather similar, as the European ones, labor market institutions and wage structures are quite different. Durand, Madaschi and Terribile (1998) find significant cross-country differences in manufacturing wages between European countries, even if cross-country differences in productivity are taken into account.

[5] The main focus in these latter articles is on the effects of national versus international unionism.

[6] It is noteworthy that these latter models yield predictions that sometimes are in apparent contradiction to those that come out of Naylor's analysis. For example, they

that Naylor's modeling approach encompasses that of Sørensen and Huizinga, which is why we have chosen to work with a model quite close to Naylor's framework.[7] Note that also this body of literature works with the assumption that FDI is not possible.[8]

The paper is organized as follows: Section 2 presents the model outline. The model can be described as a three-stage game. In section 3, we analyze the third stage of the game in which firms in an international oligopoly choose outputs. Given the nature of the previous stages of the game, we have to consider three possible trade/location regimes at this stage. In section 4, we analyze the second stage of the game in which monopoly unions set wages. Again, outcomes are regime-contingent. In section 5, we analyze the firm's subgame perfect location choice. We show how these choices vary with trade costs. We also consider the non-union benchmark case as a comparison with our main results. Section 6 discusses welfare implications and section 7 concludes.

2 The model

We consider two countries, denoted H (home) and F (foreign), and two producers, denoted A and B. Initially, producer A is located in the home country and producer B resides in the foreign country.[9] There is a monopoly trade union in country H, whereas labor is assumed non-unionized in country F. Output is produced in a constant returns to scale process, with labor as the only input. Let x and y denote A's sales and u and v denote B's sales in the home and foreign countries, respectively. We assume inverse demand in

predict that trade liberalization leads the union wage to fall, whereas Naylor predicts that it will rise. The contradiction is only apparent, though, because also Naylor's model predicts that the wage under autarky is higher than the one under full integration. But given that trade costs are sufficiently low as to induce two-way trade, a still lower trade cost will increase the wage.

[7] Andersen and Sørensen (1993) and Danthine and Hunt (1994) model trade liberalization as an increase in the elasticity of substitution between domestic and foreign goods.

[8] Naylor and Sanoni (1998), however, explicitly consider foreign direct investment in a framework corresponding to that used in Naylor (1998, 1999). This time the possibility of serving a foreign market through exports is ruled out by assumption, so again the choice between exports and foreign direct investment is not studied.

[9] We could have extended the model by, say, introducing $n > 1$ foreign firms. That would change our quantitative results, such as the cutoff points between the regimes. However, it can be shown that our main findings would not change.

the two countries to be symmetric and given by:

$$p = a - b(x + u) \tag{1}$$
$$q = a - b(v + y) \tag{2}$$

$a, b > 0$. p is the price in the home country, while q is the price in the foreign country.

The difference in unionization across the two countries is assumed to imply higher costs of production in the home country relative to the foreign one. More specifically, we model a situation where the competitive wage in the two countries are equal ($\overline{w} \geq 0$) and the union in the home market sees this wage level as their reservation wage, setting wages to maximize a simple Stone-Geary type utility function:[10]

$$U = (w - \overline{w})z \tag{3}$$

z is A's production in the home market and equals $x + y$ in the case of no FDI.[11] $\overline{w} < a$ is assumed.

Given our assumptions, B is located in a low cost country, and we assume that this producer continues to produce only in that country. We look at a situation where FDI is potentially undertaken by firm A, and focus on two different ways for that firm to invest abroad. A can sink some fixed cost $J > 0$ to establish a new production facility in the foreign country, able to supply that market. We will call this strategy regime II, or 'partial FDI'. Regime I is the base case of no investment. However, by sinking another fixed cost G, A can instead move the entire home production unit to the foreign country, enabling A to produce for both countries in the low-cost country. This strategy is referred to as regime III or 'full FDI'. The relative cost of these two investment strategies will be discussed later.

We assume competition between the two producers to be Cournot and adopt the segmented market hypothesis. Thus both firms choose separate quantities for the two markets. Furthermore, there is a per unit cost of trade, denoted $t \geq 0$, which is incurred by both producers if they attempt to export

[10] In this model, depending on trade costs and wages, either none, only one or both firms will export. Given that the wages are endogenously determined, it is not clear how the union and the firm should reach an agreement on whether to export, deter imports or adapt to imports. In a right-to-manage set-up this choice would have to be bargained over in parallel with wage determination. Using the monopoly union set-up allows both these decisions to be taken by the union, evading the problem. This consideration applies equally to the models of Naylor (1998, 1999).

[11] We have chosen this form for union utility to enable direct comparison of profits and union utility. Union utility and profits are here measured in terms of the same unit.

to the other country. Trade liberalization in our model is seen as a marginal reduction in this cost.

We model the game structure as follows: First, the home firm chooses whether to invest in the foreign market by either of the two ways described above, or not to invest at all. The most irreversible decision is arguably the one made by producer A concerning his location choice. In line with this reasoning, it is natural to let this decision be taken first. Next, we assume unions to set wages, whereupon the producers simultaneously choose quantities.[12]

We solve, of course, by backward induction, and the following sections discuss the three different stages starting with the production decision at stage three.

3 Stage 3. Production

We distinguish among three basic scenarios at the production stage: Either firm A has not invested (regime I), or it has invested in either of the two possible ways (regime II or III). In addition, the wage levels have already been determined. We also study a non-union benchmark where the wages in the two countries are assumed constant and equal.

3.1 Regime I. No FDI

Here, firm A has not invested. Thus a simple two-plant, two country Cournot duopoly prevails where the two producers choose quantities as follows:

$$x, y = \arg\max_{x,y}[(a - b(x + u) - w)x + (a - b(v + y) - w - t)y] \qquad (4)$$

$$u, v = \arg\max_{u,v}[(a - b(v + y) - \overline{w})v + (a - b(x + u) - t - \overline{w})u] \qquad (5)$$

This is of course subject to the constraint that all production quantities should be non-negative.

It is easily demonstrated that the equilibrium sales are:

[12] This sequence of moves is the same as in Naylor and Santoni (1998), Bughin and Vannini (1995), Zhao (1995) and Collie and Vandenbussche (1998). On the other hand, if the trade union could credibly commit to a wage, results would change as unions could deter investment through their choice of wage level.

$$x, u = \begin{cases} \frac{1}{3}\frac{a-2w+t+\overline{w}}{b}, \frac{1}{3}\frac{a+w-2t-2\overline{w}}{b} & if \quad w-2t \geq 2\overline{w}-a \\ \\ \frac{a-w}{2b}, 0 & if \quad w-2t < 2\overline{w}-a \end{cases} \tag{6}$$

$$v, y = \begin{cases} \frac{a-\overline{w}}{2b}, 0 & if \quad w+t \geq \frac{a+\overline{w}}{2} \\ \\ \frac{1}{3}\frac{a+w+t-2\overline{w}}{b}, \frac{1}{3}\frac{a+\overline{w}-2w-2t}{b} & if \quad w+t < \frac{a+\overline{w}}{2} \end{cases} \tag{7}$$

A lower wage set by the union leads to higher output of the unionized firm in its home market and lower sales in this market by the foreign competitor (if the latter produces for market H). If the wage is sufficiently low relative to the trade costs, the foreign competitor will not want to sell in market H. This happens for $w - 2t < 2\overline{w} - a$. However, if the wage and the trade costs are below some threshold ($w + t < \frac{a+\overline{w}}{2}$), the unionized firm will be able to export into the neighboring market. In this case, the low cost foreign producer will also export to country H.[13] Finally, there is the possibility that none of these inequalities hold, and in this case there is one way trade into the home market.

3.2 Regime II. Partial FDI

In this case, firm A has two plants, one in each country. Firm A's plant in the foreign country has by assumption lower costs than the one situated in the home country and will be used to supply the foreign country.

Given this assumption, the two producers choose quantities as follows:

$$x, y = \arg\max_{x,y}[(a - b(x + u) - w)x + (a - b(v + y) - \overline{w})y] \tag{8}$$

$$u, v = \arg\max_{u,v}[(a - b(v + y) - \overline{w})v + (a - b(x + u) - t - \overline{w})u] \tag{9}$$

The Nash equilibrium entails the same level of sales in market H as in regime I. This is secured by the segmented market hypothesis and the fact that production technology exhibits constant returns to scale, leaving the production decisions for the two markets independent. However, production for the foreign market changes:

$$v = y = \frac{1}{3}\frac{a - \overline{w}}{b} \tag{10}$$

[13] The two sets $w - 2t < 2\overline{w} - a$ and $w + t < \frac{a+\overline{w}}{2}$ are mutually exclusive for $w \geq 0$.

This is simply the usual single market, linear demand Nash equilibrium where both firms have costs $\overline{w}$.

In the foreign market the link between union wage and market shares is now broken. In regime II, unionized labor no longer takes the effect of their wage decision on exports into account.

3.3 Regime III. Full FDI

Finally, if firm A chooses to move the entire home plant abroad, incurring a cost of G, production for the two markets are symmetric and for the case of the foreign country, equal to the production derived for regime II. For the home market, however, the situation has changed and the two producers now compete on equal basis, both incurring a trade cost when producing for market H :

$$x = u = \begin{cases} \frac{1}{3}\frac{a-\overline{w}-t}{b} & if \quad t \leq a-\overline{w} \\ 0 & if \quad t > a-\overline{w} \end{cases}$$

Of course, in regime III unionized labor no longer has a role to play, so all production levels are independent of union wages.

3.4 Non-union benchmark

In this case, we assume both producers to have marginal costs equal to $\overline{w}$. It is easily verified that the following equilibrium production patterns then emerge (for regime III they are the same as for the unionized case, so this is excluded):

$$x^I, y^I = v^I, u^I = \begin{cases} \frac{a-\overline{w}+t}{3b}, \frac{a-\overline{w}-2t}{3b} & if \quad t < \frac{a-\overline{w}}{2} \\ \frac{a-\overline{w}}{2b}, 0 & if \quad t \geq \frac{a-\overline{w}}{2} \end{cases} \tag{11}$$

$$y^{II} = v^{II} = \frac{a-\overline{w}}{3b}, x^I = x^{II}, u^I = u^{II} \tag{12}$$

The expressions found in this section constitute the equilibrium production patterns *given* wages and type of foreign direct investment. We now turn to union wage setting, which will also be contingent upon the chosen type of FDI.

4 Stage 2. Wage setting

In regime III, the unionized firm has moved all production facilities abroad, and the union no longer has a role to play. However, in regime I and II, the union faces different employment possibilities, which will induce it to follow

different wage policies in the two regimes. We start out by investigating regime I, where there is no FDI. This means that we will be close to the model in Naylor (1999). The differences between our wage schedule and the one found by Naylor, stems from the fact that here only one economy is unionized, not both. The regime I wage schedule and the consequent union utility levels can be derived straightforwardly from the expressions found in the previous section:

$$w^I = \begin{cases} \frac{1}{4}a - \frac{1}{8}t + \frac{3}{4}\overline{w} & if \quad t \leq (3\sqrt{2}-4)(a-\overline{w}) \\ \frac{1}{4}a + \frac{1}{4}t + \frac{3}{4}\overline{w} & if \quad (3\sqrt{2}-4)(a-\overline{w}) < t < \frac{5}{7}(a-\overline{w}) \\ 2t + 2\overline{w} - a & if \quad \frac{5}{7}(a-\overline{w}) \leq t \leq \frac{3}{4}(a-\overline{w}) \\ \frac{1}{2}(a+\overline{w}) & if \quad t > \frac{3}{4}(a-\overline{w}) \end{cases} \tag{13}$$

$$U^I = \begin{cases} \frac{1}{48b}(2a-t-2\overline{w})^2 & if \quad t \leq (3\sqrt{2}-4)(a-\overline{w}) \\ \frac{1}{24b}(a+t-\overline{w})^2 & if \quad (3\sqrt{2}-4)(a-\overline{w}) < t < \frac{5}{7}(a-\overline{w}) \\ \frac{1}{b}(a-t-\overline{w})(2t+\overline{w}-a) & if \quad \frac{5}{7}(a-\overline{w}) \leq t \leq \frac{3}{4}(a-\overline{w}) \\ \frac{1}{8b}(a-\overline{w})^2 & if \quad t > \frac{3}{4}(a-\overline{w}) \end{cases} \tag{14}$$

In figure 1, we have plotted the wage level (top) and utility (bottom) against the trade cost (deflated by $(a-\overline{w})$; dotted lines represent the regime II case discussed later):

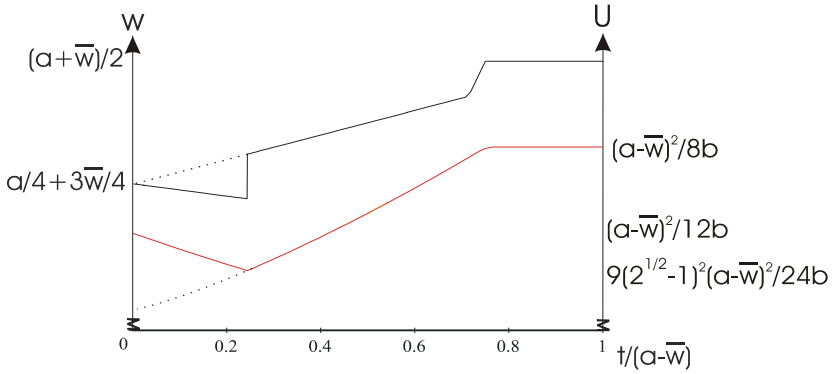

Figure 1. Union wage level and utility under regimes I and II

The wage function in regime I (and union utility) is piecewise linear with four segments, due to the following argument:

1. For high trade costs (more precisely for $t \geq \frac{3}{4}(a - \overline{w})$), the proper autarky wage - that is, the wage that would be set if there was an exogenous ban on trade - is low enough to stop trade from occurring. This wage is then chosen by the union in this segment. In the language of industrial organization, imports are *blockaded*.

2. If the union continues to choose the autarky wage for $t < \frac{3}{4}(a - \overline{w})$, the foreign competitor will choose to sell in country H. In the above specified interval, the union will opt to lower the wage in order to stop this from happening, capitalizing on the employment gain from such a strategy. We are then still in autarky since no exports or imports take place, but the possibility of trade influences outcomes. Imports are no longer blockaded, but *deterred*.

3. The above strategy implies a sinking wage as trade costs fall. At some point, the employment gain of such a strategy no longer justifies the low wage. For $t < \frac{5}{7}(a - \overline{w})$, the union will instead *adapt to imports*, setting a wage higher than the import deterring wage. A still lower trade costs means a higher level of imports, and consequently, lower domestic employment. More importantly for wages, however, is the fact that the domestic labor demand elasticity to wages increases with lower trade costs. As a response, the union lowers their wage claims (and union utility falls) as in the previous segment, but the wages are nevertheless higher than in the case of import deterrence.

4. As trade costs fall, the union - if adapting to imports - chooses to decrease wages. However, eventually, another strategy will prove to be better: By setting a low enough wage, the union may be able to induce the home firm to export. This strategy will entail a low wage, but high employment as domestic production rises. The optimal wage schedule under exports is *rising* with lower trade costs, while as we have seen, it is falling if the union adapts to imports. At $t = (3\sqrt{2} - 4)(a - \overline{w})$, the two strategies provide the union with the exact same utility, and consequently, for lower trade costs, the union chooses to *induce exports*. This implies a discontinuous fall in wages at $t = (3\sqrt{2} - 4)(a - \overline{w})$. What remains is then to explain why wages and utility is now rising with lower trade costs. When these costs fall, the domestic firm gets easier access to the foreign market. This, in turn, leads to increased domestic employment demand. At the same time, the competitor becomes a more

fierce rival at home, leading to the opposite effect. However, the net effect is increased - and more importantly, more elastic - employment demand. The union responds by setting higher wages and obtaining higher utility.[14] Qualitatively, this is the same effect as is central in Naylor's work (Naylor (1998, 1999)).[15,16]

We now turn to regime II (partial FDI). In essence, from the viewpoint of the union, regime II is simply regime I without the export option.[17] The wage schedule is now piecewise linear with *three* segments. The low-wage strategy to induce exports no longer makes sense. In reference to figure 1, the utility and wage level continue to drop as trade costs fall below $t = (3\sqrt{2} - 4)(a - \overline{w})$. This means that the high-wage strategy wage line with one-way trade is prolonged into the range with the lowest values of t (dotted lines).

Even though the wage now *drops* with lower trade costs, the wage is *higher* than it would be if no investment was undertaken. When it already has been decided to serve the foreign market through FDI, the desire to induce exports no longer brings about wage moderation. The domestic wage level increases, but employment falls and so thus union utility. However, the domestic firm's *total* wage bill may nonetheless decline: The higher domestic wage is accompanied by production for the foreign market being undertaken abroad, and wages there are by assumption lower.

[14] For a further discussion about this wage effect, see our supplementary notes in Lommerud *et. al.* (2002). There, we also show that this kind of effect from trade liberalization would apply to a much larger set of demand systems than the family of linear systems discussed here.

[15] Quantitatively, however, the wage increase following a trade cost reduction is smaller here than in Naylor's model. The Naylor model features an additional union in the foreign country. The two unions act as Bertrand competitors in a wage game to attract employment. Their wage levels are strategic complements. If both unions respond to the above incentive to increase wages, this in turn gives both unions a strategic complementarity "push" to increase wages further.

[16] In Naylor's framework, the segment of the wage schedule with one-way trade and a wage that falls with lower trade costs, is not present. As indicated earlier, this comes from our assumption of unionization in one country only, which naturally brings about one-way trade. Also, due to only modeling one union, we find a pure strategy equilibrium for intermediate trade costs, contrary to Naylor (1999).

[17] The expressions for the wage and union utility in regime II can be found in Lommerud *et. al.* (2002).

5 Stage 1. Location choice

In this section, we start out directing attention to the non-union case to establish a benchmark. We then go on to discuss the effects determining the location choice when the home labor market is unionized. To keep things instructive and short, we dispense with all mathematical expressions. For the interested reader, there is a supplement available.[18]

5.1 Non-union benchmark

Profits for this case can easily be derived from the equilibrium production quantities of section 3. The following figure plots these profits as a function of the trade cost. Fixed costs are excluded.

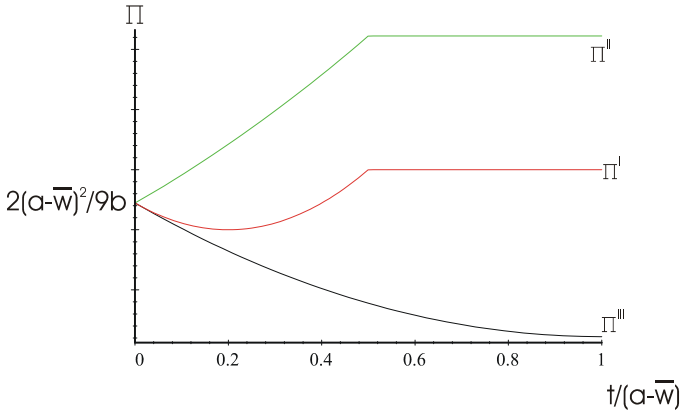

Figure 2. Profits in the non-unionized case

Both for regime I and II, there will be no trade for $t \geq \frac{1}{2}(a - \overline{w})$. In this case, the monopoly single market production quantities bring prices below the trade costs, and consequently trade is blockaded. This does not apply in regime III, as in this case, there is no producer located in country H. Here there will be trade as long as the marginal willingness to pay exceeds the trade costs ($t < (a - \overline{w})$).

In regime I, a reduction in trade cost beyond $t = \frac{1}{2}(a - \overline{w})$ has an ambiguous effect on producer A's profit. Lower trade cost results in more intense rivalry between firms. On the one hand, producer A is hurt by facing a more competitive rival - a rival with a lower trade cost - in its home market. On the other hand, producer A gains by becoming a more competitive rival in its neighboring market. In addition, producer A saves trade cost on its existing quantity of trade. The larger the amount of trade initially, the more goods

[18] Lommerud *et. al.* (2002).

are actually physically transported between the countries, and the larger the direct cost saving. This explains why a reduction in trade cost has a negative impact on profits for high values of t - where trade is limited - and a positive impact on profits for low values of t.

In regimes II and III, the relationship between trade costs and profits is more straightforward. Under partial FDI (regime II), producer A does not participate in international trade. The only effect of lower trade costs (below $t = \frac{1}{2}(a - \overline{w})$) is a more competitive rival in country H, which hurts the profit of producer A. In regime III, both producers face lower trade costs to country H. As a result, both gain from a lower trade cost.

The figure also nicely illustrates the following:

Proposition 1 :

1. *In the non-unionized case, full FDI (regime III) is never beneficial.*
2. *For high trade costs (no trade in regime I), firm A will undertake partial FDI (regime II) if the cost of this investment is less than the profit capture made possible by this investment in the foreign market.*
3. *For low t (trade in regime I), a trade cost reduction will make it less profitable/ more unprofitable to undertake partial FDI.*

Proof. The supplement contains the necessary proofs. ■

If firm A chooses no investment, the trade costs offer a shelter from intense foreign competition for the producers in their respective home markets. If full FDI is chosen, the producers are co-located in the same country. This leads to tougher competition. This is never profitable, which is summarized in the first part of the above proposition.

The second part refers to a regime II investment with double autarky as a starting point. In regime I, initiating exports is unprofitable for high trade costs, and thus the only way to capture profits from the other market is to invest and produce there. Of course, the profits earned must then be compared with the fixed costs of investment.

When we are not in initial autarky, trade prevails in the regime I equilibrium. However, profit capture from the other market may still be higher if the firm instead invested in a new plant abroad. A trade cost reduction, though, decreases the (tariff-jumping) incentive to invest, as the export option becomes relatively cheaper. We can thus conclude:

Proposition 2 *In the non-unionized case, trade liberalization by itself does not trigger foreign direct investment.*

Proof. See the supplement. ■

5.2 Location choice under unionization

Under unionization, FDI choices are steered not only by trade-cost jumping considerations; international wage differences also matter. Unionization raises wages above the competitive level, which generally increases the attractiveness of FDI. This is a level effect. However, as we have seen, wages are dependent upon the trade costs and the investment strategy chosen. This will in turn influence how trade liberalization affects FDI decisions.

We start this section by explaining how a trade cost reduction affects profits under the three different investment scenarios spelled out above. We then go on to discuss firm A's incentives to switch to a regime II situation (partial FDI) and to a regime III situation (full FDI). Finally, we bring the discussions of the two types of FDI together, focusing on *which* of the different investment strategies that are optimal - no FDI, partial FDI and full FDI - given assumptions about the fixed investment costs J and G.

5.2.1 Profits

The profits of producer A in the different regimes are illustrated in the following figure as a function of trade costs (investment costs again excluded):

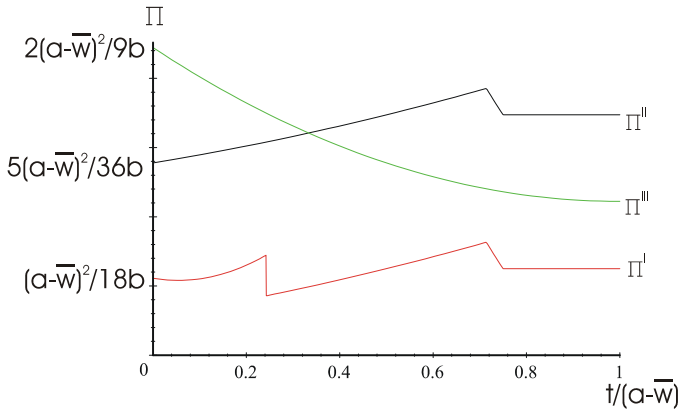

Figure 3. Profits for the unionized case

Profits for the regime III case, Π^{III}, are as for the non-union case since, in both cases, all production is undertaken utilizing foreign labor. To explain the two other profit curves, we start out with the regime I case and from high values of t, looking at how trade liberalization changes profits:

For high levels of trade costs, imports are blockaded. No trade takes place and the possibility of trade does not influence outcomes. Profits are at the one-market monopolist level (with unionized labor). The next segment still describes an autarky situation, but here the union's wage is set, as it were, to

deter imports from the foreign country. The lower the trade cost, the lower the wage, and the higher the profits. The third segment of the profit curve applies for one-way trade; from the low-cost foreign producer into firm A's home market. The lower the trade cost, the more competitive becomes the foreign firm. It is true that the union lowers the wage in response, but as we see, this does not rescue profits from falling with trade liberalization in this segment. The fourth and last segment describes two-way trade between the countries, which occurs for low trade costs. Profits rise discontinuously as the union decreases wages to induce exports.[19] A further trade cost reduction leads the domestic firm to gain easier access to the foreign market, while the foreign firm gains easier access to the domestic market. The net effect is as for the non-union case: For high trade costs (within the two-way trade interval) a trade cost reduction reduces profits, while the inverse is true for low trade costs. However, due to the increasing wages, a trade cost reduction is profitable in a smaller interval than for the non-union case.

There are two differences between profit curves Π^I (no FDI) and Π^{II} (partial FDI): For intermediate and large trade costs, the regime I domestic firm does not supply the foreign market. In contrast, in regime II, the firm serves the foreign market utilizing the plant abroad. With segmented markets and constant marginal production costs, the existence of this new plant does not affect the competitor's decisions concerning supply to the domestic market (see section 3.2). Accordingly, firm A's profits in regime I and II differ only by the equilibrium profits gained from access to the foreign market, and a trade cost reduction affects profits in the regime II case as in regime I.

This changes for low trade costs where a regime I firm would choose to export. Under partial FDI, exports are not an option, and a trade cost reduction continues to decrease profits (despite the union decreasing their wage claims).

Let us now consider the incentives for the regime I producer to undertake FDI. In the following figure we report the profitability of each of the two forms of FDI relative to no investment, given that $G = J = 0$:

[19] Naylor's paradoxical result was that wages rise with lower trade costs from this point on. As we have seen, however, wages are generally *lower* in this segment than they would have been if the union did not have the opportunity to induce exports.

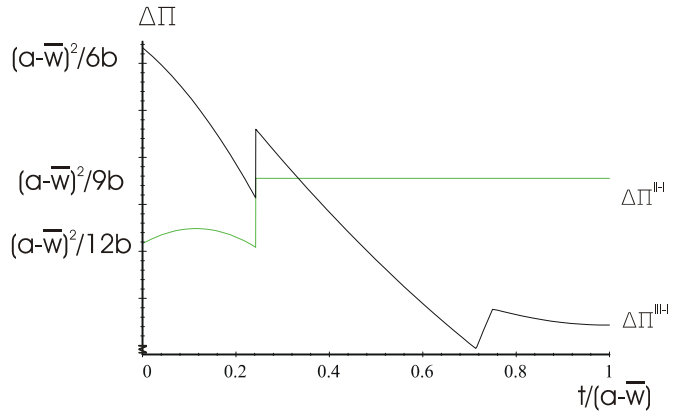

Figure 4. FDI-incentives

Now, the costs of a regime II and a regime III investment may be very different. We therefore divide the following discussion into three parts: First we assume that the costs of a regime III investment are prohibitive, so that the relevant deliberation is between no investment and partial FDI. Then we discuss the opposite situation, where full FDI is the only viable investment strategy. Finally, we turn to the relative profitability of the three investment scenarios, determining a possible synthesis of the previous discussion.

5.2.2 Partial FDI

For high values of t, we have already discussed that a decision to undertake partial FDI is determined by a comparison of the value of accessing the foreign market as a duopolist and the fixed investment costs. This result is basically the same as for the non-union case (Proposition 1, second part). Arguably, the more interesting case is when $t \leq (3\sqrt{2}-4)(a-\overline{w})$. Trade liberalization has been an on-going process for decades, so it seems intuitive that trade costs in many markets may now have reached the point where two-way trade takes place. For these low values of t, we see from figure 4 that the incentive to undertake partial FDI is *weaker*, in general, than for higher trade costs. This tallies well with the standard insight that it becomes less attractive to serve a foreign market through FDI when exports are a viable alternative.

The surprising bit comes when we study how the incentives for partial FDI change with a reduction in t, given two-way trade. For some of these values of t, the incentives for a regime II investment are *strengthened* by reduced trade costs, contrary to common wisdom. The reason for this lies in the wage formation process. With no FDI, we have already explained that wages rise with lower t in this area. With partial FDI, wages are higher, but falling with lower trade costs (cfr. fig. 1). A motivation for partial FDI is to

gain access to cheap foreign labor. On the cost side, the remaining domestic workers will increase their wage in response to this. But the size of the wage jump for domestic labor is smaller the lower the trade costs. This lies behind the counter-intuitive result that a trade cost reduction can strengthen the FDI alternative over the export alternative. We state this discussion as a proposition:

Proposition 3 *In a two-way trade situation, lower trade costs can strengthen the incentive to serve a foreign market by FDI rather than by exports. This is in contrast to the non-unionized case.*

Proof. The proof is left to the interested reader. ■

However, the 'standard' effect that lower trade costs make exports cheaper is also present, and for very low values of t - when the volume of export (if chosen) would be very high - it dominates: Lower trade costs then weakens partial FDI incentives.

5.2.3 Full FDI

>From figure 4, it is also apparent that if the regime III investment cost, G, is sufficiently low, it will always be profitable for the firm to move all its production abroad. In contrast, in the non-unionized case moving all production abroad was *never* profitable (Proposition 2, first part):

Proposition 4 *In contrast to the non-unionized case, full FDI is always profitable provided the investment costs are sufficiently small.*

Proof. The proof is left to the interested reader. ■

There will always be a cost disadvantage in being located in a unionized home country, so moving abroad would save costs. Further, this cost advantage of FDI, plus the advantage of cheaper access to the foreign market, will always outweigh the disadvantage of more costly access to the previous home market - for low enough values of the fixed cost G.

Turning to the impact of a trade cost reduction, we have already seen that this *may* increase the incentives to undertake a regime II investment. From figure 4, the effect is even more apparent for the regime III investment scenario. Full FDI avoids high production costs (wages) on the entire production quantity of firm A, but comes at the expense of incurring trade costs when supplying market H. A trade cost reduction makes this last negative effect lower, and thus contributes to higher investment incentives as trade costs fall. However, there are two exceptions to this conclusion. First, for high trade costs, the union may choose to lower wages to deter imports in

regime I, as discussed in section 4 (part 2). This accounts for the upward sloping segment of $\Delta\Pi^{III-I}$ in figure 4. Second, the union may in regime I choose to lower their wages to induce exports, which accounts for the discontinuous shift in $\Delta\Pi^{III-I}$ in figure 4. A trade cost reduction may therefore reduce the incentives to invest if we 'move across' one of these intervals for the trade cost, but the opposite may also very well happen. Referring to Proposition 3, this proposition still holds for the case of full FDI.

Also, it is worth noting that for low trade costs, the regime I option involves *higher* wages as trade costs *fall* (section 4, part 4). This means that the 'full FDI' incentive curve, $\Delta\Pi^{III-I}$, is particularly steep in that segment since a trade cost reduction both increases the equilibrium profits in regime III and helps evade the higher wages in regime I.

5.2.4 A possible synthesis

Next, let us consider *what type* of FDI the domestic firm will choose, given that one of the forms of investment is taken for granted. Assuming $G = J$, we can plot the difference in profits for the two strategies:

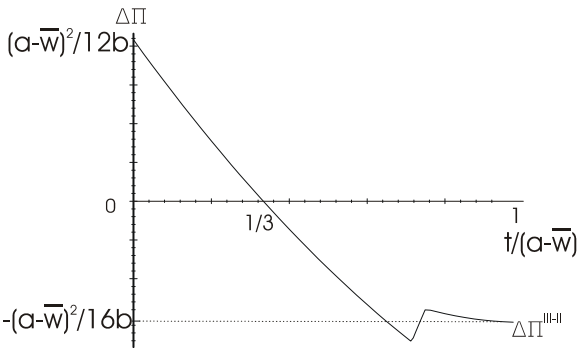

Figure 5. Relative profits from the two types of investment

The actual investment strategy will of course depend upon the costs of the two FDI-choices, but the above figure nicely illustrates that the regime III option may generally be the more profitable one for low trade costs, while the regime II investment strategy is better for high trade costs. This is so if $J = G$. These costs might be very different, though. The cost of establishing a foreign plant might for example be only a fraction of the cost of moving the whole firm abroad. Then partial FDI would be chosen also for low levels of t. However, as discussed for the case of full FDI above, the "wage-jumping" effects become increasingly important as trade costs fall. It is easily shown that G has to exceed J by no less than three fourths' of the duopoly profits in country F to make building a new plant a better alternative than moving all production abroad *no matter* the level of trade costs.

6 Welfare analysis

In this section, we explore the welfare aspects of the optimal investment decision discussed in the previous section. To do this, welfare under the three investment schemes needs to be compared. We utilize a measure of *national* welfare, calculated as the sum of consumer surplus in country H, union utility and profits for firm A. We assume that the costs of investment are real resource costs, and they influence national welfare through their deduction in firm $A's$ net profits.

Union utility and firm profits have already been discussed in some depth. In the supplement, we provide a discussion of consumer surplus in our model as well as the expressions for national welfare. Here, we turn directly to national welfare, which is illustrated in figure 6 for the three regimes (assuming again that $G = J = 0$):

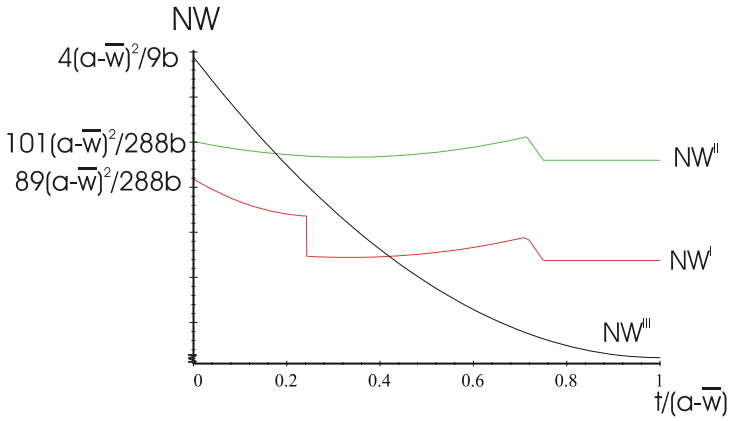

Figure 6. National welfare in the three regimes

We are interested both in studying how trade liberalization affects national welfare given an investment choice (no FDI, partial FDI and full FDI) and if the investment incentives are correct from a national welfare viewpoint. Within a given investment regime we see trade liberalization can reduce national welfare. To illustrate this, let us consider the case with one-way trade - that is the third segment from the right of the national welfare curves of regimes I and II: Here, a lower trade cost is good for consumers, as the foreign firm becomes a more potent competitor in the market under study. Domestic firms and workers suffer, however. In sum the effect on welfare is negative. A basic reason is that the increased profits earned by the foreign firm as trade is liberalized do not count in national welfare.

As can be observed from the figure, national welfare in regime II is always higher than for regime I (remember that investment costs are set to zero). For the case of high trade costs, this is entirely due to the profits accrued by

investing abroad, as union utility and consumer surplus are not affected by this move. However, for low trade costs ($t < (3\sqrt{2}-4)(a-\overline{w})$), the difference is lower due to unions lowering their wage demands to induce exports in regime I, which in turn gives lower domestic prices, higher union utility and higher profits. National welfare is only higher in regime III for low trade costs. In this case, the higher profits and the possibly increased consumer surplus (see supplement) from investing abroad more than compensate for the drop in union utility that follows a complete move of all production abroad.

We now turn to study whether or not the domestic firm has correct investment incentives from a welfare point of view. Since the union's role is the novel feature of our model, we want to focus on the distributional battle between the union and the firm. When trade costs are high, there are no trade. We have shown that the union's wage setting is then unaffected by a partial FDI decision. To allow the union to play a potential role, let us therefore concentrate on the case with low trade costs. In particular, we focus on the two-way trade situation. Attention is restricted to the case of low trade costs also when discussing full FDI. This is done both to keep the analysis compact, and because we feel that this for many markets constitutes a reasonable assumption.

Focusing, then, on the two-way trade situation, we can show that there might be *over-investment* in equilibrium:

Proposition 5 *For low trade costs (two-way trade in regime I), a regime I producer has, from a national welfare point of view, too large investment incentives.*

Proof. The proof is provided in the supplement. ■

This holds for both the 'partial FDI' case and the 'full FDI' case.

If the firm chooses full FDI, union utility will of course fall. Consumer surplus will generally rise when trade costs are low because competition becomes harsher than before.[20] However, it can be shown that the fall in union utility is larger than the possible gain in consumer surplus. Consequently, national welfare increases by less than profits. Thus there exists some range of investment costs under which the firm would undertake the investment while national welfare drops as a result.[21]

The incentives to undertake partial FDI are also too large seen from a welfare point of view. While moving - if it is undertaken - would increase

[20] This does not apply for t very close to $(3\sqrt{2}-4)(a-\overline{w})$ in the case of a shift from regime I to regime III; see figure 1 in the supplement.

[21] In the supplement we show that the same is true if firm A is initially a regime II producer and trade costs are above some very limited level.

profits, *both* union utility and consumer surplus invariably drops. Union utility decreases because the domestic firm no longer exports to the foreign market. Consumer surplus drops because the investment induces unionized labor to increase its wage claims, which leads to decreased domestic sales.

7 Concluding remarks

What shall we make of all this? This is not the place to repeat all our findings. We narrow our focus to the question of whether or not trade liberalization between a unionized and a non-unionized country seriously weakens the position of unionized labor. Naylor's result, in a somewhat different model format, that trade liberalization increases the union-set wage and utility can be seen as an optimistic "no" response to this question. In broad terms, we have reached a much less rosy conclusion: Precisely because trade liberalization has this tendency to increase union wages, the firm's incentive to move out production to a non-unionized economy is strengthened. Moreover, the incentive for a full move of all production rather than a limited move only of production destined for the foreign market, is also strengthened. Unionized labor can lose from trade liberalization, but the problem might very well be one of job losses, rather than wage cuts. From a welfare point of view, trade liberalization can be detrimental to welfare. One important reason is that fixed investment costs are undertaken mainly to win a distributional battle between firm owners and unionized labor. But it also enters the picture that trade liberalization can shift profits from domestic capitalists to foreign owners of non-unionized firms.

Speculatively, one could argue that after decades of economic integration, even further trade liberalization should probably start from quite low levels of trade costs. Moreover, we know that foreign direct investments become more and more important relative to trade. These are precisely the circumstances where further trade liberalization hurts the interests of unionized workers. One should of course be careful about drawing strong policy conclusions from a highly stylized model. But in broad terms our analysis suggests that strong unions and trade liberalization do not sit well together. The right wing version of this is to say that weaker unions would be good, since production would then not be forced out of the country at the expense of national welfare. A left wing alternative is that trade liberalization is the problem, since it undermines the efforts of ordinary workers to obtain a living wage.

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8 Supplement

In this supplement we provide some additional details concerning the analysis reported in our paper. In Section 8.1 we show that a particualar wage effect of trade liberalization - lower trade cost leads to higher wages - would be the outcome also with a more general demand system than linear demands. In Section 8.2 we report wages and utility in regime II, which supplements the last paragraph of Section 4 in the paper. In Section 8.3 we report profits in the non-union case, which supplements Section 5.1 in the paper. We also provide proofs for propositions 1 and 2. In Section 8.4 we report profits in the unionized case, which supplements Section 5.2.1 in the paper. Section 8.5 provides calculus and discussion of consumer surplus, which is a part of national welfare that is discussed in Section 6 in the paper. In Section 8.6 the explicit expressions for national welfare are reported, which supplements Section 6 in the paper, and we provide a proof of Proposition 5. In addition, we analyse the welfare effect of a move from partial to full FDI, which is referred to in footnote 21 in the paper.

8.1 The wage effect of trade liberalization

In the main paper we argued that in regime I and for $t \leq (3\sqrt{2}-4)(a-\overline{w})$, a trade cost reduction would increase wages (see Section 4, point 4 in the paper). When setting the wage, the union will balance an increase in wages against the employment reduction that follows from such a wage increase. If the elasticity of labor demand to wages becomes less negative, the union will face a less negative trade off between wages and employment, and consequently increase wage claims. This is exactly what happens when trade costs fall for $t \leq (3\sqrt{2}-4)(a-\overline{w})$, which is easily checked.

This kind of wage effect from trade liberalization would apply to a much larger set of demand systems than the linear ones discussed in the paper. Following the above argument, a downward-sloping wage schedule would be present whenever the elasticity of total labor demand, $L \triangleq x+y$, to w, $\frac{\partial L}{\partial w}\frac{w}{L}$, becomes less negative when trade costs fall. That is, if $\frac{\partial}{\partial t}[\frac{\partial L}{\partial w}\frac{w}{L}] < 0$, or equivalently:

$$-\frac{w}{L^2}\frac{\partial L}{\partial w}\frac{\partial L}{\partial t}+\frac{w}{L}\frac{\partial^2 L}{\partial w \partial t}<0. \tag{15}$$

Production will normally be negatively related to own wages, thus $\frac{\partial x}{\partial w}, \frac{\partial y}{\partial w} < 0$. Consequently, $\frac{\partial L}{\partial w} < 0$. $\frac{\partial L}{\partial t} = \frac{\partial x}{\partial t}+\frac{\partial y}{\partial t}$ is negative whenever a trade cost reduction leads to higher production by the unionized firm. This is the case in our model for equally large markets, but will generally hold if the foreign

market is sufficiently large relative to the home market: A trade cost reduction may decrease the home firm's production for the home market through a worsened competitive position. However, with a sufficiently large foreign market, this effect will be more than compensated for by the increased production for the foreign market, where the competitive position is improved (with linear demand, this argument is valid as long as the foreign market is more than *half* the size of the home market, measured in terms of the parameter b).

Thus for a wide range of demand functions, assuming some some restrictions on the difference in market sizes, $-\frac{w}{L^2}\frac{\partial L}{\partial w}\frac{\partial L}{\partial t}$ is negative. Accordingly, this analysis restricts attention to demand systems where $\frac{\partial^2 L}{\partial w \partial t}$ is negative, or positive to a limited degree (with linear demand, $\frac{\partial^2 L}{\partial w \partial t} = 0$).

8.2 Wages and union utility in regime II

It is easily verified that the wages and union utility in regime 2 are given by

$$w^{II} = \begin{cases} \frac{1}{4}a + \frac{1}{4}t + \frac{3}{4}\overline{w} & if \quad t < \frac{5}{7}(a-\overline{w}) \\ 2t + 2\overline{w} - a & if \quad \frac{5}{7}(a-\overline{w}) \leq t \leq \frac{3}{4}(a-\overline{w}) \\ \frac{a+\overline{w}}{2} & if \quad t > \frac{3}{4}(a-\overline{w}) \end{cases} \tag{16}$$

$$U^{II} = \begin{cases} \frac{1}{24}\frac{(a+t-\overline{w})^2}{b} & if \quad t < \frac{5}{7}(a-\overline{w}) \\ \frac{(a-t-\overline{w})(2t+\overline{w}-a)}{b} & if \quad \frac{5}{7}(a-\overline{w}) \leq t \leq \frac{3}{4}(a-\overline{w}) \\ \frac{1}{8}\frac{(a-\overline{w})^2}{b} & if \quad t > \frac{3}{4}(a-\overline{w}) \end{cases} \tag{17}$$

This supplements the discussion in the last paragraph of Section 4 in the paper.

8.3 Profits in the non-union case

The expressions for profits in the non-union case is not reported in the paper, but only plotted in figure 2 in Section 5.1. The profits (denoted Π_{NU}) can be derived from the equilibrium production quantities from section 3 of the

paper (eqs. (11) and (12), fixed costs excluded):

$$\Pi_{NU}^{I} = \begin{cases} \frac{1}{9b}[2(a-\overline{w})^2 - 2t(a-\overline{w}) + 5t^2] & if \quad t < \frac{a-\overline{w}}{2} \\ \frac{(a-\overline{w})^2}{4b} & if \quad t \geq \frac{a-\overline{w}}{2} \end{cases} \tag{18}$$

$$\Pi_{NU}^{II} = \begin{cases} \frac{2(a-\overline{w})^2+2t(a-\overline{w})+t^2}{9b} & if \quad t < \frac{a-\overline{w}}{2} \\ \frac{13(a-\overline{w})^2}{36b} & if \quad t \geq \frac{a-\overline{w}}{2} \end{cases} \tag{19}$$

$$\Pi_{NU}^{III} = \begin{cases} \frac{1}{9}\frac{(a-\overline{w})^2}{b} & if \quad t > a-\overline{w} \\ \frac{1}{9b}[(a-\overline{w})^2 + (a-\overline{w}-t)^2] & if \quad t \leq a-\overline{w} \end{cases} \tag{20}$$

Proof of Proposition 2: Using the above expressions, the proof of the two first parts of proposition 2 is straightforward. For a regime II investment when the starting point is not double autarky, we have $\frac{d}{dt}(\Pi_{NU}^{II} - \Pi_{NU}^{I}) = \frac{4(a-\overline{w})-8t}{9b}$. This is positive for $t < \frac{a-\overline{w}}{2}$, which proves the last part of the proposition. *QED*

Proof of Proposition 3: Since a regime III investment is never profitable, we only have to make sure that $\frac{d}{dt}(\Pi_{NU}^{II} - \Pi_{NU}^{I}) \geq 0$, which is left to the interested reader. *QED*

8.4 Profits in the unionized case

Profits in the unionized case are plotted in figure 3 in Section 5.2.1 in the paper. The explicit expressions for profits in regime I (for firm A), gross of any fixed investment cost, are:

$$\Pi^{I} = \begin{cases} \frac{1}{72b}\left(4(a-\overline{w})^2 - 4(a-\overline{w})t + 37t^2\right) & if \quad t \leq (3\sqrt{2}-4)(a-\overline{w}) \\ \frac{1}{36b}\left(a+t-\overline{w}\right)^2 & if \quad (3\sqrt{2}-4)(a-\overline{w}) < t < \frac{5}{7}(a-\overline{w}) \\ \frac{1}{b}\left(-a+t+\overline{w}\right)^2 & if \quad \frac{5}{7}(a-\overline{w}) \leq t \leq \frac{3}{4}(a-\overline{w}) \\ \frac{1}{16b}\left(a-\overline{w}\right)^2 & if \quad t > \frac{3}{4}(a-\overline{w}) \end{cases} \tag{21}$$

Profits gross of investment costs in regime II are similarly given by:

$$\Pi^{II} = \begin{cases} \frac{1}{36b}\left(5(a-\overline{w})^2 + 2(a-\overline{w})t + t^2\right) & if \quad t < \frac{5}{7}(a-\overline{w}) \\ \frac{1}{9b}(10(a-\overline{w})^2 - 18(a-\overline{w})t + 9t^2) & if \quad \frac{5}{7}(a-\overline{w}) \leq t \leq \frac{3}{4}(a-\overline{w}) \\ \frac{25}{144b}\left(a-\overline{w}\right)^2 & if \quad t > \frac{3}{4}(a-\overline{w}) \end{cases} \tag{22}$$

The simplest case concerns regime III, where gross profits are as for the non-unionized case:

$$\Pi^{III} = \begin{cases} \frac{1}{9b}[(a-\overline{w})^2 + (a-\overline{w}-t)^2] & if \quad t \leq a-\overline{w} \\ \frac{1}{9b}\left(a-\overline{w}\right)^2 & if \quad t > a-\overline{w} \end{cases} \tag{23}$$

8.5 Consumer surplus

In Section 6 of the paper we study national welfare, which is defined as the sum of consumer surplus in country H, union utility and profits for firm A. Let us here report some calculus and discussion concerning the consumer surplus. We assume consumer surplus to be approximated by the usual triangle under the demand curve given by:

$$CS^i = \frac{b}{2}(x^i + u^i)^2 \tag{24}$$

where i denotes the regime in question. Using the previous results, we can readily calculate consumer surplus in regime I:

$$CS^I = \begin{cases} \frac{49}{1152b}\left(2(a-\overline{w})-t\right)^2 & if \quad t \leq (3\sqrt{2}-4)(a-\overline{w}) \\ \frac{1}{288b}\left(7(a-\overline{w})-5t\right)^2 & if \quad (3\sqrt{2}-4)(a-\overline{w}) < t < \frac{5}{7}(a-\overline{w}) \\ \frac{1}{2b}\left(a-\overline{w}-t\right)^2 & if \quad \frac{5}{7}(a-\overline{w}) \leq t \leq \frac{3}{4}(a-\overline{w}) \\ \frac{1}{32b}\left(a-\overline{w}\right)^2 & if \quad t > \frac{3}{4}(a-\overline{w}) \end{cases} \tag{25}$$

The above expression also depicts consumer surplus in regime II for $t > (3\sqrt{2}-4)(a-\overline{w})$. However, the regime II consumer surplus is given by $\frac{1}{288b}\left(7(a-\overline{w})-5t\right)^2$ for $t \leq (3\sqrt{2}-4)(a-\overline{w})$. For regime III, consumer surplus is given by:

$$CS^{III} = \frac{2}{9b}\left(a-\overline{w}-t\right)^2 \tag{26}$$

These expressions are plotted against trade costs in figure 1:

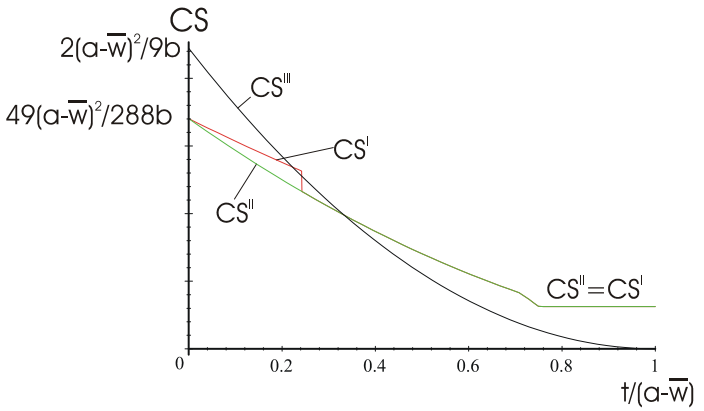

Figure 1. Consumer surplus in the three regimes

As we would expect, consumer surplus is everywhere non-increasing in trade costs, no matter the investment strategy chosen by firm A. When we

compare regimes I and II, consumers are only affected by this type of investment for low trade costs (when there is two-way trade). FDI then eliminates the home workers' incentive to moderate wage claims, so prices go up and output down, and consumers lose. As we can observe from the figure, for low trade costs consumer surplus in regime III is larger than in either of the two other regimes. Competition is harsher after a complete outward move of production. For low trade costs the extra cost of transport back into the home market is of little significance, so in sum consumers benefit.

8.6 National welfare

National welfare is plotted in figure 6 in Section 6 in the paper. It is easily verifiable that national welfare in the three regimes is given by the following expressions (investment costs excluded):

$$NW^I = \begin{cases} \frac{356(a-\overline{w})^2-356t(a-\overline{w})+665t^2}{1152b} & if \quad t \leq (3\sqrt{2}-4)(a-\overline{w}) \\ \frac{23(a-\overline{w})^2-10t(a-\overline{w})+15t^2}{96b} & if \quad (3\sqrt{2}-4)(a-\overline{w}) < t < \frac{5}{7}(a-\overline{w}) \\ \frac{1}{2}(a-\overline{w}-t)\frac{a-\overline{w}+t}{b} & if \quad \frac{5}{7}(a-\overline{w}) \leq t \leq \frac{3}{4}(a-\overline{w}) \\ \frac{7}{32}\frac{(a-\overline{w})^2}{b} & if \quad t > \frac{3}{4}(a-\overline{w}) \end{cases} \tag{27}$$

$$NW^{II} = \begin{cases} \frac{1}{288}\frac{101(a-\overline{w})^2-30t(a-\overline{w})+45t^2}{b} & if \quad t < \frac{5}{7}(a-\overline{w}) \\ \frac{1}{18}\frac{11(a-\overline{w})^2-9t^2}{b} & if \quad \frac{5}{7}(a-\overline{w}) \leq t \leq \frac{3}{4}(a-\overline{w}) \\ \frac{95}{288}\frac{(a-\overline{w})^2}{b} & if \quad t > \frac{3}{4}(a-\overline{w}) \end{cases} \tag{28}$$

$$NW^{III} = \begin{cases} \frac{1}{9}\frac{(a-\overline{w})^2}{b} & if \quad t > a-\overline{w} \\ \frac{1}{9}\frac{4(a-\overline{w})^2-6t(a-\overline{w})+3t^2}{b} & if \quad t \leq a-\overline{w} \end{cases} \tag{29}$$

Proof of Proposition 5: For $t < (3\sqrt{2}-4)(a-\overline{w})$, the following identities are readily calculated:

$$\Delta NW^{III-I} = NW^{III} - NW^I = \frac{1}{1152}\frac{156(a-\overline{w})^2 - 412t(a-\overline{w}) - 281t^2}{b} \tag{30}$$

$$\Delta\Pi^{III-I} = \Pi^{III} - \Pi^I = \frac{1}{72}\frac{12(a-\overline{w})^2 - 12t(a-\overline{w}) - 29t^2}{b} \tag{31}$$

$$\Delta NW^{II-I} = NW^{II} - NW^I = \frac{1}{1152}\frac{48(a-\overline{w})^2 + 236t(a-\overline{w}) - 485t^2}{b} \tag{32}$$

$$\Delta\Pi^{II-I} = \Pi^{II} - \Pi^I = \frac{1}{72}\frac{6(a-\overline{w})^2 + 8t(a-\overline{w}) - 35t^2}{b} \tag{33}$$

Now,

$$\Delta NW^{III-I} - \Delta\Pi^{III-I} = -\frac{1}{1152}\frac{36(a-\overline{w})^2 + 220t(a-\overline{w}) - 183t^2}{b} \quad (34)$$

$$\Delta NW^{II-I} - \Delta\Pi^{II-I} = -\frac{1}{384}\frac{16(a-\overline{w})^2 - 36t(a-\overline{w}) - 25t^2}{b} \quad (35)$$

It is easily shown that $\Delta NW^{K-I} - \Delta\Pi^{K-I} < 0$ in the relevant interval $t < (3\sqrt{2}-4)(a-\overline{w})$ for both $K = II$ and $K = III$. Thus if the firm is initially a regime I producer, for costs C ($= G$ or J) of moving production abroad such that $\Delta NW < C < \Delta\Pi$ (superscripts excluded), the firm will invest and this will lead to decline in national welfare. *QED*

*A transition from regime II to regime III*For a regime II to regime III transition, the following identity can be calculated (again superscripts excluded):

$$\Delta NW - \Delta\Pi = \frac{1}{288}\frac{3(a-\overline{w})^2 - 82t(a-\overline{w}) + 27t^2}{b}$$

The expression is positive for $t < \frac{1}{27}(a-\overline{w})$, and negative otherwise. A transition from regime II to regime III involves a larger gain in consumer surplus and a smaller drop in union utility than a transition from regime I to regime III. For low trade costs ($t < \frac{1}{27}(a-\overline{w})$), the rise in consumer surplus from moving abroad outweighs the fall in union utility (it drops as trade costs fall in regime II). If t is below such a threshold level, the national welfare gain from a regime III investment is larger than the increase in profits. For t above such a threshold level, the opposite is true. This verifies the claim in footnote 21 in the paper at the end of Section 6.

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