# FIW – Working Paper

# FDI, International Trade and Union Collusion

Domenico Buccella[*]

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Keywords: Foreign Direct Investment; International trade; Collusion; Labor unions.

# FDI, International Trade
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# 1. Introduction

Two results appear as the most evident consequence of the ongoing process of economic integration occurring at regional and global levels: The completion of the Single Market Program in 1992, establishing the free movement of goods, capital, services and people as well, among the member states of the European Union (EU); The creation of the European Monetary Union (EMU), concluding with the introduction of the Euro in 2002. This course of action is exemplified both by an increase in the degree of liberalization of capital markets, and the continuous removal of internal tariff and non-tariff barriers, with a consequent reduction of trade costs in product markets. Further developments and improvements in the Financial Service Action Plan (FSAP) and the financial market integration within the EU itself, have driven a significantly growth in the figures related to intra-industry trade (IIT) (see European Commission, 1996; 2008a) and intra-EU foreign direct investments (FDI) (see Bulletin EU 7/8, 2001; Jovanović, 2006, chap. 3, section 3.3.6; European Commission, 2008b).

As long as product and capital markets became more integrated, it was expected that also major actors in European labor markets, as trade unions, start taking into account a broader perspective in their activities. European trade unions have shown a progressive interest in trans-nationalize, usually in a softer way, the degree of cooperation in coordinating their policies and strategies in negotiations (the "Europeanization" of collective bargaining). In fact, for these purposes, the sharing of common rules in collective bargaining and institutions such as multinational collective bargains have been introduced, mainly by the European Trade Union Confederation (ETUC).[1]

Trade unions' coordination activities are frequently present at national and intersectoral level, but they are well developed on a transnational scope at the industrial (sectoral) level.[2] Front-runners among the European Industry Federations (EIFs) are the International Dock Workers Council (IDWC) and the European Metalworkers' Federation (EMF). In particular, the former attempts to implement common rules in the bargaining process for its member partners: in 1998, the EMF passed a resolution stating that "the commitment to safeguard purchasing power and to reach a balanced participation in productivity gains is the new European coordination rule for coordinated collective bargaining in the metal sector all over Europe". This evidently manifests the belief that wage coordination at European level will improve workers' bargaining position, avoiding a downward international competition in wages.

While the practice of cross border company level negotiations seemed to be much less developed by trade unions until few years ago, some European Commission initiatives revitalized trade union's interest in coordination activities also at this bargaining level. Among these initiatives, the adoption of the 1994 (recently reviewed in 2009) European Works Councils (EWC), and the 2001 European Company (Socieatas Europea, SE) Directives, which advanced the practice of informing and consulting the workforce in trans-national contexts, are notable. However, depending on the degree of market integration and the presence of productive activities organized internationally, there are remarkable distinctions among industries. In fact, in those sectors characterized by a high incidence of Multinational Enterprises (MNE) operations, company level negotiations are much more pronounced. In recent years trade unions began to exploit more intensively the potential of the

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[1] The "guideline for collective bargaining at the European level" by the European Trade Union Confederation (ETUC) yearly provides, since 1998, indications regarding the positions that the negotiators of the confederate unions should maintain during the national bargaining processes. For a more complete review on coordination activities concerning collective bargaining, see European Commission (2002; 2009).

[2] However, analogous practices appeared also at interregional level: in 1998 the national trade unions of Belgium, Germany, Luxembourg and the Netherlands signed an agreement (the "Doorn agreement") which, in addition to wage demands, focused also in promoting employment growth. This was motivated by the opinion that long-standing wage moderation had led job growth in an unsatisfactory way. In coordinating workers representation at the centralized level on a transnational extent, the trade unions would guarantee the social dialogue characterizing the wage bargaining inside each state member that belongs to the Doorn group. Practically, trade union representatives of these countries meet annually and discuss how to coordinate respectively their national wage-setting practices.

European Works Councils to coordinate across countries their activities during the bargaining process. As a result, the figures related to cross border company agreements are expected to increase constantly: in fact, among the total of transnational agreements achieved in the last years, two thirds concern European MNEs activities within the EU itself (ETUC, 2007).[3] Even more recent is a further development of trade union practices: the creation of cross border unions. On Friday, 15 May 2009, a "pioneering trans-boundary seafarers' union" was launched, Nautilus International, based in the UK and the Netherlands and representing a wide range of personnel working in the shipping sector, at sea, on inland waterways, and ashore. The new cross border union is the result of a merger process following several years of progressively closer cooperation between Nautilus NL and Nautilus UK. This cooperation includes joint industrial negotiations with companies employing British and Dutch members, and a united approach at European and international level on different issues related to maritime industry. Although at an embryonic state, in prospect this practice may affect firms' choice related to the internationalization of their activities. In fact, the potential MNE which would like to take strategically advantage of this organizational structure to circumvent the creation of an encompassing union, as Horn and Wolinsky (1988) suggest, may probably face a unique workers' representative body inside the company.[4]

Despite its broad importance in the study of the effects of globalization and "Europeanization" on the institutions governing the EU labor markets and the relative outcomes (wage and employment levels), trade unions' incentives and scopes for cooperative behavior in a framework of international product market integration is in some way a new subject in economic analysis. This work focuses precisely on these issues, extending the earlier literature investigating if unions are able to affect firms' decision related to the start of international business, and consequently the productive structures of different countries.[5]

This paper relates to a body of literature that analyzes, though within different contexts, the implications of international economic integration on labor markets outcomes in presence of unions. Nonetheless, few works have investigated how union strategic behavior is affected by this process and how unions behavior may in turns affect firms' strategic choice related to international activities. A first strand which examines how international integration affects the wage formation in presence of unionized countries is represented by Huizinga (1993), Sørensen (1993), Naylor (1998, 1999), Borghijs and Du Caju (1999), Straume (2002), Lommerud and al. (2003), Ishida and Matsushima (2008), and Strozzi (2007, 2008).

Authors such as Huizinga (1993), making use of a monopoly union model, and Sørensen (1993), utilizing a more general right-to-manage model, concluded that product market integration, exemplified by the merger of two single union-firm bargaining units into a unified market with two bargaining units, leads to an enlargement of the market size, as well as in an increase in the number of the firms which operates in the market that intensify the degree of competition. This in turns implies a decrease in the level of prices and wages. Moreover, under the assumption of linear demand and production functions, Huizinga (1993) obtains that the decrease in wage levels is more than offset by the increase in employment so that net union utility increases. Nonetheless these two

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[3] For an exposition on the evidences of trans-national unionism in Europe see Borghijs, Ederveen and De Mooij (2003), Strozzi (2008, Ch. 2), and European Commission (2009). On collective bargaining in MNEs see also Eurofound (2009).).

[4] A brief discussion on cross border trade unions can be found in Gennard (2009).

[5] Additionally, the creation of a "labor unions' cartel" could theoretically represent an anticompetitive price overcharge which has been commonly used as a basis for computing damages claims in price-fixing cartels. The European antitrust authorities have recently shown a renewed interest in properly assessing cartel damages, including the possible consideration of the passing-on defense and the legal standing of indirect purchaser or class actions for consumers (Green Paper on private cartel damages and the possibility of a passing on defense by the European Commission, 2005). Consequently, in theoretical lines, in future it could be the case that consumers have the possibility to present a class action against trade unions. On pass-through in damage actions and the possibility of passing-on defense, see i.a. Verboven and van Dijk (2007) and Boone and Müller (2008).

models do not take into account any kind of interaction between the two economies before integration occurs, and the incentives for international cooperation between labor unions are only concisely drawn.

Closely related to this work are the contributions of Naylor (1998, 1999), Borghijs and Du Caju (1999), Straume (2002) and Strozzi (2007, 2008). In Naylor (1998, 1999) two identical firms initially produce a homogeneous product for their home markets and, under the assumption of perfect symmetry in both product and labour market, they engage in reciprocal dumping when trade cost levels falls below a threshold value. This implies a fall in the wage demands by labor unions: intra-industry trade, putting union in competition internationally in the labor market, erodes drastically their monopoly power. But, as long as the degree of economic integration increases (additional reduction in trade costs), unions set higher wages due to higher profits for both firms, capturing part of firms' rent. In these works, in particular Naylor (1999), the effects of economic integration on wages and unions' outcomes and the interaction between the two economies, exemplified by the labor unions' strategic behavior in the labor markets, are deeply explored. However, also in Naylor's studies, there is a lack in the analysis for the scope and incentives for international cooperation between labor unions.

Incentives for labor union cooperation at trans-national level are deeply explored in Borghijs and Du Caju (1999), Straume (2002), and Strozzi (2007, 2008). Borghijs and Du Caju (1999) analyze the possibility for labor union cooperation within a context of international production. Starting from a very basic set up of internationalization of productive activities with a firm having two plants in different countries and product markets fully integrated, these authors find that if one union demands a wage rate too high, there is a production shift to the other plant. Assuming the presence of a transaction cost reflecting the labor unions' costs of trans-national cooperation in wage demands, the main results are that for coordination costs sufficiently high, unions act as competitors on the labor market and consequently moderate their wage demands. Below a certain threshold value of coordination costs, to cooperate turns out to be increasingly attractive for labor unions, which translates in a raise in wages. A further decrease in the value of coordination costs reduces wage rates, but the collusive wage still remains higher than the competitive wage. Conversely, the works of Straume (2002) and Strozzi (2007, 2008) analyze the scope for unions to adopt a collusive behavior within a context of a standard international duopoly game with reciprocal dumping and how this behavior could be supported as equilibrium of an infinitely repeated game. While Straume (2002), making use of the basic analytical framework of Naylor (1998, 1999), investigates the case of perfect substitute goods, Strozzi (2007, 2008) broadens the analysis introducing a degree of complementary/substitutability between products.

The papers of Lommerud and al. (2003) and Ishida and Matsushima (2008) are strictly related to this work . Lommerud and al. (2003) makes use of a two-country reciprocal dumping model of oligopoly with only one country unionized, focusing the analysis on how trade liberalisation and wage setting affects the firms' location choice, and therefore the way firms choose to serve their relevant markets. While Lommerud and al. (2003) consider the presence of one firm in each country, in a similar framework Ishida and Matsushima (2008) analyze the same issue when in one country there is domestic competition between firms. Hence, in these works the strategic interaction in the labor markets is absent, and consequently there is no room for the study of trade union cooperation.

A second strand of the literature analyzes the interaction between unionized labor markets and firm activities related to the internationalization of production through FDI. The general approach investigates the impact of FDI examining the union-firm interaction using either a "right-to-manage" (Boughin and Vannini, 1995; Naylor and Santoni, 2003; Eckel and Egger, 2009) or an efficient bargaining model (Mezzetti and Dinopoulos, 1991; Zhao, 1995; 1998) to explore the effects on wages and employment, either in a partial or in a general equilibrium framework. As in the works of Naylor and Santoni (2003), Zhao (1995) and Eckel and Egger (2009), also in the present paper intra-industry reciprocal FDI and the presence of unions in the labor market are

allowed. Notwithstanding the different approaches, underlying hypothesis and purposes of analysis, these models achieve a common result: if firms have the opportunity to invest in a foreign country, they will cause a moderation in wage demands in the bargaining process, and consequently unions' position appears to be weakened. Nevertheless, none of these works considers the possibility of union collusive behavior.

The present paper contributes to the previous literature in a twofold manner. First, as in the works of Lommerud et al. (2003) and Ishida and Matsushima (2008), it widens Naylor's analysis by allowing firms to undertake FDI. However, differently from these authors, a model where the workforce is unionized in both countries is used, which reflects better the characteristics of the EU labor market. In doing so, this work tries to create a link between two issues that in the previous literature have been mainly treated as separated subjects, giving some plausible predictions both for labor market outcomes and the nature of potential international business in an environment like the EU. Second, it analyzes the scope and incentives for unions to adopt a collusive behavior for each possible configuration of international activities, if and how this may affect the choice concerning the nature of international business by firms, and within which context union collusion is more likely to be sustained. For the purposes of this paper, a framework adapted from Straume (2002) is used, which becomes a sub-case of a more general model.

The rest of the paper is organized in the following way. Section 2 outlines the analytical framework: a non-cooperative three-stage game of international duopoly in presence of unionized labor markets is presented. Firms act as first movers choosing independently if to invest in the foreign country, paying a certain level of sunk costs, or not to invest: in that case, they may either export toward the foreign country or produce exclusively for their domestic country. Then in the second stage, trade unions, depending on firms' choice and trade cost levels, select their optimal wage strategy. The model is solved by the usual backward induction method and it is shown how, depending on sunk and trade costs, and due to the strategic interaction between firms and unions, different productive structures may arise in equilibrium. Section 3, making use of the same framework, extends the analysis to the case of union collusive behavior. Some comparative static are used to evaluate the profitability of wage collusion in most of the possible productive structure configurations. Instead, Section 4 provides an examination of the sustainability of union collusion in all the potential equilibria that might occur under this behavior. Section 5 briefly discusses the national welfare aspects of economic integration, firms' strategic behavior and unionization within the model; some policy implications are drawn. Finally, Section 6 concludes the paper.

## 2. The Basic Model

There are two fully symmetric countries, A and B. In each country the economy presents two sectors: a perfectly competitive sector, and an imperfectly competitive sector characterized by the presence of a monopolist, firm 1, located in A, and firm 2 located in B. The two firms produce a homogeneous good, denoted $x$ when produced in A and $y$ when produced in B, and consider each country as a separate market (market segmentation hypothesis). Labor is the unique factor of production, with linear technology and constant return to scale. Under these assumptions it follows that each worker produces one unit of the good: therefore, production and employment may be taken interchangeably. The perfectly competitive sector represents a buffer, where workers can always find employment at the competitive wage (normalized to zero). A crucial assumption of the model is the presence of company level unions organizing their activities in the imperfectly competitive sector, whose workers are supposed to be fully unionized.

In the first stage of the game, firms independently choose whether to invest, undertaking FDI and establishing a production plant in the other country: this implies that the firm incurs a fixed cost $F$; or not to invest: in that case, depending on the level of $t$ and unions' strategies, firms might either to serve the other country through exports, paying a constant cost $t$ per unit of the commodity exported, or to produce only for the domestic market.

**Table 1: First stage, the Firms' Game**

| Firm 1 ↓        Firm 2→ | Invest | Not invest |
|---|---|---|
| Invest | $\Pi_{1A}^{II} + \Pi_{1B}^{II} - F_{1B}^{II} ; \Pi_{2B}^{II} + \Pi_{2A}^{II} - F_{2A}^{II}$ | $\Pi_{1A}^{IN} + \Pi_{1B}^{IN} - F_{1B}^{IN} ; \Pi_{2B}^{NI}$ |
| Not invest | $\Pi_{1A}^{NI} ; \Pi_{2B}^{IN} + \Pi_{2A}^{IN} - F_{2A}^{IN}$ | $\Pi_1^{NN} ; \Pi_2^{NN}$ |

In the second stage, monopoly unions (see Dowrick, 1989) set their optimal wage strategies. Finally, in the third stage, firms are engaged in a Cournot competition,[6] choosing profit-maximizing quantities separately for each market. Market segmentation, combined with the constant marginal costs assumption, implies that the price of the good in each country depends exclusively on the total quantity available in the market.

The model is solved in the usual backward fashion: Firstly, the Cournot competition between firms in the product market is analyzed; Secondly, the unions' strategic behavior in the labor market; Finally, turning back to the first stage, it will be considered which equilibria arise and under which conditions.

**2.1 Stage 1: payoffs' description**

In the first stage each firm has two strategies,[7] as shown in Table 1: to invest in the foreign country, setting a new plant; and not to invest, maintaining all productive activities in the domestic country. As a consequence, several regimes might potentially arise: i) Reciprocal FDI (RFDI) when both firms invest; ii) two asymmetric regimes where only one firm invests; in this case, depending on trade costs and union strategies, the firm which does not invest might either to export or to produce only for the domestic market; iii) both firms do not invest: again, depending on trade cost levels and unions' strategic decisions, it may be that firms either serve the other market through exports, allowing for intra-industry trade (IIT), or they will remain in "autarky", usually defined in the literature as a situation where a firm produces just for its domestic market.[8]

In Table 1, $\Pi^{II}$ denotes RFDI profits; $\Pi^{IN}$ ($\Pi^{NI}$) denotes profits when a firm undertakes direct investment while the other does not (and vice versa); $\Pi^{NN}$ profits when both firms do not invest. The first lower script indicates the firm while the second denotes the country where firm profits are generated. Under the assumption of complete symmetry across countries it follows that $F_{1B}^{II} = F_{2A}^{II}$ and $F_{1B}^{IN} = F_{2A}^{IN}$ where $F_{1B}$ ($F_{2A}$) represents the sunk cost that Firm 1 (Firm 2) faces when it makes investment in country B (A). Obviously, depending on the different strategy adopted by the rival firm, the amount of the sunk costs needed to invest in the foreign country will vary according to the strategy profile. It turns out that to invest is a strategically viable option if profits generated by firms in the foreign country offset the cost of the initial investment, that is, $\Pi_{1B}^{II} \geq F_{1B}^{II}$ ($\Pi_{2B}^{II} \geq F_{1B}^{II}$) in the RFDI regime, and $\Pi_{1B}^{IN} \geq F_{1B}^{IN}$ ($\Pi_{2B}^{IN} \geq F_{2B}^{IN}$) in the asymmetric regimes. It is also retained all through the paper the assumption that the sunk costs are not subsidized, in the sense that firms do not receive money from the host government to locate a plant inside their country, namely $F \geq 0$.

In the next subsections the sub-games (first quantities and then wage outcomes) relatively to all regimes will be inspected to determine the union wage strategy selection in labor markets. The

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[6] As Brander (1981) pointed out, it might unquestionably be argued that the adoption of the Cournot strategy in product market by firm is unrealistic, but very sophisticated strategies are unlikely to be pursued because of high information-gathering and processing costs. Hence, in this paper, to make use of a very simple strategy could be useful for easiness of exposition.

[7] In this paper only pure strategies are taken in consideration.

[8] In principle, there are two additional outcomes in this sub-case, namely the one-way trade regimes. But, as Naylor (1999) has shown, when both markets are unionized and it is retained the symmetry assumption, one-way trade is never given.

results obtained will allow to evaluate firms' payoff in the first stage, and therefore to derive all the possible productive structures that will arise as game equilibria.

**2.2 Case 1: both firms do not invest**

In the first sub-case is analyzed the situation in which both firms decide not to invest. The results of this subsection are also found in Straume (2002) and Naylor (1998, 1999) which are the strict references for this part of the paper.

**2.2.1 Monopoly in Autarky**

The monopoly in the case of Autarky is used as benchmark. Consider country A and Firm 1. The monopolist profit function is given by

$$\Pi_1 = (1 - x)x - w_1 x \tag{1}$$

where $p = (1 - x)$ is the linear (inverse) demand function ($a$ is normalized to 1) and $w_1$ is the wage paid by Firm 1. The optimal quantity produced is given by

$$x = \frac{1}{2} - \frac{1}{2} w_1 .$$

The union utility function is the following

$$\Omega_1 = w_1 x \tag{2}$$

Substituting $x$ and solving the maximization problem, the optimal wage is then obtained

$$w_M = 1/2 \tag{3}$$

where the lower script $M$ denotes "monopoly". Further substitutions yield

$$x = 1/4 = y \,, \Omega_M = 1/8 \,, \Pi_M = 1/16 \,, CS_M = 1/32 \,, NW_M = 7/32$$

representing respectively the values for employment, union utility, profits, consumer surplus and national welfare. Given symmetry, the situation is identical in both countries.

**2.2.2 Intra-industry Trade with Bertrand Competition between Unions**

In case of intra-industry trade, in the last stage of the game firms are engaged in a Cournot competition in the product markets. The profit functions are given by

$$\Pi_1 = (1 - x_{1A} - y_{2A})x_{1A} + (1 - x_{1B} - y_{2B})x_{1B} - w_1 x_{1A} - w_1 x_{1B} - t x_{1B} \tag{4}$$

$$\Pi_2 = (1 - x_{1A} - y_{2A})y_{2A} + (1 - x_{1B} - y_{2B})y_{2B} - w_2 y_{2A} - w_2 y_{2B} - t y_{2A} \tag{5}$$

where $p_A = 1 - x_{1A} - y_{2A}$ is the price for the good in country A which depends both on the quantity produced by Firm 1 for the domestic market and the quantity produced for exports by Firm 2. Similarly $p_B = 1 - x_{1B} - y_{2B}$ is the price for the good in B. Notice that both firms pay a cost

$t \in [0,1)$ per unit of the good exported representing a basket of costs including tariffs, transportation and logistic, etc. Optimal quantities for Firm 1, subject obviously to the non-negativity constraints, are then

$$x_{1A} = \frac{1}{3} + \frac{1}{3}t + \frac{1}{3}w_2 - \frac{2}{3}w_1$$

for domestic market and

$$x_{1B} = \frac{1}{3} - \frac{2}{3}t + \frac{1}{3}w_2 - \frac{2}{3}w_1$$

for export quantities. Similarly, for Firm 2 it is obtained

$$y_{2B} = \frac{1}{3} + \frac{1}{3}t + \frac{1}{3}w_1 - \frac{2}{3}w_2$$

for domestic market and

$$y_{2A} = \frac{1}{3} - \frac{2}{3}t + \frac{1}{3}w_1 - \frac{2}{3}w_2$$

for exports. Firms' decision concerning export significantly depends on trade costs: firms would find profitable to export only if these costs are sufficiently small for intra-industry trade to contribute positively to profits. Subsequently, given the optimal quantities (and hence employment levels), each union sets the wage engaging in Bertrand competition against the other firm-level union. The utility function for Union 1 is given by

$$\Omega_1 = w_1(x_{1A} + x_{1B}). \tag{6}$$

A similar utility function holds for Union 2. Substituting quantities into union utility function, the first order condition for the maximization problem yields

$$w_1 = \frac{1}{4} - \frac{1}{8}t + \frac{1}{4}w_2$$

which represents the reaction function for union 1. Identical expression (interchanging $w_1$ with $w_2$) is obtained for union 2. The equilibrium wage level in Bertrand competition is then given by

$$w_{BC,IIT} = \frac{1}{3} - \frac{1}{6}t. \tag{7}$$

In case of intra-industry trade, unions compete between them over employment, causing a fall in wage levels compared to autarky regime. Hence trade, within this model, deteriorates union power. Nevertheless $\partial w_{BC,IIT} / \partial t < 0$: an increase in economic integration will induce trade unions to raise wages. The intuition is the following. For values less than a certain threshold (see below), IIT occurs between the two countries. A decrease in trade cost levels will induce a harsher competition amongst the participants in the international oligopoly: firms' output rises because exports increase; consequently, labor demand increases as well, and therefore unions will choose to set higher wages, capturing a higher share of oligopoly rents, while firms may experience a loss in profits.

Putting equation (7) into the quantity expressions allows to compute the following values:

$$x_{1A} = y_{2B} = \frac{2}{9} + \frac{7}{18}t, \ x_{1B} = y_{2A} = \frac{2}{9} - \frac{11}{18}t$$

which are the optimal Cournot quantities. After subsequent substitutions the union utility, firm profits, consumers' surplus, tariffs' entry and, finally, the national welfare are obtained,[9] given by

$$\Omega_{BC,IIT} = \frac{1}{27}(2-t)^2, \ \Pi_{BC,IIT} = \frac{8}{81} - \frac{8}{81}t + \frac{85}{162}t^2, \ CS_{BC,IIT} = \frac{4}{81}(2-t)^2, \ T_{BC,IIT} = \frac{2}{9}t - \frac{11}{18}t^2,$$

$$NW_{BC,IIT} = \frac{4}{9} - \frac{2}{9}t.$$

### 2.2.3 Second stage: unions' strategy selection

It should be noted that the optimal strategy selection by unions between a high-wage strategy, inducing autarky, and a low-wage strategy, allowing for IIT, depends exclusively on trade cost levels. IIT is supported in a pure strategy Nash equilibrium if the level of trade costs is below a particular critical value, given by $t \le 8/(13 + 9\sqrt{2}) \approx .31$ as shown in Naylor (1998, Appendix). Note that, as Naylor (1999) proves, in a symmetric unionized framework, inside the range $.31 < t < .354$ there is no equilibrium in pure strategies, with $t = .354$ representing the prohibitive trade cost levels at which trade no longer occurs: for higher values, unions will set a wage level which induces exclusively home production. [10]

### 2.3 Case 2: both firms invest. International Production with Bertrand Competition between Unions

If both firms reciprocally invest into the other country, the RFDI regime is given. Firms' profit functions are then the following

$$\Pi_1 = (1 - x_{1A} - x_{2A})x_{1A} + (1 - y_{1B} - y_{2B})y_{1B} - w_1 x_{1A} - w_1 y_{1B} - F \tag{8}$$

$$\Pi_2 = (1 - x_{1A} - x_{2A})x_{2A} + (1 - y_{1B} - y_{2B})y_{2B} - w_2 x_{2A} - w_2 y_{2B} - F \tag{9}$$

where $p_A = 1 - x_{1A} - x_{2A}$ is the price for the good in country A which depends both on the quantity produced by Firm 1 in country A and the quantity produced by the branch located in the same country by Firm 2. Similarly, $p_B = 1 - y_{1B} - y_{2B}$ is the price for the good in B. Notice that, when firms become multinational, they will pay the same wage in both countries: this hypothesis is coherent with the idea, frequently found in the literature, that a multinational will pay a wage rate *different* from that of domestic firms, see i.e. Leahy and Montagna (2000).

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[9] National welfare is defined as the sum of profits generated by the national firm (in case of international production offshore profits are obviously repatriated), union rents generated *inside* a country, consumers' surplus and, in the case of exports, tariff revenues. As Naylor (1998) pointed out, if $t$ is interpreted as partly comprising transport, logistic and other transaction costs, $T$ should not fully enter in the definition of the national welfare. For easiness of exposition, it will be assumed that the fraction of $t$ related to transport is negligible with respect to the tariff part.

[10] It can be shown that in the subsystem represented by firm profits related to production in country A (B), firm's 2 (1) profits from exports correlated to the optimal union 1 (2) high-low wage strategy will be positive for $t \le 5/7 \approx .714$ and $t \le 10/17 \approx .588$, respectively. But these values are greater than $t \le .31$ and $t = .354$ which represent two more stringent restrictions on firms profit functions.

Cournot competition outcomes in stage 3 of the game yield the following expression for quantities produced by the two firms into the two countries

$$x_{1A} = \frac{1 - w_1}{2} - \frac{1}{2} x_{2A}$$

$$y_{1B} = \frac{1 - w_1}{2} - \frac{1}{2} y_{2B}$$

$$y_{2B} = \frac{1 - w_2}{2} - \frac{1}{2} y_{1B}$$

$$x_{2A} = \frac{1 - w_2}{2} - \frac{1}{2} x_{1A}.$$

In presence of competition in the product markets, the following labor demand functions in terms of the two wage levels are derived

$$x_{1A} = \frac{1}{3} + \frac{1}{3} w_2 - \frac{2}{3} w_1, \text{ for } x_{2A} > 0, \ x_{1A} \geq 0 \text{ only if } w_1 \leq \frac{1 + w_2}{2} \tag{10}$$

$$y_{1B} = \frac{1}{3} + \frac{1}{3} w_2 - \frac{2}{3} w_1, \text{ for } y_{2B} > 0, \ y_{1B} \geq 0 \text{ only if } w_1 \leq \frac{1 + w_2}{2} \tag{11}$$

$$y_{2B} = \frac{1}{3} + \frac{1}{3} w_1 - \frac{2}{3} w_2, \text{ for } y_{1B} > 0, \ y_{2B} \geq 0 \text{ only if } w_2 \leq \frac{1 + w_1}{2} \tag{12}$$

$$x_{2A} = \frac{1}{3} + \frac{1}{3} w_1 - \frac{2}{3} w_2, \text{ for } x_{1A} > 0, \ x_{2A} \geq 0 \text{ only if } w_2 \leq \frac{1 + w_1}{2} \tag{13}$$

Equations (10)-(13) represent the production boundaries shown in Figure 1: given that the multinationals will pay the same wage in both countries, it turns out that if unions set too high wage levels (regions II and III in Figure 1) not only they do not consent to invest, but they also price out the firm from the domestic market, condemning their workers out of the labor markets. Hence, in stage 2 of the game each company-level union chooses a wage allowing firms both for domestic production and foreign investment. Making use of the optimal quantities, the utility function for Union 1 is given by

$$\Omega_1 = w_1 (x_{1A} + y_{1B}) \tag{14}$$

and the utility function for Union 2 takes a similar form.[11] Substitution of (10) and (11) into (14), and solving the maximization problem, leads to the following expression:

$$w_1 = \frac{1}{4} + \frac{1}{4} w_2$$

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[11] Obviously in this model each union, given its firm-level nature, is implicitly assumed to operate and coordinate its activities at company level in both countries.

**Figure 1: Investment Boundaries and Unions' Reaction Functions**
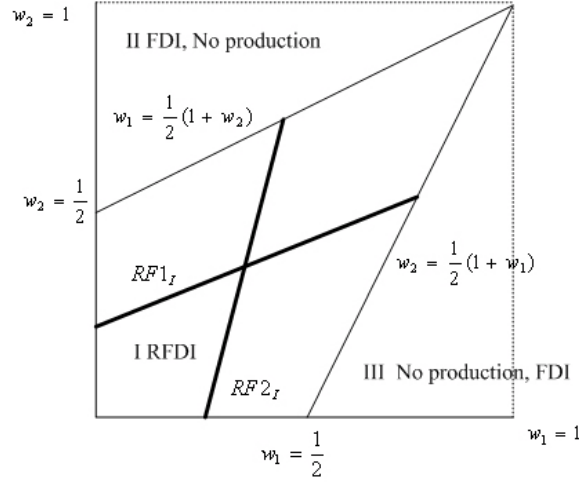


which is the reaction function for Union 1. A similar result (interchanging $w_1$ with $w_2$) is obtained for Union 2. Putting each of the two expressions into the other, the equilibrium wage level in Bertrand competition is derived,

$$w_{BC,RFDI} = 1/3 \tag{15}$$

where the lower script indicates "Bertrand Competition in RFDI regime". It follows that production levels are given by

$$x_{1A} = y_{1B} = y_{2B} = x_{2A} = 2/9$$

In the case of international business it is immediately clear that, when comparing wages (see equations (15) and (7)) and production outcomes, unions in equilibrium get for both higher values in a RFDI regime with respect to IIT reaching, consequently a higher utility level. This is so because unions will be able to capture a higher share of firm rents derived from the trade cost savings. Therefore the firm investment strategy will be advantageous for company level unions which may welcome FDI.

After subsequent substitutions, the union utility, firm profits, the expression for consumer surplus and finally the value for national welfare are respectively obtained:

$$\Omega_{BC,RFDI} = \frac{4}{27}, \ \Pi_{BC,RFDI} = \frac{8}{81} - F, \ CS_{BC,RFDI} = \frac{8}{81}, \ NW_{BC,RFDI} = \frac{28}{81} - F.$$

**2.4 Case 3: only one firm invests. Asymmetric regimes**

To establish where a particular equilibrium of the game is given, it is also required to evaluate firms' profits in asymmetric regimes, namely when one firm adopts the investment strategy while the other firm does not the same. In these asymmetric regimes, depending on unions high-low wage strategies, different configurations in both the product and the labor markets are possible. To define all the possible scenarios, consider for example the case that Firm 1 does not invest while Firm 2 undertakes a FDI. In the general case, profit function expressions are then the following:

$$\Pi_1 = (1 - x_{1A} - x_{2A})x_{1A} + (1 - x_{1B} - y_{2B})x_{1B} - w_1 x_{1A} - w_1 x_{1B} - tx_{1B} \tag{16}$$

$$\Pi_2 = (1 - x_{1A} - x_{2A})x_{2A} + (1 - x_{1B} - y_{2B})y_{2B} - w_2 x_{2A} - w_2 y_{2B} - F \tag{17}$$

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where $p_A = 1 - x_{1A} - x_{2A}$ is the price for the good in country A which depends both on quantities produced by Firm 1 and the quantities eventually produced by the subsidiary located in the same country by Firm 2, while $p_B = 1 - x_{1B} - y_{2B}$, the price of the good in B, depends on the quantity eventually imported by country B from Firm 1 and the quantity produced by Firm 2 for its originally domestic market B. Cournot competition in this case gives the following expressions for quantities produced by the two firms

$$x_{1A} = \frac{1 - w_1}{2} - \frac{1}{2} x_{2A}, \text{ for } x_{2A} = 0, \ x_{1A} \geq 0 \text{ only if } w_1 \leq 1 \tag{18}$$

$$x_{1B} = \frac{1 - w_1 - t}{2} - \frac{1}{2} y_{2B}, \text{ for } y_{2B} = 0, \ x_{1B} \geq 0 \text{ only if } w_1 \leq 1 - t \tag{19}$$

$$y_{2B} = \frac{1 - w_2}{2} - \frac{1}{2} x_{1B}, \text{ for } x_{1B} = 0, \ y_{2B} \geq 0 \text{ only if } w_2 \leq 1 \tag{20}$$

$$x_{2A} = \frac{1 - w_2}{2} - \frac{1}{2} x_{1A}, \text{ for } x_{1A} = 0, \ x_{2A} \geq 0 \text{ only if } w_2 \leq 1 \tag{21}$$

Expressions (18) to (21) represent the absolute upper bounds in absence of competition in the product markets in asymmetric regimes. But if wages set by unions are such that firms may compete, then the optimal Cournot quantities in terms of union wage rates are given by

$$x_{1A} = \frac{1}{3} + \frac{1}{3} w_2 - \frac{2}{3} w_1, \text{ for } x_{2A} > 0, \ x_{1A} \geq 0 \text{ only if } w_1 \leq \frac{1 + w_2}{2} \tag{22}$$

$$x_{1B} = \frac{1}{3} + \frac{1}{3} w_2 - \frac{2}{3} w_1 - \frac{2}{3} t, \text{ for } y_{2B} > 0, \ x_{1B} \geq 0 \text{ only if } w_1 \leq \frac{1 + w_2 - 2t}{2} \tag{23}$$

$$y_{2B} = \frac{1}{3} + \frac{1}{3} w_1 - \frac{2}{3} w_2 + \frac{1}{3} t, \text{ for } x_{1B} > 0, \ y_{2B} \geq 0 \text{ only if } w_2 \leq \frac{1 + w_1 + t}{2} \tag{24}$$

$$x_{2A} = \frac{1}{3} + \frac{1}{3} w_1 - \frac{2}{3} w_2, \text{ for } x_{1A} > 0, \ x_{2A} \geq 0 \text{ only if } w_2 \leq \frac{1 + w_1}{2}. \tag{25}$$

All the boundary conditions and the possible asymmetric configurations are depicted in Figure 2. Consider for example the boundary expression in (23): Firm 1 exports for rates of $w_1$ lower than the boundary expression. This expression binds until $w_2 < 1$, while for higher values of $w_2$ such that $y_{2B} = 0$, then $w_1 \leq 1 - t$ binds. Instead, consider the boundary expression in (24): home production for Firm 2 along the boundary is exactly equal to zero. This constraint binds until exports by Firm 1 are strictly positive, that is, for $w_1 < 1 - t$. For higher values of $w_1$, $x_{1B} = 0$; then boundary constraint in (20), $w_2 \leq 1$, binds. With a similar reasoning, all the other boundaries are derived.

The boundary conditions generate six potential qualitatively different possible output regions, three involving trade, and three FDI. In Region I all quantities are positive. This region is related to values of wages sufficiently low such that both firms are allowed to undertake international business, either in the form of exports or FDI. In Region II, $w_1$ is high enough, given $w_2$ and $t$, that

**Figure 2: Trade and Investment Boundaries and Possible Configurations In Asymmetric Regimes**
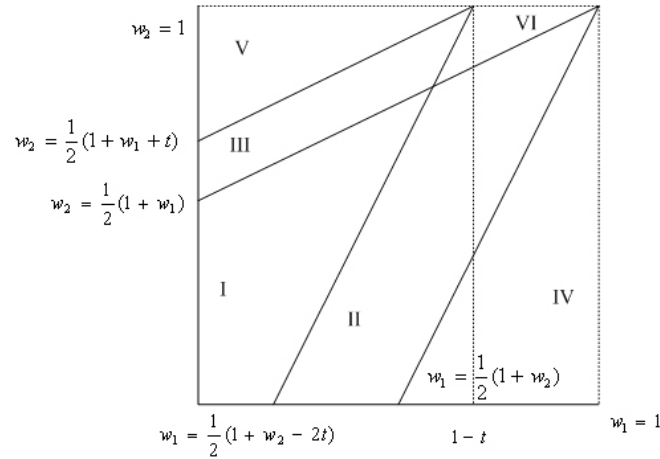


Firm 1 cannot export: in this case only Firm 2 undertakes international business in the way of FDI, while $w_1$ is still sufficiently low to ensure that Firm 1 produces retaining only a share for its original domestic market. Region III, instead, is characterized by a situation where the wage level fixed by the Union 2, $w_2$, given $w_1$ and $t$, is prohibitive to consent Firm 2 to exploit the production plant located in the other country, but it is still sufficiently low to allow exclusively domestic production. In Region IV (and similarly in Region V), $w_1$ ($w_2$) is so high that Firm 2 (Firm 1) establishes a monopoly in both markets. Regions I, II, III, IV and V embrace types of configurations where forms of international activities are engaged. In Region VI, in contrast, no international business occurs and firms produce only domestically.[12]

From equations (18) to (25) it follows that, depending on the particular region, labor demand functions for each union will differ, and consequently the best-reply functions (and the relative utility levels associated) of each of them with respect to the high-low wage strategy played by the rival union. In order to find the sub-game equilibria in asymmetric regimes, some preliminary consideration are exploited. First, unions will never set wages that will priced out the firm from the product market, that is, in the case under consideration, Union 1 will never play wage levels residing along the boundary between Region II and IV and in Region IV, while Union 2 will never play wage levels along the boundary between Region III and V and in Region V. Second, the following result is derived.

**Proposition 1:** *In asymmetric regimes, the union in the firm which invests does not play a high wage strategy.*

Proof: see the appendix.

Proposition 1 establishes that, whenever a firm has chosen to invest, the relevant union's best reply function is that associated to the low wage strategy: although there may be the possibility, the union will never set a wage which precludes the exploitation of the foreign plant result of the FDI. The reason lies in the fact that high wage rates are not sufficient to compensate the drastic loss in employment opportunities for the union in the foreign country: FDI will induce unions to moderate wage demands with respect to the autarky position, but this is more than offset by the occupational growth. It follows that, in the case under exam, Union 2 will never play wage levels in Region III.

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[12] Theoretically there are two other regions (not depicted in the figure): a region where wage rates are so high that in country B there is neither production nor consumption , but $w_1$ is sufficiently low to produce in country A; and a region where wage rates are so high that in both countries there is there is neither production nor consumption.

From this discussion, the analysis concerning the determination of sub-game equilibria candidates in asymmetric regimes can be restricted to Regions I and II.

### 2.4.1 Region I

As earlier said, Region I is characterized by values of wage rates sufficiently low to consent also Firm 1 to undertake international business in the form of exports. Hence, the labor demand functions faced by the two unions are given by the sum of (22) and (23) for Union 1

$$x_{1A} + x_{1B} = \frac{1}{3}(2 - 4w_1 + 2w_2 - 2t) \tag{26}$$

and (24) and (25) for union 2, that is

$$y_{2B} + x_{2A} = \frac{1}{3}(2 - 4w_2 + 2w_1 + t). \tag{27}$$

From (26) and (27) it is suddenly evident that total employment and production levels of the multinational are greater than those of the exporting firm. This is due to the effect of the saving in trade costs by the multinational. Additionally, these "trade barriers" act as a kind of protection with respect to "home" workers of Firm 2, as it is possible to see from equation (24).

Utility function in this case for Union 1 is given by

$$\Omega_1 = w_1(x_{1A} + x_{1B}) \tag{28}$$

while for Union 2 is given by

$$\Omega_2 = w_2(x_{2A} + y_{2B}). \tag{29}$$

The optimal utility related to the low-wage strategy for Union 1, that is, the wage level allowing for trade with the other country, is then given by $w_1 = \arg\max_{w_1}\{\Omega_{1,I}^L\}$, from which

$$RF_{1,I}^L = w_1 = \frac{1}{4}(1 + w_2 - t) \text{ implying } \Omega_{1,I}^L = \frac{1}{12}(1 + w_2 - t)^2 \tag{30}$$

where the first expression in (30) is the reaction function of Union 1 in region 1, $RF_{1,I}^L$. Similarly, for Union 2 it is obtained $w_2 = \arg\max_{w_2}\{\Omega_{2,I}\}$, which yields the reaction function

$$RF_{2,I}^L = w_2 = \frac{1}{8}(2 + 2w_1 + t) \text{ implying } \Omega_{2,I}^L = \frac{1}{48}(2 + 2w_1 + t)^2 \tag{31}$$

Using (30) and (31) the following wage levels in equilibrium for each union are obtained

$$w_{1BC,Asy,tr} = \frac{1}{3} - \frac{7}{30}t \tag{32}$$

$$w_{2BC,Asy,tr} = \frac{1}{3} + \frac{1}{15}t. \tag{33}$$

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After further substitutions of equilibrium wages, optimal quantities are obtained

$$x_{1A} = \frac{2}{9} + \frac{8}{45}t, \ x_{1B} = \frac{2}{9} - \frac{22}{45}t; \ y_{2B} = \frac{2}{9} + \frac{19}{90}t, \ x_{2A} = \frac{2}{9} - \frac{11}{90}t.$$

It is immediately evident that $t$ plays a different role on wage levels, depending on the type of international economic activity the firm has undertaken. In fact, increasing economic integration (in the form of a further reduction in barriers to trade) stimulates exports and implies an increase in wages for the union which operates in the exporting firm, while a higher degree of economic integration translates both in a decrease in the multinational firm production and in a reduction in wages for its workers. Nonetheless, wages and output in the multinational firm are always higher than those in the exporting firm, unless $t = 0$: the union in the multinational is able to capture higher shares of the firm's rents generated by the savings in trade costs.

Finally, subsequent substitutions of equilibrium wages and quantities lead to all the other values for union utility level, firms' profit functions, consumers' surplus and for national welfare in the case of the (export; FDI) regime, where lower scripts indicate "Bertrand Competition in Asymmetric Regime with trade".[13]

$$\Omega_{1,BC,Asy,tr}^{NI} = \frac{1}{675}(7t - 10)^2, \ \Pi_{1,BC,Asy,tr}^{NI} = \frac{8}{81} - \frac{56}{405}t + \frac{548}{2025}t^2, \ CS_{A,BC,Asy}^{NI} = \frac{1}{648}(8 + t)^2,$$

$$NW_{A,BC,Asy,tr}^{NI} = \frac{34}{81} - \frac{281}{810}t + \frac{5453}{16200}t^2;$$

$$\Omega_{2,BC,Asy,tr}^{IN} = \frac{4}{675}(5 + t)^2, \ \Pi_{2,BC,Asy,tr}^{IN} = \frac{8}{81} + \frac{16}{405}t + \frac{241}{4050}t^2 - F, \ T_{B,BC,Asy,tr}^{IN} = \frac{2}{9}t - \frac{22}{45}t^2,$$

$$CS_{B,BC,Asy,tr}^{IN} = \frac{1}{648}(5t - 8)^2, \ NW_{B,BC,Asy,tr}^{IN} = \frac{22}{81} + \frac{67}{810}t - \frac{6559}{16200}t^2 - F.$$

### 2.4.2 Region II

In Region II $w_1$ is sufficiently high, given $w_2$ and $t$, that Firm 1 cannot export. The labor demand functions faced by the two unions are given by (22) for Union 1 and by the sum of (20) with $x_{1B} = 0$ and (25) for Union 2, that is

$$y_{2B} + x_{2A} = \frac{1}{6}(5 - 7w_2 + 2w_1). \tag{34}$$

Hence union utility functions are given by

$$\Omega_1 = w_1 x_{1A} \tag{35}$$

$$\Omega_2 = w_2(x_{2A} + y_{2B}). \tag{36}$$

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[13] Note that in the expression of national welfare are computed union rents generated *inside* the country, that is, union rents assigned to all workers that *operates* in a country.

Since Union 1 in Region II is playing a high wage strategy while Union 2 play a low wage strategy, the reaction function and the related utility to this region for Union 1 is given by $w_1 = \arg\max_{w_1}\{\Omega_1^H\}$, from which it is obtained

$$RF_{1,II}^H = w_1 = \frac{1}{4}(1 + w_2) \text{ implying } \Omega_{1,II}^H = \frac{1}{24}(1 + w_2)^2 \tag{37}$$

and for Union 2, $w_2 = \arg\max_{w_2}\{\Omega_{2,II}\}$, from which it is obtained

$$RF_{2,II}^L = w_2 = \frac{1}{14}(2w_1 + 5) \text{ implying } \Omega_{2,II}^L = \frac{1}{168}(5 + 2w_1)^2. \tag{38}$$

To complete the analysis relatively to Region II, at the boundary between Region I and II it is obtained that (27) is equal to (34), that is,

$$w_2 = 2w_1 + 2t - 1 \tag{39}$$

which is consistent with (23), and represents Union 2 reaction function along the boundary. Using Cournot quantities and (37) and (38) it is derived

$$w_{1BC,Asy,nt} = 19/54 \tag{40}$$

$$w_{2BC,Asy,nt} = 11/27 \tag{41}$$

where low script indicate "Bertrand Competition in Asymmetric Regime, no trade". The resulting wage levels in equilibrium are obviously independent on trade cost. It is important to note that wage rates in both countries are now higher with respect to the case of reciprocal investment: the mere fact that one firm decides not to invest allows unions to recover part of their monopoly power because of a reduced competition, obtaining a higher wage. Making use of (40) and (41), the optimal quantities produced are derived

$$x_{1A} = 19/81; \quad y_{2B} = 8/27, \quad x_{2A} = 29/162$$

and, after subsequent substitutions, the union utility level, firm profits, the expression for consumer surplus and finally the value for national welfare[14] are respectively obtained

$$\Omega_{1,BC,Asy,nt}^{NI} = \frac{361}{4374}, \ \Pi_{1,BC,Asy,nt}^{NI} = \frac{361}{6561}, \ CS_{A,BC,Asy,nt}^{NI} = \frac{152}{2187}, \ NW_{A,BC,Asy,nt}^{NI} = \frac{7975}{26224};$$

$$\Omega_{2,BC,Asy,nt}^{IN} = \frac{847}{4374}, \ \Pi_{2,BC,Asy,nt}^{IN} = \frac{3145}{26244} - F, \ CS_{B,BC,Asy,nt}^{IN} = \frac{32}{729}, \ NW_{B,BC,Asy,nt}^{IN} = \frac{14948551}{57351888} - F.$$

**2.4.3 Second stage: Union 1 strategy selection**

While Union 2 will always select a wage level such that Firm 2 can operate in both markets,

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[14] Notice that in the national welfare of country A is computed also the share of union rents obtained by workers of the Firm 2 employed in country A.

**Figure 3: Trade and Investment Boundaries and**
**Unions' Reaction Functions in Asymmetric Regimes**
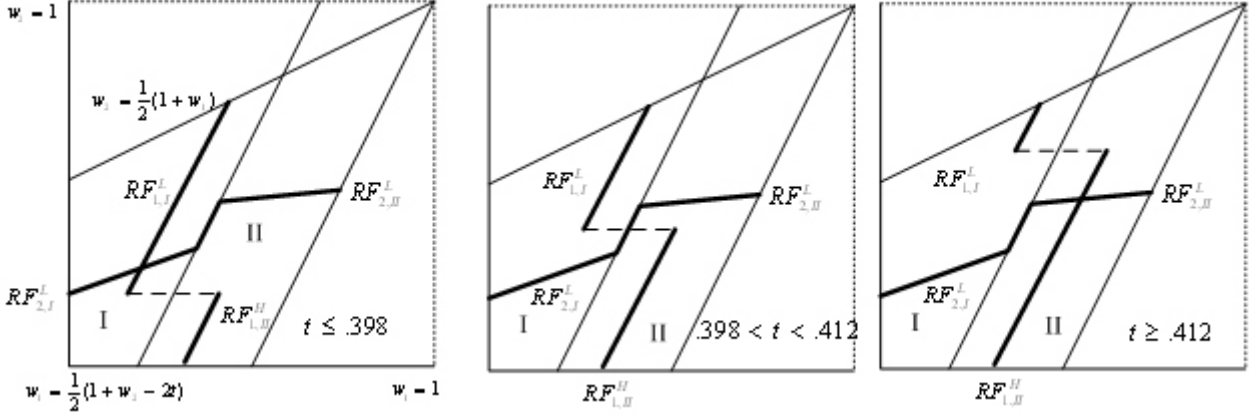


Union 1 in the not investing firm has the opportunity to choose between a high-low wage strategy. Union 1 will switch from high to low wage strategy if and only if $\Omega_{1,I}^{L} \geq \Omega_{1,II}^{H}$, that is, from equations (30) and (37), at the wage level

$$w_2 \geq (2 + \sqrt{2})t - 1.$$

The switching wage for Union 1 matches the point of intersection of the low-wage part of the Union 1 reaction function with the best reply for Union 2 in Region I, $RF_{2,I}$, when satisfying concurrently with the Bertrand equilibrium wage in equation (33); it follows that the critical value of $t$, above which trade in asymmetric regimes is not supported as pure strategy equilibrium, is equal to

$$\frac{1}{3} + \frac{1}{15}t \geq (2 + \sqrt{2})t - 1$$

that is, at the critical value of trade cost levels $t \leq 20/(29 + 15\sqrt{2}) \approx .398$. Instead, the switching wage for Union 1 matches the point of intersection of the high-wage part of the Union 1 reaction function with the best reply for Union 2 in Region II ($RF_{2,II}$ in Figure 3) when fulfilling simultaneously with the Bertrand equilibrium wage in equation (40); consequently the critical value of $t$ above which home production in asymmetric regimes is given as equilibrium in pure strategies is equal to

$$11/27 \leq (2 + \sqrt{2})t - 1$$

that is, at the critical value of trade cost level $t \geq 38/27(2 + \sqrt{2}) \approx .412$.

From these results directly follows that if $t \leq .398$, then Union 1 will set unambiguously a wage level which allows Firm 1 to export in the other country, while for $t \geq .412$, Union 1 will set unequivocally a wage level that induces Firm 1 to produce only domestically. What happens in the range $.398 < t < .412$? This could be also exemplified graphically in Figure 3, which describes unions' best reply functions.

For $t$ marginally above the critical value $.398$, equilibrium defined by (33)-(34) is not given because Union 1 would switch to a high-wage strategy. When Union 1 switches to a high-wage strategy ($RF_{1,II}^{H}$ in Figure 3), then Union's 2 wage raises under the best response function in Region I, $RF_{2,I}^{L}$. At the new level of wage rate set by Union 2, Union 1 will respond under the revised best

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response function, but the process does not converge. Instead, for $t$ below the critical value $.412$, equilibrium defined by (41)-(42) is not given and Union 1 will play a low-wage strategy. Once again, the best response by Union 2 is such that at the new wage level $w_2$, the process does not converge: the best response functions in the range $.398 < t < .412$ do not intersect. It follows that, in such a range, a sub-game equilibrium in pure strategies does not exist.

### 2.5 First stage: Firms' Selection Strategy and Game Equilibria under Union Competition

It is now possible to go back to the first stage of the game to investigate the strategies selected by firms. Depending both on trade and investment costs, and wage levels selected by unions, under certain conditions different productive structures might arise as equilibria of the game.

It was found that in the sub-game defined by the firms' strategy profile $(N;N)$, IIT is supported as Nash equilibrium in pure strategies by unions if the trade cost level is below $t \le .31$; for $t > .354$ unions' optimal wage strategy is to set high wages such that firms are induced to produce only for the domestic markets; in the range $.31 < t < .354$, there is no equilibrium in pure strategies. Instead, firms' payoffs in the RFDI regime depend on wage levels set by unions and the amount of fixed costs.

Conversely, in the two sub-games identified by the firms' strategy profiles $(I;N)$ and $(N;I)$, depending on $t$, $F$ and the union wage strategy in the firm which does not invest,[15] two different asymmetric regimes are possible. If $t \le .398$, then the union in the firm which maintain all productive activities at home will set a wage level such that the firm would export towards the other country, while for $t \ge .412$ the union will choose unequivocally a wage rate inducing only home production. In the range $.398 < t < .412$, there is no equilibrium in pure strategies.

To obtain well defined solutions in pure strategies, in the subsequent analysis the following restrictions on the values of the parameters are imposed.

**Restriction 1.** $\tau \equiv t \in [0,1) \Big/ \left( \dfrac{8}{(13 + 9\sqrt{2})}, \dfrac{6 - \sqrt{21}}{4} \right) \cup \left( \dfrac{20}{(29 + 15\sqrt{2})}, \dfrac{38}{27(2 + \sqrt{2})} \right).$

**Restriction 2.** $\forall \tau$, $F_{1B} \in \left[0, \min(\Pi_{1B}^{II}; \Pi_{1B}^{IN})\right] \text{ and } F_{2A} \in \left[0, \min(\Pi_{2A}^{II}; \Pi_{2A}^{IN})\right]$ .

While Restriction 1 simply allows to delimitate the ranges of the trade costs where sub-game perfect equilibria in the union game are existent, the meaning of Restriction 2 is that the profits generated in the foreign market by the firm which invests have to be greater than the size of the fixed costs to undertake the investment in the foreign country. These profits will differ according to the strategy selected by the rival firm: hence, Restriction 2 defines a set where the investment strategy can be played either when both firms invest or when only one firm makes a foreign investment.[16]

Making use of the results of stages 2 and 3 and given Restrictions 1 and 2, it follows that firms' payoff structure in stage 1 of the game are represented by
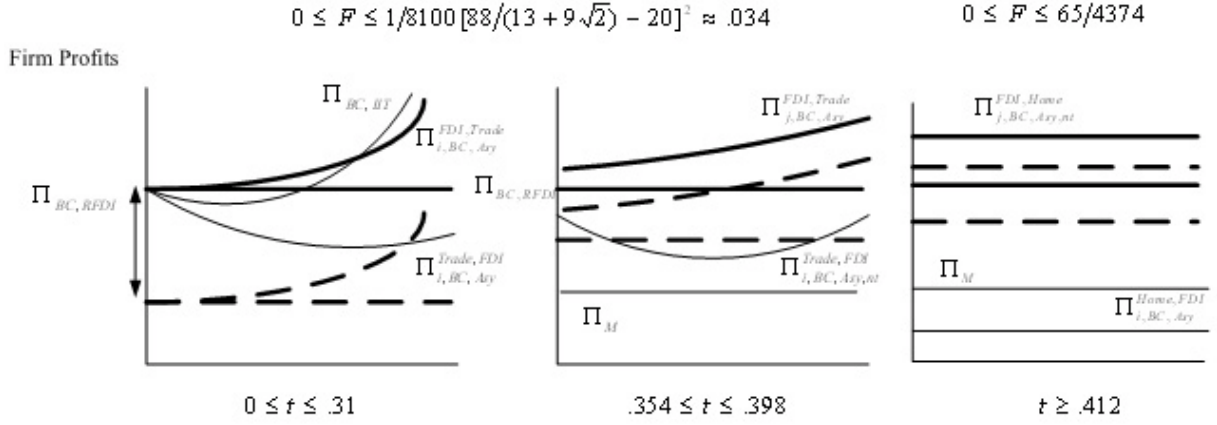
1) in $0 \le t \le .31$:

$(\Pi_{1,BC,RFDI}^{II}; \Pi_{2,BC,RFDI}^{II})$, $(\Pi_{1,BC,Asy,tr}^{IN}; \Pi_{2,BC,Asy,tr}^{NI})$, $(\Pi_{1,BC,Asy,tr}^{NI}; \Pi_{2,BC,Asy,tr}^{IN})$ $(\Pi_{1,BC,IIT}^{NN}; \Pi_{2,BC,IIT}^{NN})$ ;

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[15] In fact, from Proposition 1, the union operating in the firm which decided to become multinational will always set a wage such that the plants in both countries are exploited.

[16] If restriction 2 does not hold, the investment strategy is not always practicable, and hence the results of the analysis are those obtained in Naylor (1999).

**Figure 4: Firm Profits in Stage 1**

$$0 \leq F \leq 1/8100\,[88/(13 + 9\sqrt{2}) - 20]^2 \approx .034 \qquad\qquad 0 \leq F \leq 65/4374$$



Note: bold lines represent profit functions associated to the FDI strategy

2) in $.354 < t \leq .398$:

$$(\Pi_{1,BC,RFDI}^{II}; \Pi_{2,BC,RFDI}^{II}), (\Pi_{1,BC,Asy,tr}^{IN}; \Pi_{2,BC,Asy,tr}^{NI}), (\Pi_{1,BC,Asy,tr}^{NI}; \Pi_{2,BC,Asy,tr}^{IN}), (\Pi_{1,M}^{NN}; \Pi_{2,M}^{NN});$$

3) for $t \geq .412$:

$$(\Pi_{1,BC}^{II}; \Pi_{2,BC}^{II}), (\Pi_{1,BC,Asy,nt}^{IN}; \Pi_{2,BC,Asy,nt}^{NI}), (\Pi_{1,BC,Asy,nt}^{NI}; \Pi_{2,BC,Asy,nt}^{IN}), (\Pi_{1,M}^{NN}; \Pi_{2,M}^{NN}).$$

The situation is exemplified in Figure 4, while game equilibria are reported in Table 2. In the range $0 \leq t \leq .31$ it is obtained that the size of sunk costs must be

$$F_{1B} \in \left[0, \min(\Pi_{1B,BC,RFDI}^{II}; \Pi_{1B,BC,Asy,tr}^{IN})\right] \text{ and } F_{2A} \in \left[0, \min(\Pi_{2A,BC,RFDI}^{II}; \Pi_{2A,BC,Asy,tr}^{IN})\right]$$

where $\Pi_{1B,BC,RFDI}^{II} = \Pi_{2A,BC,RFDI}^{II} = 4/81$ and $\Pi_{1B,BC,Asy,tr}^{IN} = \Pi_{2A,BC,Asy,tr}^{IN} = (11t - 20)^2/8100$. It can be easily checked that all over this range of analysis,

$$\Pi_{1B,BC,RFDI}^{II} = \Pi_{2A,BC,RFDI}^{II} \geq \Pi_{1B,BC,Asy,tr}^{IN} = \Pi_{2A,BC,Asy,tr}^{IN},$$

with the equality holding only for $t = 0$. Hence, the relevant range of $F$ is given by $F \in \left[0, (\Pi_{1B,BC,Asy,tr}^{IN} = \Pi_{2A,BC,Asy,tr}^{IN})\big|_{t=.31}\right]$: in fact, at the upper bound of this interval, profits associated to asymmetric structures of international activities are the lowest for the firm which invests, allowing for FDI at every value of $t$ whenever sunk costs are lower than this threshold.

When $F = 0$ (direct investment no costly) and unions act competitively, in the range $0 < t \leq 140/471 \approx .297$, RFDI is the Nash equilibrium of the game, while for $t > 140/471$ both RFDI and IIT are given. As long as the magnitude of the sunk costs for the direct investment $F$ will vary, the profit function associated to FDI goes down. This implies that there will be areas where the profits associated to the not invest strategy are superior to those related to the investment strategy. It follows that there exist combinations of the values of the parameters $t$ and $F$ allowing simultaneously both for RFDI and IIT as Nash Equilibria of the game.

Given the firms' payoff structure, as well in the range of trade costs $.354 < t \leq .398$ it is obtained that $F \in \left[0, (\Pi_{1B,BC,Asy,tr}^{IN} = \Pi_{2A,BC,Asy,tr}^{IN})\big|_{t=.31}\right]$: depending both on the size of sunk costs and the values of $t$, different equilibria can arise. In particular, within this range, asymmetric regimes of international business may be possible.

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## Table 2: Sub-game Nash Equilibria, First Stage

**First stage, Nash Equilibria**

1) in ... and ... for $0 \leq F \leq 1/8100[88/((13 + 9\sqrt{2}) - 20]^2 \approx .034$:

a) in the range $0 < F \leq 392/38151 \approx .0102$:

in $0 \leq t \leq 35/137 - 5/274\sqrt{196 - 11097F}$, IIT Nash equilibrium of the game;

in $35/137 - 5/274\sqrt{196 - 11097F} < t \leq 70/471 - 5/942(\sqrt{784 - 76302F})$, RFDI, IIT equilibria;

in $70/471 - 5/942(\sqrt{784 - 76302F}) < t \leq 70/471 + 5/942(\sqrt{784 - 76302F})$, RFDI equilibrium;

in $70/471 + 5/942(\sqrt{784 - 76302F}) < t \leq .31$, RFDI and IIT Nash equilibria;

b) in the range $392/38151 < F \leq 1184/81675 \approx .0145$:

in $0 \leq t \leq 35/137 - 5/274\sqrt{196 - 11097F}$, IIT Nash equilibrium of the game;

in $35/137 - 5/274\sqrt{196 - 11097F} < t \leq .31$, RFDI and IIT Nash equilibria;

c) in the range $1184/81675 < F \leq 196/11097 \approx .0176$:

in $0 \leq t \leq 35/137 - 5/274\sqrt{196 - 11097F}$, IIT Nash equilibrium of the game;

in $35/137 - 5/274\sqrt{196 - 11097F} < t \leq 35/137 + 5/274\sqrt{196 - 11097F}$, RFDI and IIT Nash equilibria;

in $35/137 + 5/274\sqrt{196 - 11097F} < t \leq .31$, IIT Nash equilibrium,

d) for $196/11097 < F \leq 1/8100[88/((13 + 9\sqrt{2}) - 20]^2 \approx .034$, IIT unambiguously the unique Nash equilibrium in the range $0 \leq t \leq .31$.

2) in the range $(6 - \sqrt{21})/4 < t \leq 20/(29 + 15\sqrt{2}) \approx .398$ and for $0 \leq F \leq 1/8100[88/((13 + 9\sqrt{2}) - 20]^2 \approx .034$:

a) for $0 \leq F \leq 701600\sqrt{2}/1375929 - 8779552/12383361 \approx .012$, RFDI equilibrium;

b) for $.012 < F \leq 341\sqrt{2}/2025 - 227/300 \approx .015$

in the range $6 - \sqrt{21}/4 < t \leq 35/137 + 5\sqrt{196 - 11097F}/274$, RFDI equilibrium;

in the range $35/137 + 5\sqrt{196 - 11097F}/274 < t \leq 20/(29 + 15\sqrt{2}) \approx .398$, Asymmetric regimes equilibria;

c) for $.015 < F \leq 1/8100[88/((13 + 9\sqrt{2}) - 20]^2 \approx .034$, Asymmetric regimes equilibria.

3) for $t \geq 38/27(2 + \sqrt{2}) \approx .412$ and for $0 \leq F \leq 65/4374 \approx .14$ RFDI Nash equilibrium of the game.

Instead, for $t \geq .412$, given the switch toward the high wage strategy by unions in the firms' strategy profile $(N; N)$, profits are no more affected by trade costs. The relevant range of sunk costs is now represented by

$$F_{1B} \in \left[0, \min(\Pi_{1B,BC,RFDI}^{II}; \Pi_{1B,BC,Asy,nt}^{IN})\right] \text{ and } F_{2A} \in \left[0, \min(\Pi_{2A,BC,RFDI}^{II}; \Pi_{2A,BC,Asy,nt}^{IN})\right]$$

implying $F \in \left[0, (\Pi_{1B,BC,Asy,nt}^{IN}; \Pi_{2A,BC,Asy,nt}^{IN})\right]$. The firms' strategy selection depends on the wage level set by unions and on the sunk costs of undertaking FDI.[17]

The broad picture relatively to the productive structures arising in equilibrium is quite complex. This is so because of the interdependence of $t$ and $F$, as it is possible to see from Figure 5, which reports graphically the results in Table 2 in the $(F, t)$-space (changes in $F$ may shrink or enlarge the area where a particular productive structure is given). Additionally, these parameters in turn affect both directly and indirectly the union wage strategy selection. Nonetheless, some general observations can be addressed. First, provided that to invest is a feasible strategic option as assumed, autarky will never arise as equilibrium of the game. The reason resides in the fact that firms, by having the opportunity to undertake FDI, can elude the potential unions' threat of adopting a high-wage strategy in case of a non investment choice.

Second, it is possible that a RFDI regime could be given not only when trade costs are sufficiently high (the so called *tariff jumping argument*), but also when trade costs are low and IIT is a likely outcome; that is, reciprocal investments could simply arise for strategic reasons. The explanation may be the following: increasing economic integration in form of a reduction in trade barriers could make the investment option more attractive. In fact, differentiating it is obtained that $\partial(\Pi_{1B,BC,Asy,tr}^{IN} = \Pi_{2A,BC,Asy,tr}^{IN})/\partial t < 0 \; \forall t \in [0,.31]$: a reduction in trade costs raises foreign profits, enlarging the set for which to invest is a feasible strategy.

Third, for intermediate values of trade costs, either RFDI or asymmetric regimes could be given: if sunk costs are not too large, to make a foreign investment seems to play an increasing fundamental role as firm strategic choice. Finally, for $t$ sufficiently high, the tariff jumping argument is valid: in order to avoid prohibitive trade cost levels, to invest becomes the only feasible alternative to start international activities. These results could be summarized in the following proposition.

**Proposition 2:** *Under Restrictions 1 and 2, and unions acting competitively in the labor market, to invest is the more expected strategic option for firms, unless the value of the parameters $t$ and $F$ is sufficiently low. Hence, RFDI is the more likely regime that could be given, but for a high degree of economic integration, IIT is expected to occur.*

The next section will investigate if the collusive behavior by unions in the labor market could eventually alter these findings, and if this is the case, in which measure.

## 3. Union Collusion

In this model collusion stands for unions to find an agreement to fix a wage that maximizes their joint union utility (*efficient union collusion*). Generally this agreement determines a wage level higher than the Bertrand competitive one. While in symmetric situations this kind of collusion seems to be a plausible strategy, in asymmetric cases there are various reasons that may hinder it. Coordination problems are clearly more complex when agents have divergent preferences respect to collusive outcomes. Furthermore, asymmetry may also deter the sustainability of collusion. In fact, (i) it may be more difficult to react against the economic agent having a marginal advantage in case of deviation from the collusive agreement, and (ii) the economic agent who is in a position of

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[17] In reality, trade costs, affecting unions' utility and their optimal wage strategy, indirectly influence firm profits.

**Figure 5: Productive Structures in Equilibrium with Union Bertrand Competition**
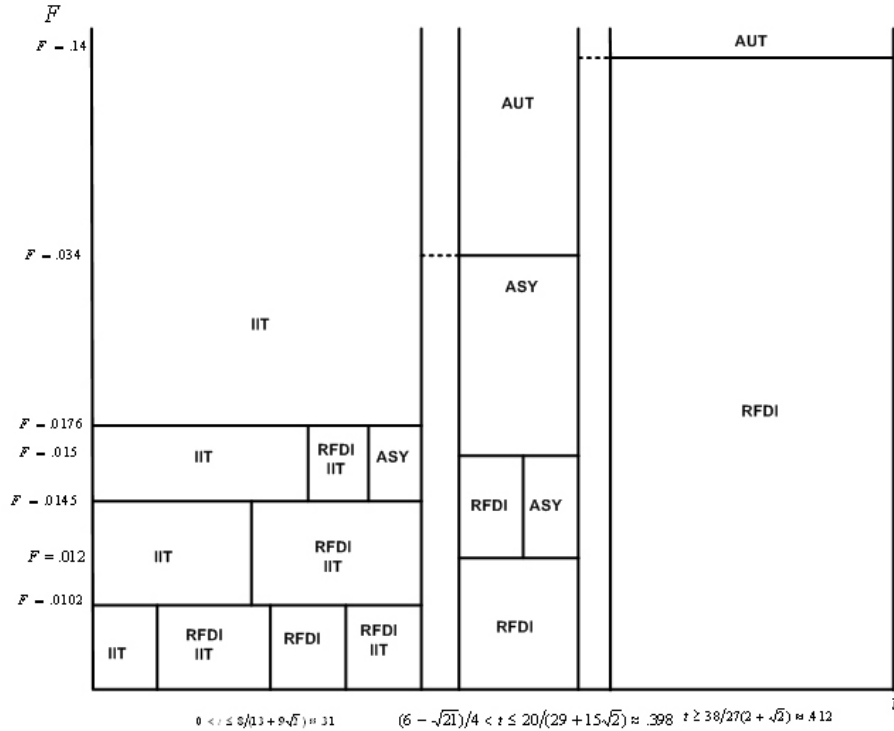


advantage in terms of marginality may gain relatively more from deviating in the short-term (Miklos-Thal, 2008). Nevertheless, in this paper it will be considered the maximization of the joint union utility also in asymmetric regimes. The reason is dictated by the need of giving a homogeneous definition of collusion all over the possible firms' strategy profiles. This will allow to compare how collusive behavior could alter the strategic choice of firms related to the beginning of international activities, and consequently the specification of game equilibria in stage 1 respect to the union competitive case.

Collusion could be implemented in a repeated game. With four players the set of possible strategy combinations is clearly very huge. It follows that a very simplified assumption is needed: for the purposes of this paper, it is assumed that firms have not the possibility to collude. Although in a repeated game framework this is a very strong assumption (because also firms have incentives to reach a collusive agreement), it is retained in order to isolate exclusively union collusive behavior; but this hypothesis could be also seen as if there is a sufficiently effective Antitrust Authority able to avoid tacit collusion in the product market.

**3.1 Union Collusion when firms do not invest**

This subsection analyzes the case of unions' collusive behavior in the second stage of the game when firms decide not to adopt the investment strategy. Unions may collude in two different ways: 1) to set a very high wage level such that each firm does not find profitable to produce for exports, inducing them to remain in an autarky position; 2) to collude selecting a wage level which allows firms for intra-industry trade. As Straume (2002) shows, in the first case it is obtained that if $t > 2 - \sqrt{3} \approx .268$, the wage level (and consequently the values of all other variables) will be the same of the monopoly in autarky regime, that is $w_{C,M} = 1/2$. In the second case, if $t \leq 2 - \sqrt{3}$, the unions' maximization problem leads to

$$w_{C,IIT} = \frac{1}{2} - \frac{1}{4}t \qquad (42)$$

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allowing for IIT. With subsequent substitutions of equation (42), optimal quantities for domestic production and for export are obtained

$$x_{1A} = y_{2B} = \frac{1}{6} + \frac{5}{12}t$$

$$x_{1B} = y_{2A} = \frac{1}{6} - \frac{7}{12}t.$$

Once optimal quantities are derived, further substitutions then allow to evaluate union utility, firm profits, consumer surplus, tariffs' entry and national welfare under union collusive agreement in IIT regime

$$\Omega_{C,IIT} = \frac{1}{24}(2 - t)^2, \Pi_{C,IIT} = \frac{1}{18} - \frac{1}{18}t + \frac{37}{72}t^2, CS_{C,IIT} = \frac{1}{36}(2 - t)^2, T_{C,IIT} = \frac{1}{6}t - \frac{7}{12}t^2,$$

$$NW_{C,IIT} = \frac{1}{3} - \frac{1}{6}t.$$

### 3.2 International Production with Union Collusive Behavior

Now it is considered the case that unions, also in presence of multinational activities, are able to sign a collusive agreement to raise their wage levels, capturing a greater share of the rent gained in the product market by firms. Contrary to the case of IIT, when both firms decide to undertake a direct investment the joint union utility is not affected by trade costs. Hence, when firms are in a RFDI regime, the union problem is to maximize the following utility function

$$\Omega_{C,RFDI} = w_{C,RFDI}(\frac{2}{3} - \frac{2}{3}w_{C,RFDI}) \tag{43}$$

where the lower script indicates "Collusive in RFDI". Maximization of equation (43) yields

$$w_{C,RFDI} = 1/2 \tag{44}$$

and, after substitution, it is obtained that optimal duopoly quantities are
$$x_{1A} = y_{1B} = y_{2B} = x_{2A} = 1/6.$$

Notice that, although the wage level is identical to the wage in autarky, now production and employment levels are higher due to the fact that each firm has planted a branch in the other country. With the equilibrium quantities and the collusive wage are then derived all the other relevant values for union utility level, firm profits, consumer surplus and national welfare, respectively given by

$$\Omega_{C,RFDI} = \frac{1}{6}, \Pi_{C,RFDI} = \frac{1}{18} - F, CS_{C,RFDI} = \frac{1}{18}, NW_{C,RFDI} = \frac{5}{18} - F.$$

### 3.3 Asymmetric Regimes with Union Collusive Behavior

Consider now the case of collusive behavior between unions in asymmetric regimes. From now one of the two firm does not invest, joint union utility could be affected by trade costs depending on the

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strategic choice made by the union which operates within the firm which does not invest. Suppose, like in the previous subsection, that Firm 1 does not invest while Firm 2 undertakes FDI. In stage 2 union maximization problem is represented by

$$w_{C,Asy,tr} = \arg\max w_{C,Asy,tr} \left(\frac{4}{3} - \frac{4}{3} w_{C,Asy,tr} - \frac{1}{3} t\right) \text{ if } w_1 \leq \frac{1+w_2-2t}{2}$$

(45)

$$w_{C,Asy,nt} = \arg\max w_{C,Asy,nt} \left(\frac{7}{6} - \frac{11}{6} w_{C,Asy,nt}\right) \text{ if } w_1 > \frac{1+w_2-2t}{2}$$

where the lower script indicates "Collusive in Asymmetric regime". In the maximization problem, the constraint simply states that the collusive wage could be either at a level that allows Firm 1 to export (Trade) or to induce Firm 1 to produce only domestically (No Trade). Maximization of equations (45) yields the following collusive wage levels

$$w_{C,Asy,tr} = \frac{1}{2} - \frac{1}{8} t \quad \text{if} \quad t \leq \frac{2}{7}(8 - 5\sqrt{2}) \approx .265$$

(46)

$$w_{C,Asy,nt} = \frac{1}{2} \qquad \text{if} \quad t > \frac{2}{7}(8 - 5\sqrt{2})$$

(47)

When the level of trade costs is sufficiently low, namely for $t \leq .265$, the union organized within the firm which has chosen not to invest will find suitable to establish a collusive agreement with the other firm-level union at a wage level such that exports are possible. Instead, for higher values of trade costs, the same union will reach a higher utility with an agreement on a wage rate which induces the firm to produce only domestically. It should be noted that: 1) by colluding in asymmetric regimes, unions will get a wage outcome higher than the IIT regime; 2) since the wage rate is commonly fixed, contrary to asymmetric regimes with international rivalry in the labor markets trade liberalization now leads both unions to set higher wages; and finally, 3) union collusion allowing for international activities in asymmetric regimes requires a slightly higher degree of economic integration in the form of lower trade barriers with respect to IIT, reversing the results obtained under union competition.

Putting equation (46) into quantities expressions it is obtained that in asymmetric regimes involving both types of international activities production levels are given by

$$x_{1A} = \frac{1}{6} + \frac{1}{24} t, \; x_{1B} = \frac{1}{6} - \frac{5}{8} t; \; y_{2B} = \frac{1}{6} + \frac{3}{8} t, \; x_{2A} = \frac{1}{6} + \frac{1}{24} t.$$

Inserting quantity levels in profit equations (16) and (17) and in all other relevant expression, union utility [18] and the value of the relevant variable are subsequently computed

$$\Omega_{A,C,Asy,tr} = \frac{1}{192}(4-t)(12-13t), \; \Pi_{1C,Asy,tr}^{NI} = \frac{1}{18} - \frac{7}{36} t + \frac{113}{288} t^2, \; CS_{A,C,Asy,tr}^{NI} = \frac{1}{288}(4+t)^2,$$

$$NW_{A,C,Asy,tr}^{NI} = \frac{13}{36} - \frac{1}{2} t + \frac{89}{192} t^2;$$

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[18] Union rents components in national welfare in this case is given by the proportional share of joint utility related to workers that operate in each country.

$$\Omega_{B,C,Asy,tr} = \frac{1}{192}(4-t)(4+t), \Pi^{IN}_{2C,Asy,tr} = \frac{1}{18} + \frac{5}{36}t + \frac{41}{288}t^2 - F, CS^{IN}_{B,C,Asy,tr} = \frac{1}{288}(4-3t)^2,$$

$$T^{IN}_{B,C,Asy,tr} = \frac{1}{6}t - \frac{5}{8}t^2, NW^{IN}_{B,C,Asy,tr} = \frac{7}{36} + \frac{2}{9}t - \frac{263}{576}t^2 - F.$$

Instead, using equation (47) it is obtained that in the other asymmetric regime, with the firm not investing which produces only for its domestic market, quantities are given by

$$x_{1A} = x_{2A} = 1/6; \; y_{2B} = 1/4.$$

With the wage level in (47) and the optimal quantities produced under union collusion, profits, union utilities and the value of the other relevant variable are finally obtained

$$\Omega_{A,C,Asy,nt} = 1/6, \Pi^{NI}_{1C,Asy,nt} = 1/36, CS^{NI}_{A,C,Asy,nt} = 1/18, NW^{NI}_{A,C,Asy,nt} = 1/4;$$

$$\Omega_{B,C,Asy,nt} = \frac{1}{8}, \Pi^{IN}_{2C,Asy,nt} = \frac{13}{144} - F, CS^{IN}_{B,C,Asy,nt} = \frac{1}{32}, NW^{IN}_{B,C,Asy,nt} = \frac{71}{288} - F.$$

### 3.4 First stage: Firms' Selection Strategy and Game Equilibria under Union Collusion

The determination of the collusive wage levels is achievable in each potential configuration of productive activities that could arise. After that it is possible to go back to the first stage of the game in order to investigate if union collusion is able to alter the strategy choice by firms (and eventually in which manner) respect to the competitive framework. As well as in the previous situation, game equilibria will depend both upon trade and investment costs, and wage levels.

Firms' payoffs in the RFDI regime obviously do not depend on trade costs. Instead, when both firms adopt a strategy implying no investment (the strategy profile $(NI; NI)$), IIT is supported in pure strategies as Nash equilibrium under union collusion if the trade cost levels are below $t \leq 2 - \sqrt{3} \approx .268$ (lower than those obtained with union competition, $t \leq .31$), while for higher values unions will set a wage rate inducing exclusively home production.

Like in the competitive framework, also in asymmetric regimes, depending on $t$, two different configurations are possible. When $t \leq .265$, the union organized within the firm not investing will collude to a wage level which allows to export. For higher trade costs, the same union would like to collude to a wage which consents only domestic production. Similarly to the strategy profile $(NI; NI)$, in asymmetric regimes as well union collusion, compared to the competitive union situation ($t \leq .398$), lowers the threshold of trade barriers allowing for international activities.

Although at different levels in different ranges of trade costs, collusive wages are well defined for each productive structure all over the interval of existence of the parameter $t$. Consequently, to derive game equilibria, only the following restriction on the values of the parameter $F$ is required.

**Restriction 3.** $\forall t \in [0,1]$, $F_{1B} \in \left[0, \min(\Pi^{II}_{1B,C}; \Pi^{IN}_{1B,C})\right]$ and $F_{2A} \in \left[0, \min(\Pi^{II}_{2A,C}; \Pi^{IN}_{2A,C})\right]$

The economic meaning of Restriction 3 is similar to that of Restriction 2: the profits' scale under union collusion generated in the foreign market by the firm which invests must be larger than the magnitude of the fixed costs to make the foreign investment.

Taking in consideration the results presented in the previous subsections and given Restrictions 3, it follows that firms' payoff structure in stage 1 of the game under union collusive behavior is given by
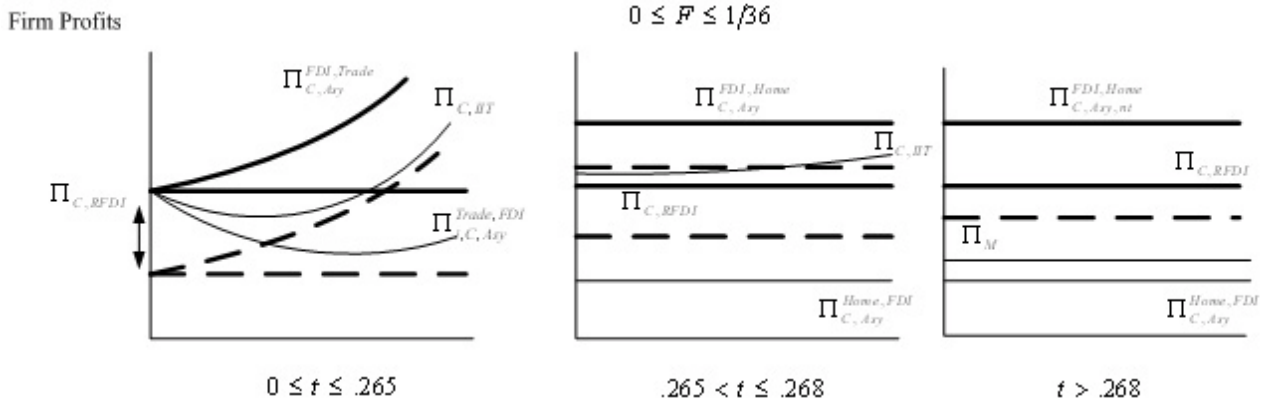
Note: bold lines represent profit functions associated to the FDI strategy.

1) in $0 \leq t \leq .265$,

$$(\Pi_{1,C,RFDI}^{II}; \Pi_{2,C,RFDI}^{II}), \ (\Pi_{1,C,Asy,tr}^{IN}; \Pi_{2,C,Asy,tr}^{NI}), (\Pi_{1,C,Asy,tr}^{NI}; \Pi_{2,C,Asy,tr}^{IN}), \ (\Pi_{1,C,IIT}^{NN}; \Pi_{2,C,IIT}^{NN});$$

2) in $.265 < t \leq .268$,

$$(\Pi_{1,C,RFDI}^{II}; \Pi_{2,C,RFDI}^{II}), (\Pi_{1,C,Asy,nt}^{IN}; \Pi_{2,C,Asy,nt}^{NI}), (\Pi_{1,C,Asy,nt}^{NI}; \Pi_{2,C,Asy,nt}^{IN}), (\Pi_{1,C,IIT}^{NN}; \Pi_{2,C,IIT}^{NN})$$

3) for $t \geq .268$,

$$(\Pi_{1,C,RFDI}^{II}; \Pi_{2,C,RFDI}^{II}), (\Pi_{1,C,Asy,nt}^{IN}; \Pi_{2,C,Asy,nt}^{NI}), (\Pi_{1,C,Asy,nt}^{NI}; \Pi_{2,C,Asy,nt}^{IN}), (\Pi_{1,M}^{NN}; \Pi_{2,M}^{NN}).$$

The situation is depicted in Figure 6, while game equilibria are reported in Table 3.
In the range $0 \leq t \leq .265$, it is obtained that the size of sunk costs must be

$$F_{1B} \in \left[0, \min(\Pi_{1B,C}^{II}; \Pi_{1B,C,tr}^{IN})\right] and \ F_{2A} \in \left[0, \min(\Pi_{2A,C}^{II}; \Pi_{2A,C,tr}^{IN})\right]$$

whit $(\Pi_{1B,C}^{II} = \Pi_{2A,C}^{II}) = 1/36$ and $(\Pi_{1B,C,Asy,tr}^{IN} = \Pi_{2A,C,Asy,tr}^{IN}) = (4+t)^2/576$. It is easily verified that for every value of $t$ in this range of analysis, $(\Pi_{1B,C,Asy,tr}^{IN} = \Pi_{2A,C,Asy,tr}^{IN}) \geq (\Pi_{1B,C}^{II} = \Pi_{2A,C}^{II})$, that is, profit levels associated to the investment strategy in asymmetric regimes are higher than those when both firms invest, with the equality holding only for $t = 0$. It follows that the relevant range of the sunk costs is given by $F \in \left[0, (\Pi_{1B,C}^{II} = \Pi_{2A,C}^{II})\right]$.

For $F = 0$ (direct investment no costly) and with union collusion, it is obtained that in the range $0 \leq t \leq .265$, RFDI is the Nash equilibrium of the game. The presence of positive fixed costs for the direct investment will alter this situation: profits associated to the investment strategy lowers. Consequently, there will be combinations of the parameters $t$ and $F$ allowing for ranges where profits associated to the "not invest" strategy are superior to those associated to the investment strategy, giving rise to different possible productive structure in equilibrium.

Instead, in the range of trade cost levels between $.265 < t \leq .268$, it is given that

$$F_{1B} \in \left[0, \min(\Pi_{1B,C}^{II}; \Pi_{1B,C,nt}^{IN})\right] and \ F_{2A} \in \left[0, \min(\Pi_{2A,C}^{II}; \Pi_{2A,C,nt}^{IN})\right]$$

**Table 3: Sub-game Nash Equilibria under Union Collusion, First Stage**

**First stage, Nash Equilibria under Union Collusion**

1) in $0 \le t \le 2/7(8 - 5\sqrt{2}) \approx .265$ and for $0 \le F \le 1/36 \approx .027$:

a) in the range $0 < F \le 97/4050 \approx .0239$:

in $0 \le t \le 28/107 - 4/107 \sqrt{49 - 1926F}$, IIT Nash equilibrium of the game;

in $28/107 - 4/107 \sqrt{49 - 1926F} \le t \le 28/113 - 4/113 \sqrt{49 - 2034F}$, asymmetric regimes equilibria;

in $28/113 - 4/113 \sqrt{49 - 2034F} < t \le 2/7(8 - 5\sqrt{2})$, RFDI Nash equilibrium;

b) in the range $97/4050 < F \le 103/4050 \approx .02543$:

in $0 \le t \le 28/107 - 4/107 \sqrt{49 - 1926F}$, IIT Nash equilibrium of the game;

in $28/107 - 4/107 \sqrt{49 - 1926F} \le t \le 2/7(8 - 5\sqrt{2})$, asymmetric regimes equilibria;

c) in the range $103/4050 < F \le 49/1926 \approx .02544$:

in $0 \le t \le 28/107 - 4/107 \sqrt{49 - 1926F}$, IIT Nash equilibrium of the game;

in $28/107 - 4/107 \sqrt{49 - 1926F} < t \le 28/107 + 4/107 \sqrt{49 - 1926F}$, asymmetric regimes equilibria;

in $28/107 + 4/107 \sqrt{49 - 1926F} < t \le 2/7(8 - 5\sqrt{2})$, IIT Nash equilibrium of the game;

d) in the range $49/1926 < F \le 1/36 \approx .0277$:

in $0 \le t \le 2/7(8 - 5\sqrt{2})$, IIT is the unique Nash equilibrium all over the range

2) in $2/7(8 - 5\sqrt{2}) < t \le 2 - \sqrt{3} \approx .268$ and for $0 \le F \le 1/36 \approx .027$:

a) in the range $0 < F \le 2\sqrt{3} - 497/144 \approx .0128$: RFDI Nash equilibrium;

b) in the range $2\sqrt{3} - 497/144 < F \le 1445\sqrt{2}/441 - 32603/7056 \approx .0132$:

in $2/7(8 - 5\sqrt{2}) < t \le 2/37 + 1/74 \sqrt{386 - 10656F}$, RFDI equilibrium

in $2/37 + 1/74 \sqrt{386 - 10656F} < t \le 2 - \sqrt{3}$, IIT and RFDI equilibria;

c) in the range $.0132 \le F \le 1/36 \approx .027$: IIT and RFDI equilibria

3) for $t > 2 - \sqrt{3} \approx .268$ and for $0 \le F \le 1/36 \approx .027$:

RFDI Nash equilibrium of the game.

implying that sunk costs have to belong to the interval $F \in [0, 1/36]$ since $\Pi_{1B,C}^{II} = \Pi_{1B,C,Asy,nt}^{IN}$ (exactly the same applies for Firm 2). Depending both on $t$ and $F$, also in this range of trade cost levels different productive structure can arise as Nash equilibrium of the game.

Conversely, for $t \geq .268$, given the change by unions toward the high wage strategy in the ($NI; NI$) profile, firm profits are no more affected by trade costs. The relevant range of sunk costs is still represented by $F \in [0, 1/36]$ and the firms' strategy selection depends exclusively on the wage level set by unions and on the scale of sunk costs of the foreign investment. It is found that in this range RFDI is the unique Nash equilibrium of the game.

Like in the situation of unions acting competitively, game equilibria under union collusive behavior obviously still depend on $t$ and $F$. What is the role played by union collusion?

If there is no investment by firms, in a one-shot game the existence of labor unions lowers the prohibitive level of trade costs such that IIT is supported as Nash equilibrium of the game, making this configuration less likely (Naylor, 1999). Instead, in a repeated game framework, if firms have the possibility to collude, this result is reversed: IIT is a more likely equilibrium (Straume, 2002). But if firms cannot collude, the effect of wage collusion is simply to lower the threshold level of trade costs allowing for IIT: thus, the presence of unions acting collusively when firms cannot makes the conditions for IIT as outcome of the repeated game more stringent.

Additionally union collusion, rising wages and squeezing foreign profits, makes the investment option by firm less feasible: while in asymmetric regimes a higher degree of economic integration is required to consent international activities for the firm which has not chosen to invest, in RFDI regime (because of an inferior level of profits generated in the foreign market), to invest becomes a practicable option only for lower magnitudes of sunk costs. Therefore, under the assumption of firms that do not collude in the repeated game, unions' collusive behavior requires, as expected, a higher degree of economic integration to allow international activities.

Concerning the productive structures arising in equilibrium, looking at the results in Table 3 (reported graphically in Figure 7), and comparing them with those in Table 2 and Figure 5, it should be noted that also under union collusive behavior, unless sunk costs are sufficiently high, the autarky regime will never occur as sub-game perfect equilibrium of the game.

**Figure 7: Productive Structures in Equilibrium with Union Collusion**
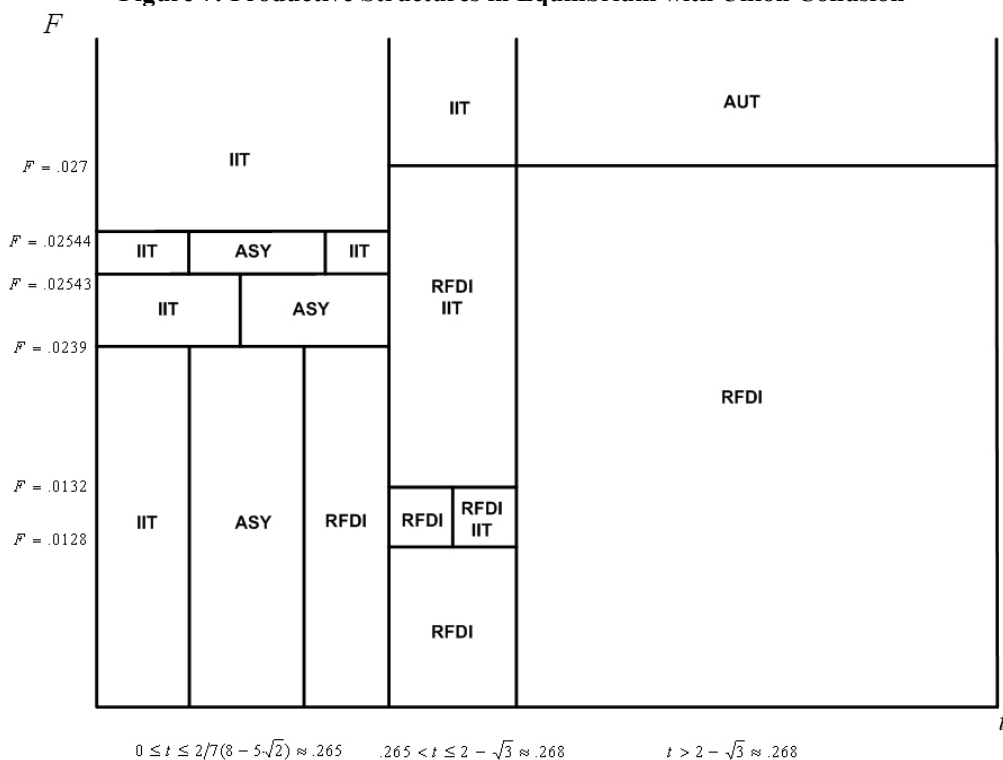
Also under union collusion there are some parameter combinations for which multiple equilibria might be given. However, differently from the union competitive case, these equilibria may arise for lower degrees of economic integration (higher values of sunk and trade costs), and they seem to be relatively less probable to take place. With respect to union competition, RFDI regime is less likely to arise for low values of trade costs ($0 \leq t \leq 2/7(8 - 5\sqrt{2}) \approx .265$), while either IIT and asymmetric regimes become more probable: not to invest is the most feasible strategy and hence IIT is the most likely outcome to be given. Instead, for sufficiently high values of $t$ (which are however lower respect to the case of competing unions), to invest becomes once again the most expected strategic option for firms (the *tariff jumping argument*). These findings can be summed up in the subsequent proposition.

**Proposition 3.** *When unions collude, under Restrictions 3 and the assumption of firms not colluding in the repeated game, like in the case of unions acting competitively, not to invest is the more expected strategic option for firms for low values of trade costs while the investment strategy is more expected for higher trade cost levels. Hence, IIT and RFDI are the more likely regimes that could be given under union collusive behavior, but RFDI is given for a wider range of trade cost levels.*

The analysis conducted until now shows that union collusion somewhat alters the possible productive structures' equilibria. But at this point, a question immediately rises: is it collusion most of the time profitable for labor unions? Setting apart from the discussion the asymmetric cases (which are the minority), and focusing exclusively on the symmetric regimes, whenever for a given combination of sunk and trade costs the productive structure equilibrium is the same both under union competition and collusion, the answer is obviously yes. The same holds true when at mixed equilibria under union competition, correspond a symmetric equilibrium in collusion (or the reverse). But it may occur that for other parameter configurations, these equilibria will differ. Indeed, overlapping Figures 5 and 7, it can be found that there exist a range of sunk costs in the $(F, t)$-space, precisely for $F \in [.0176, .0239]$, where for some ranges of trade costs under union competition, IIT is given as equilibrium, while under union collusion RFDI takes place. A specific numerical example may help to better illustrate the point.

Consider the case that the sunk cost for the investment is $F = .02$. At this level, under union competitive behavior, IIT is given all over the range of trade costs $0 \leq t \leq .31$, while under union collusion RFDI will arise for $.146 \leq t \leq .265$. Therefore, in the latter range the union utility levels under the two diverse equilibria are directly comparable, and it can be easily shown that $\Omega_{C, RFDI} = 1/6 > (2 - t)^2 / 27 = \Omega_{BC, IIT} \ \forall t \in [.146, .265]$.

Although this discussion does absolutely not represent an exhaustive answer, it may give some insights on the fact that collusion, at least in the majority of the cases, seems to be profitable for unions. But, is collusive behavior always given? Is collusion in wages by labor unions in the repeated game likely to be sustained for each configuration of productive structures in equilibrium? These questions are addressed in the next section, where the sustainability of union collusion will be explored in all the potential equilibria that can arise under union collusive behavior.

## 4. Sustainability of Unions' Collusive Agreement

This section investigates the sustainability of union collusion in the possible productive structures' configurations that may arise as equilibrium of the game. Each union will capture an instantaneous utility gain by unilaterally deviating from the collusive strategy. Deviation implies a reduction in wage levels which will induce the firm to act more aggressively in the foreign market either by increasing exports in case of trade, or production in the foreign plant in case of FDI.

It is assumed that both unions adopt the trigger strategy, that is, a strategy with a Nash reversion to the competitive strategy whenever there is deviation from the collusive wage-setting, although this is not the optimal form of punishment (Abreu, 1986). The collusive agreement between unions is possible to be sustained if it is supported by some realistic threats, such that the one-period gain from cheating will be lower than the discounted expected value from punishment. As previously noted, unions within the framework of this model are not able to collude in such a way to induce autarky positions: in fact firms, being first movers and having the investment strategy option, could escape at least this kind of collusive agreement. Hence, labor unions could behave collusively when IIT, RFDI and asymmetric regimes are given. In the symmetric cases, the discounted factor is identical for both unions, while asymmetric regimes will inevitably produce different discount factors for the two unions. Generally, the trigger strategy constitutes a sub-game perfect equilibrium in the infinitely repeated game when the following condition is satisfied

$$\frac{1}{1-\delta}U^C \geq U^D + \frac{\delta}{1-\delta}U^P \tag{48}$$

where $U^C$ is the utility level from collusion, $U^D$ is the utility level from the one-period defection and $U^P$ the utility derived from punishment. In order to specify the relevant payoff functions it is necessary to make a distinction between the different sub games: in fact, depending on the specific configuration, punishment utility, $U^P$, the collusive utility, $U^C$, and the utility from deviation, $U^D$, will differ.

Consider first the IIT equilibrium case. When the cheating union (e.g. Union 1) deviates, the maximization problem is represented by

$$w_1 = \arg\max w_1(\frac{2}{3} - \frac{4}{3}w_1 - \frac{1}{3}t + \frac{2}{3}w_{2C})$$

where $w_{2C} = w_C$ in equation (42). This maximization problem yields the following optimal wage level under deviation

$$w_1 = \frac{3}{8} - \frac{3}{16}t$$

and consequently the following union utility level

$$\Omega^D = \frac{1}{64}(2 - t)^2.$$

Inserting the relevant payoffs into (48) it is obtained that the critical discount factor is given by

$$\delta = 9/17 \tag{49}$$

that is, the sustainability of union collusion is independent from trade costs: a marginal reduction in trade cost levels will lead to a proportionate increase in both the discounted union utility obtained from collusion and the discounted utility from deviation, therefore maintaining unaltered the critical discount factor. This result is also derived in Straume (2002), and Strozzi (2007) for the case of perfect substitute goods.

Let consider now the situation where union colludes in the RFDI regime. Here, given the absence of trade, the discount factor is obviously not affected by the parameter $t$. The union which deviates now solves the following maximization problem

$$w_1 = \arg\max w_1 \left( \frac{2}{3} - \frac{4}{3} w_1 + \frac{2}{3} w_{2C,RFDI} \right)$$

where $w_{2C,RFDI} = w_{C,RFDI}$ in equation (44). The maximization problem leads to the following wage

$$w_1 = 3/8$$

while the union utility level is given by

$$\Omega^D = 3/16.$$

Further substitutions of the relevant payoffs in (48) yields to $\delta = 9/17$, exactly as in equation (49). This result is quite amazing. In fact, the expressions of the discount factor threshold are exactly the same for the IIT and the RFDI regimes: no matter which is the nature of the international business undertaken by firms, in symmetric regimes union collusion is sustainable under the identical condition.

Finally, consider the case of union collusion in asymmetric regimes.[19] In this case, condition (50) is required to be satisfied concurrently by both unions. Since the wage equilibrium in Bertrand competition is not the same for the two unions, it follows that, due to the asymmetric nature of the game, the discount factor here is not equal for unions. Referring to the situation in which Firm 1 exports and Firm 2 makes a FDI, if Union 1 cheats, the maximization problem is represented by

$$w_1 = \arg\max w_1 \left( \frac{2}{3} - \frac{4}{3} w_1 - \frac{2}{3} t + \frac{2}{3} w_{2C,Asy,tr} \right)$$

with $w_{2C,Asy,tr} = w_{C,Asy,tr}$ in equation (48). The maximization problem above leads to

$$w_1 = \frac{3}{8} - \frac{9}{32} t$$

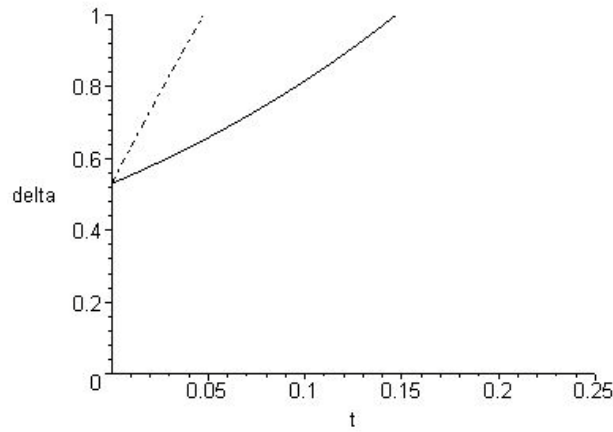and a union utility level equal to

$$\Omega^D = \frac{3}{256} (4 - 3t)^2$$

while, if Union 2 deviates from the collusive behavior, it is obtained that the maximization problem becomes

$$w_2 = \arg\max w_2 \left( \frac{2}{3} - \frac{4}{3} w_2 + \frac{1}{3} t + \frac{2}{3} w_{1C,Asy,tr} \right)$$

where $w_{1C,Asy,tr} = w_{C,Asy,tr}$ is again the wage rate in equation (46), leading to

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[19] Union collusion in the other asymmetric case, namely the situation where one firm invests while the other produces only domestically, as well as union collusion inducing autarky when both firms do not invest, are not investigated since these productive structures do not arises as Nash equilibria of the game.

Note: the solid line refers to $\delta_1$, the dash line to $\delta_2$.

$$w_2 = \frac{3}{8} + \frac{3}{32}t$$

and a union utility level equal to

$$\Omega^D = \frac{3}{256}(4+t)^2.$$

Plugging the relevant payoffs into (48) yields for Union 1

$$\delta_1 = 225 \frac{25t^2 + 40t + 16}{5681t^2 - 12760t + 6800} \tag{51}$$

while for Union 2 it is obtained

$$\delta_2 = 225 \frac{16 + 328t - 47t^2}{1001t^2 + 5960t + 6800} \tag{52}$$

Analytical inspection of expressions (51) and (52) leads to $\partial\delta_1/\partial t > 0$ and $\partial\delta_2/\partial t > 0$ in the relevant range $t \in [0,1)$, as it is also possible to see from Figure 8: a reduction in the trade cost level makes collusion more sustainable. Nonetheless, further observations are needed. First, the discount factor threshold for both unions starts form the value of $\delta = 9/17$ at $t = 0$, and then, as long as trade costs raise, it increases: hence, efficient union collusion in asymmetric regimes is more difficult to be sustained with respect to symmetric regimes. Second, collusion with the adoption of the trigger strategy may be sustained only if trade costs are sufficiently low: in fact, it can be shown that if $.0475 \le t$, $\delta \in (0,1)$ for both unions. Therefore some collusion is sustainable under asymmetry also when collusion is sustainable under symmetry: if economic integration is relatively high, collusion is sustainable also in absence of side payments between the two unions. Instead, when trade costs become higher, the union within the firm which invests (Union 2 in this example) will gain relatively more in its welfare from cheating collusion on wages in terms of higher employment levels, making collusion not sustainable. In these cases, as also Straume (2002) pointed out, the collusive asymmetric solution has to implicitly imply some transfer of utility between the two unions, which seems difficult to be implemented in reality. It is beyond the scope of this paper to study optimal penal codes and the "side payments" issue between the two unions participating in

the "labor market cartel". Nonetheless, it can not be theoretically ruled out that also whereas collusion is unsustainable with the simple trigger strategy without side payments, more severe punishment schemes and the transfers between unions may make some collusion possible.

The results of this section could be summarized in the following proposition.

**Proposition 4.** *In symmetric regimes of firms' international activities, union collusive behavior may be likely to happen and to be sustained at the same conditions, while in asymmetric regimes wage collusion may be sustained for low values of integration costs. If integration costs are sufficiently high, union collusion is not sustainable.*

Concluding, although its simplistic nature, the trigger strategy could serve as an intuitively and useful demonstration of the relative practicability of a collusive agreement between unions whenever the organization of productive activities is symmetrical. Instead, when asymmetric structures of production can arise as possible equilibria of the game, collusive agreements between unions can be supported only for high degrees of economic integration. Nonetheless, it appears unsustainable if integration costs become sufficiently high because of the different effect that trade costs plays on the two unions discount factors. It follows that the collusive behavior in these regimes suffers a lack of credibility, and a competitive wage outcome in the labor market is more likely to be given; in such a case, firms' strategic choices in international activities seem to be affected exclusively by the investment and trade costs, while labor unions' behavior appears to be unlikely to influence this decision.

## 5. Welfare and Policy Implications

Now it is possible to turn the attention on national welfare level. As it was shown in section 2.5, when unions act in a competitive way in the labor market, firms' decision concerning international activities in correspondence of some critical ranges can switch from a no investment strategy with exports toward the foreign market to a direct investment strategy. It depends on the values of the parameters $F$ and $t$ (and relative restrictions), In the range $0 \leq t \leq .31$ either an IIT regime, a RFDI regime or both regimes could arise as Nash equilibria of the game. Instead, in the range $.354 \leq t \leq .398$, either RFDI or asymmetric regimes could be given as productive structures in equilibrium, while for $t \geq .412$, trade costs are high enough that both firms find profitable to invest: RFDI is the unique configuration of international activities that is given in equilibrium.

**Figure 9: Welfare under Union Competition**



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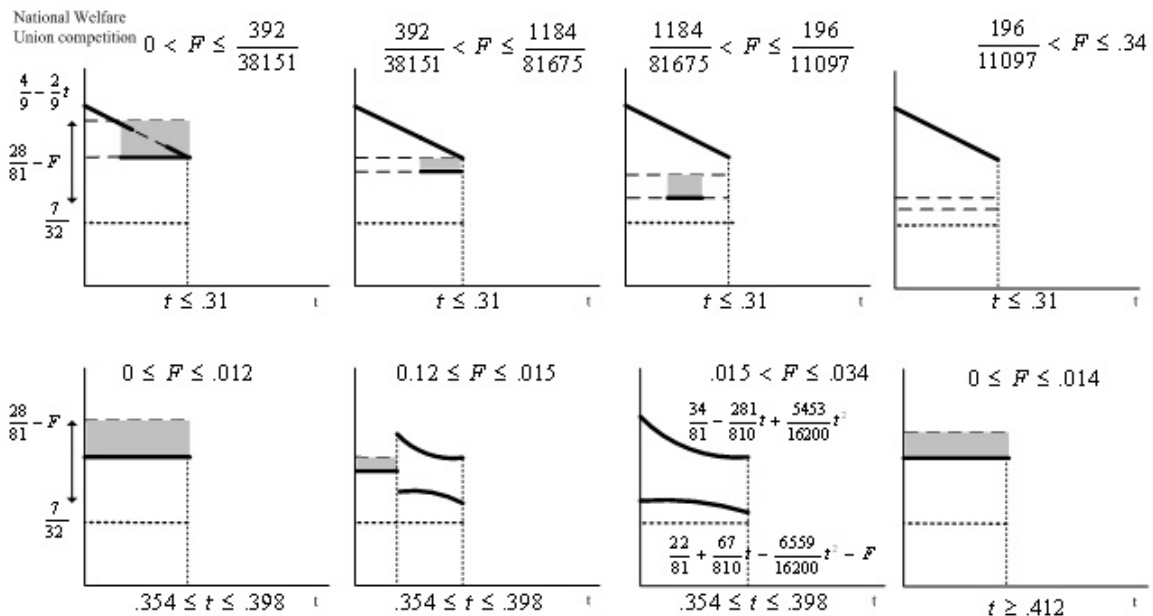
Hence, national welfare function presents "jumps" and peculiarities related to the strategy that firms have chosen in these critical ranges, as shown in Figure 9.

Also under union collusion, firms' decision concerning international activities depends on the values of the parameters $F$ and $t$, and in certain intervals the strategic choice can switch from a no investment strategy allowing for trade to a direct investment strategy. The effect of union collusion can be summarized in a substantial need of a higher level of economic integration for firms to start international activities. In fact, under the assumptions outlined in the paper, collusion has two implications: 1) rising wages, firm profits shrinks both in the domestic and in the foreign market: specifically, profits generated in the foreign market are relevant for the firms when choose to adopt the investment strategy. If foreign profits lowers, it follows that to invest becomes a feasible strategic option only for lower magnitudes of sunk costs; 2) a lower degree of trade costs is needed for international trade: with respect to the competitive case, both in symmetric and asymmetric regimes a higher degree of economic integration (a lower level of trade costs) is required to allow for the firm not investing to export its production. As a consequence, when investing is a viable option, a RFDI regime will arise as the productive structure equilibrium of the game at lower level of trade costs, namely for $t \geq .268$ (Figure 10).

Because of the interdependence of the parameters $F$ and $t$, and of the strategic interaction between unions and firms', the whole picture appears quite complex. Nonetheless, some general considerations could be addressed.

First, a national government would like to preclude that an autarky regime is reached, because if this equilibrium is given, the welfare level is the lowest possible. How to avoid this result? The only way to preclude this situation is that foreign investment should be a viable strategic option for firms, and this could be done only for sufficiently low levels of sunk costs. To promote a direct investment, a national government might reduce part of these costs without necessarily subsidize them (excluded by assumption in this model). For example requiring no (or minimal) license fees for the rights to establish a plant in their own country: creating the conditions for potential direct investments (or, in other words, making the investment strategy a suitable alternative) will erode union monopoly power and avoid collusion on a wage level inducing exclusively domestic production.

**Figure 10: Welfare under Union Collusion**



34
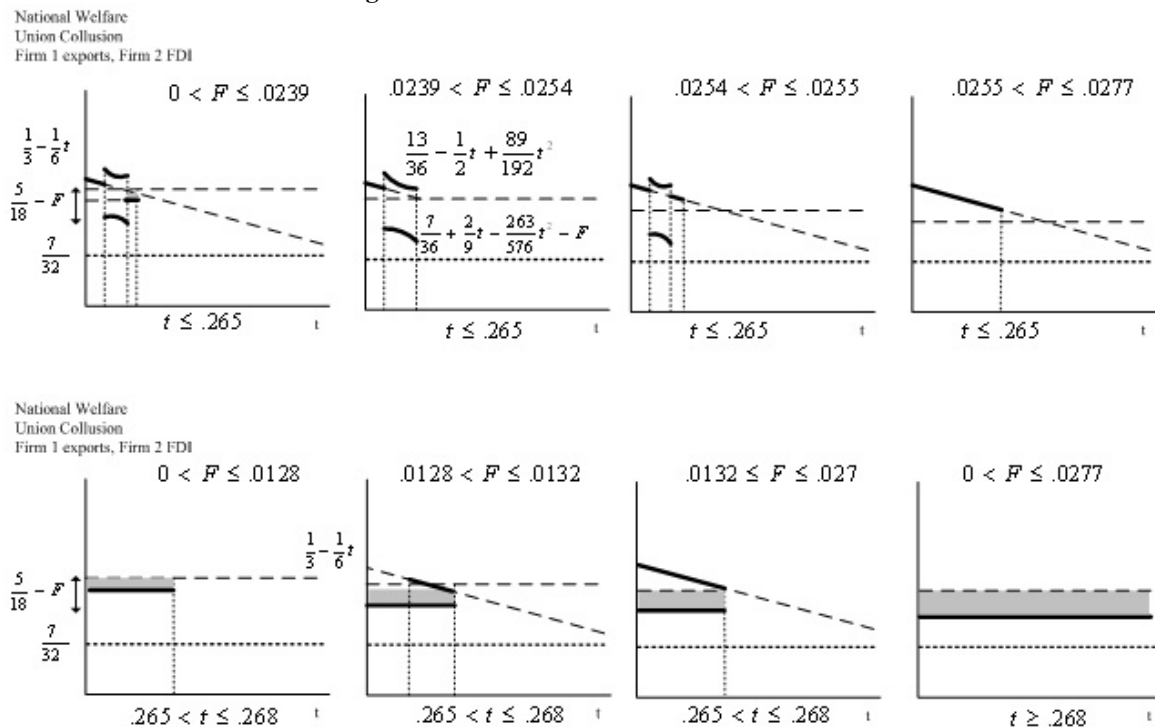
Second, even if autarky positions are prevented, this does not imply that collusive agreements for unions are not affordable. Once repetition is allowed in the union game, collusion in wage levels is plausible under certain conditions when the structures of international activities are symmetric while under asymmetric regimes will not arise. Both governments are interested in promoting FDI, but since welfare levels in IIT regime with union collusion are higher with respect to those in RFDI, a Pareto improving policy could be increasing economic integration promoting strong trade liberalization policies.

Third, if unions in the repeated game adopt a collusive behavior, the welfare level will drastically decrease. The reduction will be more important as long as integration improves, and it will be unambiguously lower than that attained when unions act competitively, because in this case higher profits for firms, lower prices and hence higher surplus for consumers are given from lower wages.

As a consequence, it appears that governments maximizing social welfare should discourage unions to sign collusive agreements, inducing them to act competitively, and subsequently to have a national government intervention implementing redistributive policies.

## 6. Conclusions

This paper deals with the consequences of the process of international market integration, exemplified both by the reduction in trade costs and the possibility to undertake direct investment in a foreign country, on firms and unions' strategic behavior. Developing a general framework, it was analyzed how these two aspects of economic integration could affect both firms' decision concerning international business and the strategic behavior of labor unions in the labor market. The framework focuses particularly on the scope for unions' collusive behavior, exploring the relationship between wage outcomes and the nature of firms' international activities.

This model allows firms to undertake foreign investments, complementing and extending the basic two-way intra-industry trade analytical framework of Naylor (1998, 1999), and the repeated game version of the model of Straume (2002). Although the present model has a slight variation with respect to the latter work in order to isolate exclusively the possible outcomes due to union collusive behavior.

Adopting a three-stage game, where firms are first movers and choose independently whether to invest in a foreign country or not to invest, and labor unions in the second stage have the possibility to opt between a high-low wage strategy that may, it was shown how a union's wage strategy choice will depend on the value of trade costs and how this in turns may affect the strategic behavior of firms. Considering the possible wage strategies of rival unions, it was characterized the complete set of productive structures regimes and configurations of international activities that can arise as sub-game perfect Nash equilibria for different combinations of wages, trade cost levels and sunk costs of the investment were derived. The main results are reported below.

It was found that a first element influencing firms' decision related to international activities is the amount of the fixed costs that are needed to make a FDI. An important result was that firms, by having the advantage of being first-movers and under the assumption, retained all over the paper, that to invest is a viable option, will induce in some cases the company-level unions to a moderation in wage demands. It was shown that, whenever a firm adopts an investment strategy to begin international business, unions can not choose a prohibitive wage rate that condemns either their workers to be priced out of the labor market or in an excessive loss of employment opportunities. Nevertheless, although the firms' investment strategy may induce a wage moderation, trade unions with respect to IIT regime will gain a larger share of firms' rents because of the saving in trade costs and : unions may welcome FDI.

Firms' payoffs in the sub-game characterized by the RFDI regime is influenced exclusively by wage levels set by unions. In the sub-game defined by the firms' strategy profile ($NI$; $NI$) with unions' Bertrand competitive behavior, IIT is supported as Nash equilibrium in pure strategies if the trade cost level is below $t \leq .31$, while for $t \geq .354$ unions set high wages such that only domestic

production may potentially arise as Nash Equilibrium. Instead, in the range $.31 < t < .354$, there is no equilibrium in pure strategies. These are the results obtained in Naylor (1999). Instead, in the two sub-games identified by the firms' strategy profiles $(I; NI)$ and $(NI; I)$, depending on $t$ and on wage strategies, two different asymmetric regimes are possible. If $t \leq .398$, then the company level union which operates within the firm not investing will set a wage level such that the firm would export in the other country, while for $t \geq .412$ the union will unequivocally chose a wage strategy inducing only home production. In the range $.398 < t < .412$, there is no equilibrium in pure strategies.

Because of the interdependence of $t$, $F$ and unions' strategic behavior, equilbria involving different configurations of international activities can arise. Nonetheless, some important observations can be addressed. First, the autarky regime will never be given as equilibrium of the game. The rationale is inherent in the fact that firms, making FDI, can elude the unions' threat of a high-wage strategy selection which might be given in case of no investment. Second, it is possible that a RFDI regime could occur also for low values of trade costs: to invest could be a viable strategic option for a firm not only for the tariff jumping argument, but also when IIT is a likely outcome. A possible explanation for this result could lie in the fact that increasing economic integration makes the investment option less prohibitive. Third, for intermediate values of trade costs, either RFDI or asymmetric regimes with a firm investing could be obtained: if the scale of sunk costs are not too large, the investment strategy appears to play an increasing fundamental role in firms' choice related to international business. Finally, for $t$ high enough, the tariff jumping argument is valid. Hence, with union acting competitively, to invest is the more expected strategic option for firms and RFDI is the more likely regime that could be given.

Instead, under union collusive behavior it was obtained that in the range $0 \leq t \leq .268$, depending both on $t$ and $F$, different productive structure can arise as Nash equilibrium of the game, and for some parameter combinations in small ranges also multiple equilibria may occur. Conversely, for $t \geq .268$, given the switch toward the high wage strategy by unions in the strategy profile $(NI; NI)$, firm profits are no more affected by trade costs: firms' strategy selection depends exclusively on the wage level set by unions and on the size of fixed costs of the investment. Union collusion, rising wages over the Bertrand competitive level, shrinks foreign profits and makes the investment option by firm less practicable. However, in IIT and asymmetric regimes a higher degree of economic integration is required to consent international activities for the firm which has chosen not to invest. On the other hand, RFDI regime, because of lower profits generated in the foreign market, the investment strategy becomes a practicable option only for lower magnitudes of sunk costs. Nonetheless, for lower values of trade costs, IIT is more likely to arise as Nash equilibrium under union collusive behavior. Summarizing, union collusion requires a higher degree of economic integration to allow international business.

The analysis has intuitively shown that a collusive agreement between unions is more practicable whenever the organization of productive activities is symmetrical, while in asymmetric regimes collusion is sustainable only for very high degrees of economic integration. After an analysis of the sustainability of union collusion some policy insights are derived.

Given the hypothesis outlined in the model and the results obtained from the previous analysis, it seems that national governments efforts should be devoted in acting policies that: 1) have to avoid an autarky regime, making FDI a feasible option in international activities for firms; 2) support trade liberalization; and 3) to encourage union competitiveness, promoting subsequent welfare redistributive measures in each country. Nevertheless, the open question is to evaluate and establish the appropriate policy instruments to redistribute national welfare; this is left for future further research.

It was used a very simple framework and the model presents a certain lack of robustness such as the use of very specific functional forms for utility, production and cost functions. However, this paper wants to offer a theoretical contribution in analyzing how firms' strategic behavior concerning international activities, even in an area with a higher degree of integration, could be affected by

union behavior. After the completion of the Single Market and the birth of the Monetary Union, as long as the European integration process will continue, it seems plausible that also the European labor market will become more and more integrated. Coordinated activities by unions in the labor market will arise in the future turning the actual implicit practices into more explicit ones.

**Appendix**

**Proof of Proposition 1.**

To prove proposition 1, union's 2 payoffs related to the high wage strategy are compared with respect to payoffs associated to the low wage strategy.
First, suppose that union 2 is playing a high wage strategy setting a wage rate in Region III such that Firm 2 cannot make a foreign investment, while Firm 1 is allowed to export. The labor demand function faced by union 2 is given by equation (24). Union's 2 utility in Region III is then given by

$$\Omega_2 = w_2 y_{2B}.$$

It follows that the reaction function and the utility associated to this region for union 2 is given by $w_2 = \arg\max_{w_2}\left\{\Omega_{2,III}^{H}\right\}$ from which it is obtained

$$RF_{2,III}^{H} \equiv w_2 = \frac{1}{4}(1 + w_1 + t) \text{ implying } \Omega_{2,III}^{H} = \frac{1}{24}(1 + w_1 + t)^2.$$

For $t \in [0,1]$, the intercept of $RF_{2,III}^{H}$ is below or at maximum equal to the intercept of the boundary condition between Region I and III, $B_{I,III}$. From differentiation of both $RF_{2,III}^{H}$ and the boundary it is also obtained that $\partial RF_{2,III}^{H}/\partial w_1 < \partial B_{I,III}/\partial w_1$. This two results jointly define that the $RF_{2,III}^{H}$ path resides entirely in Region I, where from definition the best reply function $RF_{2,I}^{L}$ assures the highest level of utility. In fact, it is directly obtained that in Region I the labor demand function for union 2 is given by (24) and (25)

$$y_{2B} + x_{2A} = \frac{1}{3}(2 - 4w_2 + 2w_1 + t).$$

yielding the following union utility function

$$\Omega_2 = w_2(x_{2A} + y_{2B}).$$

The optimal utility related to the low-wage strategy, for union 2 it is obtained from $w_2 = \arg\max_{w_2}\left\{\Omega_{2,I}^{L}\right\}$,

$$w_2 = \frac{1}{8}(2 + 2w_1 + t) \text{ implying } \Omega_{2,I}^{L} = \frac{1}{48}(2 + 2w_1 + t)^2.$$

Comparing, it is obtained that $\Omega_{2,I}^{L} > \Omega_{2,III}^{H} \quad \forall w_1 \geq 0$.

Suppose now that neither Firm 1 exports nor Firm 2 undertakes FDI. In such a case wage rates are no more interdependent one from the other, and hence the optimal wage is that obtained in the autarky case in subsection 2.2.1. It follows that

$$w_2 = 1/2 \text{ implying } \Omega_{2,VI}^{H} = 1/8$$

Also in this case, the $w_2$ path associated to the low-wage strategy resides entirely in a region, Region II, where FDI is still given. The labor demand function faced by union 2 in Region II when it is played a low wage strategy is given by

$$y_{2B} + x_{2A} = \frac{1}{6}(5 - 7w_2 + 2w_1).$$

and the union utility is hence represented by the following expression

$$\Omega_2 = w_2(x_{2A} + y_{2B}).$$

Union's 2 reaction function (and the utility related to this region) is given by $w_2 = \arg\max_{w_2}\left\{\Omega_{2,II}^{L}\right\}$, from which it is obtained

$$w_2 = \frac{1}{14}(2w_1 + 5) \text{ implying } \Omega_{2,II}^{L} = \frac{1}{168}(5 + 2w_1)^2$$

From comparison, it directly follows $\Omega_{2,II}^{L} > \Omega_{2,VI}^{H} \quad \forall w_1 \geq 0.\ \square$

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