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## Abstract

The five works presented in this dissertation aim to investigate different aspects of the effects of increasing economic integration on the behavior of labor unions. This research, ideally, can be split into two parts. Firstly, it investigates the subjects of market entry and monopoly regulation in a unionized industry in the context of an open economy. Secondly, it explores in depth the transnationalization of labor union activities, in particular related to the experience of the European Union.

The first paper (published in *Económica*, La Plata, Vol. LVII, Enero-Diciembre 2011) is an extensive survey of the microeconomic literature on different aspects of product market integration and internationalization of firms' activities upon labor unions' behavior. It devotes significant attention to those works which have investigated union incentives to coordinate their bargaining activities at transnational level.

Firstly, the survey reviews the effects of trade liberalization on labor union behavior. Trade liberalization, in the economic literature, has been modeled in several ways. This survey concentrates on two precise definitions: reduction in trade barriers (tariffs and non tariff barriers), and integration of product markets. The survey, concerning the reduction in trade barriers, explores at first the main contributions related to the effects of strategic trade policy on unionized labor markets. It then focuses on the effects of increasing international trade, due to decreasing trade barriers, on labor market outcomes (wage and employment levels), and the union incentives that arise, for labor unions, to coordinate wage policies (union collusion) at transnational level (Naylor, 1999, Union Wage Strategies and International Trade, *The Economic Journal* 109, 452: 102-115; Straume, 2002, Union collusion and intra-industry trade, *International Journal of Industrial Organization* 20: 631-652; Strozzi, 2007, Product Market Integration and Union Collusion, *Review of International Economics* 15, 1: 17-36; Strozzi, 2008, Union Coordination and Economic Integration, VDM Verlag Dr. Müller: Saarbrücken). As regards integration of markets, the paper reviews the works analyzing how the merger of national product markets into a unified, integrated product market affects the outcomes of unionized workers. Also included at this stage is an analysis of the papers investigating union coordination (Huizinga, 1993, International Market Integration and the Union Wage Bargaining, *Scandinavian Journal of Economics* 95, 2: 249-255; Borghijs and Du Caju, 1999, Globalisation, EMU and European Trade Union Cooperation. University of Antwerp (UFSIA) Department of Economics, Research Paper 99-013).

Secondly, the survey turns its attention to the impact of the internationalization of production activities on labor unions. The review focuses principally on those contributions which have investigated internationalization of production via greenfield - Foreign Direct Investment (FDI). Attention has been devoted to the analysis of the influence that the unionization structure and bargaining level has on firms' choices of three different alternatives: whether to invest in a foreign country (Zhao, 1995, Cross-hauling Direct Foreign Investment and Unionized Oligopoly, *European Economic Review* 39: 1237-1253); whether to enter the market via export (Bughin and Vannini, 1995, Strategic direct investment under unionized oligopoly, *International Journal of Industrial Organization* 13: 127-145; Glass and Saggi, 2005, Exporting versus direct investment under local sourcing. *Review of World Economics* 141, 4: 627-647) or, alternatively, to remain in an autarky position (if export is not an available option, as for the market of services: Naylor and Santoni, 2003, Foreign Direct Investment and Wage Bargaining. *Journal of International Trade and Economic Development* 12, 1: 1-18). Finally, the survey presents a review of the recent empirical works, based on micro-data, investigating the direct effects of increasing economic integration in terms of wage and employment outcomes on the European labor unions.

The second paper (published in *International Journal of Industrial Organization*, Vol. 29, 2011, 6: pp. 690-693) developed in this dissertation is a corrigendum to the Bughin's article (1999, "The

strategic choice of union-oligopoly bargaining agenda”, *International Journal of Industrial Organization* 17, 1029-40). The paper deals with the issue of market entry deterrence in a unionized sector. Assuming Cournot competition, Bughin (1999) states that, in a unionized oligopoly with negotiations conducted at the firm level, Efficient Bargaining (EB) is always the industry equilibrium both under blockaded and non-blockaded market structures. The paper extends Bughin’s (1999) framework to a conjectural variation model (Dowrick, 1989, Union-Oligopoly Bargaining, *The Economic Journal* 99, 1123-42), and shows that EB emerges as industry equilibrium only for entry deterrence reasons. In all other cases, conflicts of interest between the bargaining parties arise due to the difference in dominant strategies, whatever the degree of competitiveness of the industry. Although never mentioned, this paper relates to international economics by simply assuming that the potential entrant in the unionized sector is a Multinational Enterprise interested in undertaking FDI in the country.

The third work (published in *Economics Bulletin*, Vol. 32 (1) (March 2012), pp. 932-940) analyzes the differences between strategic trade and domestic competition policies to regulate a unionized monopoly. The domestic government has to choose whether to regulate it via market contestability, with a firm’s entry into the market; or via strategic trade policy, allowing imports from a unionized foreign country and applying an optimal tariff. Assuming an industry-wide union, the entry of a domestic competitor does not reduce labor market distortions, while strategic trade policy reduces both labor and product market distortions. Given the assumptions of the model, the domestic government does not contemplate the option of the entry of an international competitor, because the international entrant will repatriate profits to the country of origin: a domestic entry is always preferred. The choice between the two policies for the domestic government depends crucially on the amount of the fixed costs for the domestic entrant and the employment orientation of the foreign union. If the foreign union is relatively low employment-oriented and the fixed costs for the entrant are also low, the competition policy ensures a welfare level higher than the strategic trade policy. As the foreign union sensitivity increases, the threshold level of the fixed costs making the market entry profitable diminishes, and the strategic trade policy ensures a high level of national welfare. The paper relates to Vandebussche and Konings (1998, Globalisation and the Effects of National versus International Competition on the Labour Market: Theory and Evidence from Belgian Firm Level Data, *The World Economy* 21, 1151-1177) and Vandebussche (2000, Trade Policy Versus Competition Policy: Substitutes or Complements?, *De Economist* 148, 625-642.), which also analyze the differences between trade and competition policies. However, this paper differs from these works in several aspects. Firstly, in the case of trade policy, the foreign wage is not exogenously given: the foreign union sets its wage endogenously, competing over jobs with the domestic union, as in Naylor (1998, International Trade and Economic Integration when Labour Markets Are Generally Unionised, *European Economic Review* 42, 1251-1267). Secondly, it models explicitly the presence of tariff barriers and, therefore, the implementation of strategic trade policy, elements absent in Vandebussche and Konings (1998) and Vandebussche (2000).

The fourth paper investigates the incentives for unions to coordinate wage demands in an integrated product market, and the sustainability of unions’ wage collusion. The model is a two-country, two-stage, partial equilibrium duopoly model with integrated product markets. The model is solved by backward induction. In the second stage, Multinational Enterprises, characterized by decreasing return to scale technology, compete à la Cournot for differentiated goods. In the first stage, national, industry-wide monopoly unions set wages. Unions, to coordinate wage policies, have to sustain transaction costs. Thus, the paper concentrates on union coordination at the industry level. It differs from recent contributions which analyze, in an efficient bargaining model, union coordination in a Multinational company producing homogeneous goods with constant return to scale (Eckel, and Egger, 2012, The Dilemma of Labor Unions: Local Objectives vs. Global Bargaining’. CEPR Discussion Paper no. 8784). The focus is on the impact of labor market integration, measured by a

decrease in coordination costs (Borghijs and Du Caju, 1999, Globalisation, EMU and European Trade Union Cooperation. University of Antwerp (UFSIA) Department of Economics, Research Paper 99-013), rather than on the integration of product markets (Straume, 2002, Union collusion and intra-industry trade, *International Journal of Industrial Organization* 20: 631-652; Strozzi, 2007, Product Market Integration and Union Collusion, *Review of International Economics* 15, 1: 17-36).

It is shown that, for transaction costs sufficiently low, incentives for transnational wage coordination exist: unions find coordination profitable, no matter what the degree of product differentiation. However, unions face a classic Prisoner's Dilemma. The sustainability of wage coordination (an element of the analysis which is lacking in Borghijs and Du Caju, 1999) as equilibrium of the unions' game depends on coordination costs and the degree of product differentiation. The analysis also shows that there is no clear-cut relation between increasing labor market integration and transnational union collusion. In fact, for low minimum wages, collusive behavior among unions is more easily sustained for intermediate values of coordination costs than in the presence of extremely high and extremely low costs. On the other hand, for minimum wages high enough, as labor markets become more integrated, union collusion is always profitable. However, the union collusion is always more sustainable when minimum wages are relatively small. A remarkable result is that, contrary to conventional wisdom that wage collusion is always welfare-detrimental (Straume, 2002; Strozzi, 2007), under the hypotheses of this paper, wage coordination in the presence of low minimum wages may lead, from a social point of view, to a Pareto superior outcome with respect to separate wage settings with relatively high minimum wages.

Finally, the fifth paper analyzes firms' decisions concerning international activities (trade vs. Foreign Direct Investment, FDI) in the presence of company-wide unions. The model is a two-country, three-stage game duopoly model where firms produce a homogeneous product. Product markets are assumed to be segmented, and both countries are characterized by unionized labor markets. In the first stage of the game, firms choose autonomously whether to invest. Each firm has two strategies: not to invest, maintaining all productive activities in the domestic country; and to invest abroad, setting up a new plant. If firms undertake FDI and establish a production plant in the foreign country, they incur an exogenous, positive sunk cost. Otherwise, firms may serve the other country through exports, paying constant, exogenous trade costs per unit of the commodity exported. Equilibrium regimes depend on the interdependence of the exogenous integration costs (sunk and trade costs), endogenous union wage strategies, and firms' strategic interactions. The work derives the full set of production structures arising in equilibrium when internationalization (via export or FDI) is a viable option: symmetric (intra-industry trade or reciprocal FDI), multiple symmetric (intra-industry trade and reciprocal FDI) and asymmetric regimes (a multinational which coexists with an exporting firm) arise as sub-game perfect equilibria of the game. The crucial difference with respect to previous theoretical models (Glass and Saggi, 2005, Exporting versus direct investment under local sourcing. *Review of World Economics* 141, 4: 627-647; Naylor and Santoni, 2003, Foreign Direct Investment and Wage Bargaining. *Journal of International Trade and Economic Development* 12, 1: 1-18) is the assumption that unions organize themselves at company level even in the case of FDI and bargain over wages as a unique workers' representative body.

Moreover, the paper widens Naylor's analysis (1998, International Trade and Economic Integration when Labour Markets Are Generally Unionised, *European Economic Review*, 42, 1251-1267; 1999, Union Wage Strategies and International Trade, *The Economic Journal*, 109, No. 452, 102-115) by allowing firms to undertake FDI, as in Lommerud, Meland, and Sørgard (2003, Unionised Oligopoly, Trade Liberalisation and Location Choice, *The Economic Journal*, 113, Vol. 490, 782-800). However, differently from Lommerud et al. (2003), the model considers unionized workforces in both countries, in a more realistic reflection of the characteristics of the EU labor market. By assumption, the MNE's workers are organized at company level: the model retains this hypothesis

to capture the latest evidence on transnational company agreements in Europe. In fact, European unions have recently been exploiting the potential of the European Works Councils intensively during company-wide bargaining processes. Therefore, the hypothesis of company-wide unions aims to reflect the prominence, in several industries within the European Union, of company-level negotiations, especially in those sectors characterized by a high incidence of Multinational Enterprise operations. The consequences due to the adoption of this framework are not trivial. In fact, firstly, as in Lommerud et al. (2003), trade liberalization makes the investment strategy more profitable but, in contrast with these authors, FDI may take place even if the wage level in the investing firm is higher than the wage resulting from the choice of exporting. Secondly, in the presence of FDI, exports may be present, in equilibrium, for a range of trade costs wider than that found in Naylor (1999). In exploring these issues, this paper aims to create a link between two topics that the received literature treated as separate subjects, trying to give some plausible predictions for labor market outcomes and the organization of international business in an economic environment like the EU.



# Labor Unions and Economic Integration: A Review

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**Resumen:** Este artículo presenta una revisión de la literatura microeconómica teórica y empírica que investiga los efectos de la integración de los mercados de productos y de la internacionalización de las actividades de las firmas sobre el comportamiento de los sindicatos. El trabajo relaciona estos temas a la experiencia de Europa, indicando las líneas de investigación futura en este tópico.

Clasificación JEL : F21; F23; J50.

Palabras clave: integración económica, sindicatos.

**Abstract:** This paper reviews the theoretical and empirical microeconomic literature on the effects of product market integration and internationalization of firms activities upon labor unions. It relates these issues to the European experience, indicating following lines of research in this field.

JEL classification: F21; F23; J50; J51.

Keywords: economic integration, labor unions.

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## 1. Introduction

Economic integration is an ongoing process which has known in the last decades a dramatic pace of development, both at regional and global levels. Political issues like the reduction in tariff and other trade barriers have mainly driven this process, occurring either within supranational bodies like the WTO and the European Commission (EC), or through unilaterally moves by individual countries. Falling transportation and communication costs' further contributes to increase the flows of goods, services, and in some cases of people (workers). Furthermore, deregulation in international capital markets allows to move rapidly capital between different locations, leading to a process of disintegration of production, both of services and goods.

The European Union (EU) emerges as one of the major results of the ongoing process of international integration. One of the pillars of the EU economic integration process was the completion of the Single Market Program in 1992, which came into force by 1 January 1993. It resulted in the adoption of measures eliminating caveats and barriers on trade (reduction of tariffs and the removal of non-tariff barriers) to create a large integrated market for goods and services (allowing to realize and exploit economies of scale). Other measures were aimed at generating an increasing competitive environment to attain (allocative and productive) efficiency gains, reducing distortions in national product markets. The construction of the European Monetary Union (EMU), a second pillar of the EU integration process, initiated in 1990 and ended by the introduction of the Euro in 2002, has intensified economic integration between European countries by reducing trade costs and removing currency risks. The progresses in the Financial Service Action Plan and closer financial market integration further give a contribution to the process, making international capital mobility deal in an easier way with Foreign Direct Investment (FDI) operations.<sup>1</sup>

The deepening of economic integration has significant consequences for outcomes (wage and employment levels) and institutions of European labor markets. Product market integration, as well as increasing transparency and comparability of prices across boundaries (at least in those countries adopting the single currency), is expected to make price competition stronger and reduce the margin of profits. Financial market integration has enhanced the importance of private capital in job creation. Both these aspects of economic integration pose wages and labor costs developments as key variables to improve the countries' international competitiveness and attractiveness.

While the European economy is turning out to be progressively more integrated, labor unions operate mostly at national level. Ongoing internationalization will probably continue to exert pressures on unionized workers. This may occur through several channels. As mentioned, increasing competition is a first channel (Dreher and Gaston, 2007). The presence of international competitors increases the number of actors in imperfectly competitive product markets, shrinking the economic rents over which employers and workers negotiate. A second channel, identified both by Rodrik (1997) and Dreher and Gaston (2007), has to do with the ease with which domestic workers can be replaced by workers abroad either through trade or delocalization via FDI toward countries with lower wage levels. Technically, trade and international production flatten the labor demand at home which becomes more elastic, allowing for employers to react at changes in wages substituting workers by moving all or part of their operations abroad. It is commonly perceived that product market integration reduces the relative bargaining power of labor unions, and European integration seems to increase the labor demand sensitivity to wages, which may induce labor unions to moderate their wage claims. In economic sectors highly exposed to international competition, the demand for higher wages may trigger considerable occupational losses because of a deteriorated competitive position. European integration makes less complicated for firms, predominantly Multinational Enterprises (MNEs), to spread their activities between plants, located in different countries, to capture advantages in terms of reduction in production costs. Moreover, not only

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<sup>1</sup> The realization of the Single Market Program and the completion of the Single Market for financial services has subsequently driven a growth in the figures concerning both intra-industry trade (see European Commission, 2008a) and intra-EU FDI (see European Commission, 2005, 2008b; Jovanović, 2006, chap. 3, section 3.3.6).

effective delocalization but the simple threat of delocalizing weakens unions' positions, allowing for firms to obtain favorable concessions during negotiations. The adoption of labor market policies by national Governments whose aim is to weaken union bargaining strength; and the institutional convergence towards the more decentralized, less regulated and less unionized U.S. labor market (considered the ideal model to face the challenges posed by international integration) are two additional elements (Dreher and Gaston, 2007).

Nonetheless, following more integrated product and financial markets, and fostered by processes promoted by the EU institutions, notably the adoption of the 1994 (recently revised in 2009) European Works Councils (EWC) and the 2001 European Company Directives, in recent times also European labor markets have shown signs of changes in bargaining practices. Major actors like trade unions, stimulated by the concern that would be opposed against each other in a strong competition over jobs and income, have shown increasing interest in trans-nationalize their activities. This took place typically in softer, non-binding forms, intensifying the degree of cooperation in coordinating their policies, and taking into account a broader perspective in negotiation strategies at every level (the "Europeanization" of collective bargaining). To pursue these objectives, since 1998, the sharing of common rules in collective bargaining to confederate negotiators (the "guideline for collective bargaining at the European level") by the European Trade Union Confederation (ETUC), and institutions such as multinational collective bargains has been introduced. However, similar practices emerged also in initiatives apart from the ETUC, like the "Doorn agreement", a transnational agreement endorsed by the national trade unions of Belgium, Germany, Luxembourg and the Netherlands in 1998, whose central points were wage demand coordination and the support of occupational growth.<sup>2</sup>

While the ETUC and the "Doorn agreement" provide guidelines and policy orientations in coordinating activities at cross sectoral level, unions in the European Industry Federations (EIF) mainly pursued at the industry level these initiatives, according to the sector they cover. Within the EIFs, the European Metalworkers' Federation (EMF) is in a leading position. The EMF was the first industry level union federation which adopted a "coordination approach" to attain a European dimension in coordination activities related to national bargaining policies and minimum standards. With the purpose of preventing possible downward competition on wages and working conditions, in December 1998 the EMF, in defining its own strategy, adopted the so-called "European coordination rule". This "coordination rule" is based on two central elements: a joint commitment to European guidelines for national collective bargaining, aimed at preventing downward competition; and the political purpose of "EMF minimum standards" which all EMF associates should feel obliged to bargain for. Precisely, the EMF stated that "the wage policy of trade unions in all countries must be to offset the rate of inflation and ensure that workers' incomes retain a balanced participation in productivity gains".

The approval of the EWC Directive is modifying the level at which collective bargaining occurs in many industrial sectors in Europe. In fact, in those sectors characterized by a high incidence of Multinational Enterprises (MNE) operations, there is an increasing evidence of company level negotiations rather than industry-wide agreements. As a consequence, recently unions start to take advantage of the EWCs' potential to coordinate activities across countries during the bargaining process. For example, in the banking sector, Danish trade unions received the mandate to negotiate on behalf of all employees working at Danske Bank (EIROnline, 2009). The EMF and UNI Europa Graphical (UEG, another cross border industry union belonging to the EIFs), devised a procedure to receive the mandate in representing the workers' side all through company-wide transnational agreements (Eurofound, 2009; Gennard, 2009).

Hence, labor unions are developing trans-national cooperation strategies. In the next future, unions may seek to coordinate wage policies to improve their positions in negotiations with employers. Aim of this paper is to sum up the theoretical and empirical literature related to the effects of

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<sup>2</sup> See European Commission (2002) for an extensive review on coordination activities about collective bargaining.

international integration on organized labor, considering the strategic interactions among economic actors in the product and labor markets. It focuses to the works analyzing the scope and incentives for unions' international coordination, as a means to face the impact of product and capital markets' integration. These issues relates in particular to the European experience.

The rest of the paper organizes as follows. Section 2 presents some preliminary considerations connected to the received literature: discussion of unions' objective functions; description of the features related both to the bargaining processes among unions and firms, and the structure of international markets; discussion about the concept of economic integration. Section 3 provides a review of the literature on the effects of international trade liberalization in unionized frameworks, focusing on wage and employment outcomes, and on the diverse features of union coordination. Instead, Section 4 devotes to the internationalization of productive activities and its consequences for labor unions. Section 5 presents a review of the empirical literature on the impact of economic integration on European unions' outcomes. Section 6 closes the paper.

## 2. Economic integration and unionized labor markets: preliminary considerations

There are some important issues to take into account when starting to analyze the effects of closer economic integration on unionized labor markets and union behavior. A first element is the union objective function. In the recent literature, unions are usually seen as optimizing agents, which maximize diverse utility functions. A general specification, encompassing several union objectives, is the following Stone-Geary utility function:

$$U = (w - \bar{w})^\theta (l - \bar{l})^{(1-\theta)}$$

where  $w$  is the wage rate,  $\bar{w}$  the reservation wage;  $l$  is the number of workers employed, and  $\bar{l}$  is the reservation employment. The parameter  $\theta \in [0,1]$  represents the relative weights that the union assigns to the rent over the reservation wage and the reference level of employment. The union is wage (employment) oriented if  $\theta > 1 - \theta$  ( $\theta < 1 - \theta$ ), or neutrally oriented if  $\theta = 1/2$ . When

$\theta = 1/2$  and  $\bar{l} = 0$ , the union has a rent-maximizing utility function. Additionally, if the reservation wage is  $\bar{w} = 0$ , the union maximizes the total wage bill. Finally, if  $\theta = 1$ , the union maximizes the wage premium; with  $\bar{w} = 0$ , the union simply maximizes the wage rate.

Other functional forms often used in representing union objectives are the utilitarian utility function,

$$U = lu(w) + (m - l)u(b)$$

and its slightly modified version, the expected utility function,

$$U = \frac{l}{m}u(w) + \frac{(m - l)}{m}u(b)$$

where  $u(w)$  is the utility function of the individual employed union member,  $m \geq l$  represents the number of union members, generally assumed as fixed;  $b$  is the alternative wage or the unemployment benefits. The utilitarian union utility function maximizes the sum of the utility of employed members and the utility of any unemployed member; the expected utility function maximizes the expected utility of the representative union member. If  $m$  is treated as a variable, the two utility forms differ. While the utilitarian utility is increasing in membership because is an aggregating function, the expected utility is decreasing: employment is a random draw across identical members, and growing membership lowers for each member the probability of being

occupied. Finally, under the assumptions of perfect symmetry in objectives and in preferences over wages and employment, theoretical works mainly describe wage coordination among (usually two) unions as efficient union collusion, where the sum of unions' utility is maximized; but in some exceptional cases, the product of union utilities is maximized.

A second group of features that should be taken into account are related to bargaining: the scope, the type, and level.<sup>3</sup> Concerning the scope of bargaining, almost all cases consider either negotiations over wages only, or both employment levels and wage rates. The former refers to the right-to-manage model: unions and firms bargain over wages, but once the wage rate is fixed, firms have the right to decide employment levels. In this case, the equilibrium solution stays on the firms' labor demand. Instead, the latter refers to the efficient bargaining model: firms and unions negotiate simultaneously over wages and employment, and the Pareto-efficient equilibrium resides somewhere on the contract curve's locus to the right of the firms' labor demand function. Rarely, a labor-hoarding model is considered: unions and firms bargain over wages and overhead labor, namely the proportion of unproductive time a worker is paid for. If workers value on-the-job leisure, overhead labor constitutes a bargaining issue for the union.

As regards the type of negotiation, the Nash Bargaining Solution is mainly adopted. This implies the maximization with respect to the bargaining scope of the Nash Product, given by:

$$NP = (U - \bar{U})^\alpha (\Pi - \bar{\Pi})^{(1-\alpha)}.$$

The parameter  $\alpha$  captures the relative bargaining power during negotiations,  $\Pi$  represents firm profits, while  $\bar{\Pi}$  and  $\bar{U}$  are the parties' outside options, or conflict payoffs in case of strikes. Several models assume that these are equal to zero. A special case of the Nash Product is the Monopoly Union model, where  $\alpha = 1$ : unions have the complete power to fix wages, and subsequently firms choose the employment level.

Bargaining between workers and employers representatives may take place at different levels. The most decentralized is the firm level. However, a distinction may be done among plant specific and company-wide agreements. Higher negotiation levels, involving an increasing degree of centralization, are industry-wide and national. In a context of increasing economic integration, especially referring to the European experience, also transnational bargaining is considered.

A third element to take in consideration is the structure of the international product market, and therefore the type of competition therein. International competition takes place in almost all works in a two-country model, but exceptionally, also a three-country model may be used. It is adopted either an oligopoly or a monopolistic competition framework; sometimes also perfectly competitive markets are assumed. As regards oligopoly markets, it is assumed that there is a given number of interacting firms, ranging from 2 to  $n$ : Cournot competition is the assumption most frequently made, although Bertrand competition and conjectural variation models are sometimes also analyzed. Markets may be fully integrated, where firms decide output levels for the entire market; alternatively, the market segmentation hypothesis is used, where firms choose production levels separately for each relevant market. For analytical convenience and tractability, linearity in demand functions is generally assumed, but some works use more general functional forms. Goods may be homogeneous or heterogeneous as well as substitutes or complements.

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<sup>3</sup> Another feature related to bargaining (not covered in this work) is the timing at which negotiations might occur. The literature here reviewed assumes that negotiations between unions and firms occur at the same time at every level. That is, bargaining is synchronized. Only few exceptions consider the effects of sequential bargaining: negotiations take place first in a firm, industry or country which is in a "leading" position, and then the agreement reached there becomes the "pilot agreement" for all subsequent negotiations. On this topic see De Fraja (1993), Dobson (1994), Corneo (1995) and Wang et al. (2009) for theoretical models; and Traxler and al. (2008), and Traxler, F., Brandl, B. (2009) for empirical research in European countries.

Finally, economic integration in itself represents a broad definition. It may refer to increasing product markets integration via international trade, due to reductions or elimination of tariff and non-tariff barriers, or because of falling general trade cost barriers such as transportation, logistic and “red-tape” costs; but also to capital markets liberalization. Consequently, economic integration can be modeled in different ways. When refers to product markets, integration is generally depicted either as a marginal reduction in trade costs or in a change from autarky to full market integration. However, in some papers, product market integration is measured by other parameters as the share of firms which start to sell their goods in the international market, or an increasing substitutability among domestic and foreign goods. The advantage of the first approach is that the economic integration is measured by the trade cost parameter. This allows to analyze the effects of marginal changes in the degree of integration. On the other hand, this method does not capture a key aspect of integration: firms in different countries may enter into foreign markets, implying increasing product market competition. The second approach captures the market access aspect, but in general it compares two extreme regimes. If international economic integration relates to capital markets liberalization, this could be viewed in increasing possibilities for firms to undertake FDI in other countries, allowing for internationalization of productive activities.

Next sections review the theoretical and empirical works on the effects of international economic integration on labor unions’ behavior and labor market outcomes, considering different dimensions and approaches towards this phenomenon.

### **3. Labor unions and economic integration: international trade**

This section discusses the papers whose focus is the study of the labor unions’ behavior in a context of international trade. These works are classified in accordance with the different methodologies describing international product market integration.<sup>4</sup>

#### **3.1 Labor unions and trade liberalization: reduction in trade barriers**

First theoretical contributions related to the effects of economic integration on labor markets, analyzing the related wage and employment outcomes as well as incentives for unions to cooperate internationally in face of increasing trade competition in product markets, are the models by Driffill and van der Ploeg (1993, 1995).

Driffill and van der Ploeg (1993) analyze a two-country model of international trade with barriers whose revenues are returned as lump-sum subsidies. Firms in each country produce homogeneous goods and specialize in the production of their own exportable. The domestic and the foreign goods are imperfect substitutes in consumption. There are no assets; thus equilibrium always requires balanced trade and monetary issues need not be taken in consideration. Labor factor is immobile. Households maximize the following CES utility function which depends on the consumption of domestic ( $x_1$ ) and foreign ( $x_2$ ) goods,

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<sup>4</sup> Several papers have studied the impact of trade liberalization on labor unions. These works considered a framework where unionized countries face product market competition from countries with perfectly competitive labor market. A crucial issue (not covered in this work) is that of strategic trade policy; that is, the choice of trade policy interventions by governments aiming at maximize domestic welfare. In general, these models apply in oligopoly frameworks and investigate the effects of the implementation of such strategic trade policy instruments as tariffs, subsidies and import quotas, on unionized workforce. This strand of the literature was pioneered by the works of Brander and Spencer (1988) and Mezzetti and Dinopoulos (1991), and further developed by Santoni (1996), Bandyopadhyay and Bandyopadhyay (1999, 2001), Campbell and Vousden (2000), Bandyopadhyay, Bandyopadhyay and Park (2000), Collie and Vandebussche (2005), and Ma (2008). Another topic is the analysis of different forms of trade liberalization as unilateral reduction in tariffs, creation of free-trade agreements or free-trade areas. This is the subject of the three-country models with one non-unionized country of Fisher and Wright (1999) and Mauleon, Song, and Vanetelbosch (2006).

$$\begin{aligned}\tilde{U}(x_1, x_2) &= [(1 - \lambda)x_1^\theta + \lambda x_2^\theta]^{\frac{1}{\theta}} \quad \text{for } 0 < \theta \leq 1 \\ &= x_1^{1-\lambda} x_2^\lambda \quad \text{for } \theta = 0\end{aligned}\tag{1}$$

subject to the following budget constraint

$$x_1 + tex_2 = m = pu,\tag{2}$$

where  $\lambda$  is a parameter of the utility function representing the fraction of the foreign goods,  $m$  indicates income,  $p$  is the price index associated with the composite commodity  $u$ ,  $e$  denotes the real exchange rate, namely the price of the foreign goods in terms of home products, and  $t \equiv 1 + T$  with  $T$  the tariff rate charged by the home country on imports. From the maximization problem, the following expression for the CPI is derived:

$$\begin{aligned}p &= [(1 - \lambda)^b + \lambda^b (te)^{1-b}]^{\frac{1}{1-b}} \quad \text{if } b > 1 \\ &= [(1 - \lambda)^{1-\lambda} \lambda^\lambda]^{-1} (te)^\lambda \quad \text{if } b = 1\end{aligned}\tag{3}$$

The CPI depends on the tariffs  $t$ , the real exchange rate  $e$  and the elasticity of substitution between domestic and foreign goods,  $b \equiv [1/(1 - \theta)] \geq 1$ . Since  $\partial p/\partial t > 0$ , a reduction in tariff barriers leads to a reduction in the CPI with a consequent increase in the demand for the goods produced in the foreign country. In particular, when  $b > 1$ , the substitution effect dominates the income effect and therefore there is a reduction in the demand for the domestic goods; instead, with the Cobb-Douglas utility function ( $b = 1$ ), income and substitution effects are exactly offset.

Firms operate in a perfectly competitive market and demand  $l$  units of labor, the unique factor of production, to maximize profits,  $f(l) - wl$ , where  $f(l)$  is a production function with diminishing returns to labor, and  $w$  is the product wage. The labor demand is then  $l = L(w)$ ,  $L' = 1/f'' < 0$ , and the product supply is  $f[L(w)] \equiv Q(w)$ ,  $Q' = f'/f'' < 0$ , both decreasing functions of the wage. Product market equilibrium requires that  $Q(w) = x_1 + x_2^*$ , where  $x_2^*$  represents exports (asterisks indicate foreign variables). The government distributes tariff revenues as lump-sum subsidies, so that  $(t - 1)ex_2 = s$  and  $m = Q(w) + s$ .

Given the condition for balanced trade  $x_2^* = ex_2$ , the equilibrium real exchange rate's expression is  $e = E(w, w^*, t, t^*)$ ; further substitution in the CPI expression yields  $p = P(w, w^*, t, t^*)$ . An increase in the domestic product wage decreases the aggregate product supply at home, and causes a relative increase in the price of home products with respect to foreign products. This leads to an appreciation of the real exchange rate (a reduction of  $e$ ), and consequently in a reduction of the CPI (from equation (3),  $\partial p/\partial e > 0$ ): an increase in the product wage leads to an increase in the consumption wage. Similarly, an increase in the foreign product wage leads to an expansion of the aggregate supply of the domestic goods in the home market. This in turn implies depreciation of the real exchange rate, and thus an increase in the CPI. A tariff cut at home, instead, shrinks the demand for domestic products, increases the demand of foreign goods. This induces depreciation of the real exchange rate attenuating the drop in the CPI due to the tariff reduction.

Trade unions are supposed to maximize a utilitarian utility function which depends on employment and the consumption wage:

$$U\left(\frac{w}{p}, l\right) \equiv L(w)u\left(\frac{w}{p}\right) + [\bar{l} - L(w)]\bar{u}, \quad u' > 0, \quad u'' \leq 0 \quad (4)$$

where  $\bar{l}$  is the exogenous union membership and  $\bar{u}$  is the utility of leisure time. If unions suppose that their members have wage income only, equivalent to  $w$  units of the domestic product, the utility of each member is linear in the consumption wage,

$$u\left(\frac{w}{p}\right) = \left(\frac{w}{p}\right). \quad (5)$$

Three types of unions are considered: decentralized trade unions (*D*), centralized trade unions (*C*) and international trade unions (*I*). In case of decentralized unions, from equation (5) it is obtained that the maximization problem leads to

$$\frac{\partial U}{\partial w} = L'(w)u\left(\frac{w}{p}\right) + u'\left(\frac{w}{p}\right)L(w) - L'(w)\bar{u} = 0$$

from which it is obtained that wages are set according to

$$\left[ \frac{u\left(\frac{w}{p}\right) - \bar{u}}{\left(\frac{w}{p}\right)} \right] = \left[ \frac{-L(w)}{wL'(w)} \right] \equiv \left( \frac{1}{d} \right)$$

which, given (5), becomes

$$w_D = p_D \frac{\bar{u}}{\left(1 - \frac{1}{d}\right)} \quad (6)$$

where  $1/d$  is the inverse of the elasticity of labor demand respect to the real product wage: a low elasticity and high unemployment induce unions to set high wages. When unions are decentralized, they are so small that the effect of raising wages on the CPI and the exchange rate are ignored. In case of centralized unions, they are sufficiently large that the effect of increasing national wages on the domestic CPI is taken into account. It follows that the maximization problem now becomes,

$$U\left(\frac{w}{p(w)}, l\right) \equiv L(w)u\left(\frac{w}{p(w)}\right) + [\bar{l} - L(w)]\bar{u} \quad (7)$$

from which the first order condition is:

$$\frac{dU}{dw} = L'(w)u\left(\frac{w}{p}\right) + (1 + \varepsilon)u'\left(\frac{w}{p}\right)L(w) - L'(w)\bar{u} = 0.$$

Consequently, the wage rate is set in accordance to the condition

$$\left[ \frac{u\left(\frac{w}{p}\right) - \bar{u}}{\left(\frac{w}{p}\right)} \right] = \left( \frac{1 + \varepsilon}{d} \right),$$

which given (5) turns out to be

$$w_c = p_c \frac{\bar{u}}{\left(1 - \frac{1 + \varepsilon}{d}\right)} \quad (8)$$

where  $\varepsilon \equiv -wP_w/p > 0$  is the elasticity of the CPI with respect to the domestic product wage. It is obtained that, in the symmetric equilibrium ( $t = t^*$ ), the CPI is  $p_c = p_D = \left[ (1 - \lambda)^b + \lambda^b t^{1-b} \right]^{\frac{1}{1-b}}$ , implying that  $w_c > w_D$ . This is so because decentralized unions do not take into account the positive effect that an increase in the wage rate has on union utility through a reduction in the CPI: the wage demand is lower than a centralized union, and consequently the employment level higher. If unions are centralized and cooperate at international level, they internalize the adverse effects of a wage increase on the unions' utility abroad through the increase in the foreign CPI which causes, given the foreign product wage, a reduction in the consumption wage in that country. In equilibrium, this will cause a wage level which is lower than those fixed by centralized unions with an exclusively national viewpoint. It follows that international unions maximize

$$U\left(\frac{w}{p(w, w^*)}, l\right) \equiv L(w)u\left(\frac{w}{p(w, w^*)}\right) + [\bar{l} - L(w)]\bar{u}. \quad (9)$$

Differentiation leads to

$$\frac{dU}{dw} = L'(w)u\left(\frac{w}{p}\right) + (1 + \varepsilon - \varepsilon^*)u'\left(\frac{w}{p}\right)L(w) - L'(w)\bar{u} = 0.$$

Hence, trade unions fix the wage following the condition

$$\left[ \frac{u\left(\frac{w}{p}\right) - \bar{u}}{\left(\frac{w}{p}\right)} \right] = \left( \frac{1 + \varepsilon - \varepsilon^*}{d} \right)$$

which becomes

$$w_I = p_I \frac{\bar{u}}{\left(1 - \frac{1 + \varepsilon - \varepsilon^*}{d}\right)} \quad (10)$$

where  $\varepsilon^* \equiv w^* P_{w^*} / p > 0$  is the elasticity of the CPI with respect to the foreign product wage. In the symmetric equilibrium ( $\varepsilon = \varepsilon^*$ ), it follows that  $w_c > w_D = w_I$ . This result corresponds to an international version of the original findings by Calmfors and Driffil (1988) of the hump-shaped relationship between wages and the degree of corporatism.

Driffill and van der Ploeg (1993, footnote 2) show that national centralized unions have a utility level lower than decentralized and international unions; it follows that national unions could find profitable to cooperate across countries (improving their welfare) because of higher employment levels. However, decentralized unions could find advantageous to move from centralization towards decentralization of the wage setting; but if wage arrangements in the foreign country are taken as given, it could be the case that decentralized unions would prefer a centralized wage setting. In other words, unions could face a classical Prisoners' Dilemma.

The effects of increasing economic integration (a reduction of  $t = t^*$ ) are also considered. In case of Cobb-Douglas preferences, it is obtained that

$$e = \left( \frac{w}{w^*} \right)^{-c}, \quad p = [(1 - \lambda)^{1-\lambda} \lambda^\lambda]^{-1} t^\lambda \left( \frac{w}{w^*} \right)^{-\lambda c}$$

where  $c \equiv -(wQ'/Q) > 0$  is the elasticity of production to product wage. With Cobb-Douglas preferences, the elasticity of the CPI with respect to home and foreign product wage is constant ( $\varepsilon = \varepsilon^* = \lambda c$ ) and independent from tariffs. It is also derived that, in the symmetric equilibrium,

$$\frac{w_I}{p} = \frac{w_D}{p} = \frac{\bar{u}}{\left(1 - \frac{1}{d}\right)} < \frac{w_c}{p} = \frac{\bar{u}}{\left(1 - \frac{1 + \lambda c}{d}\right)} \quad (11)$$

from which it can be noted that inefficiencies from the absence of international cooperation between unions (low output and employment levels) are larger when the share of imported goods in total consumption is large and when the aggregate supply curve is very elastic. Instead, in case of CES preferences ( $b > 1$ ), the authors show that for  $e = 1$  and  $t = t^*$ ,  $\partial \varepsilon / \partial t < 0$ : centralized unions set higher wages if tariffs and  $\varepsilon$  are low, and consequently a further reduction in trade barriers deepens the wage differential between centralized setting and the other two settings. Nonetheless, the union utility as a whole decreases in case of centralized wage setting because the fall in employment level does not overcome gains from higher wage rates, and hence incentives for international cooperation between trade unions increase.

Driffill and van der Ploeg (1995) face the same issues addressed in their previous work adopting a different setting; they show that the results strongly depend on the hypothesis lying behind the models. A two-country model of intra-industry trade in differentiated goods is used where in the product market monopolistic competitive firms operate. Firms freely enter and leave until profits are bid down to zero. The production function exhibits increasing returns to scale. Moreover, in this work, the authors consider a utilitarian monopoly trade union in an industry which represents a small fraction of the country GDP, and consequently a small part of the consumers' budget. Therefore, differently from Driffill and van der Ploeg (1993), since the wage paid in the industry might have only a small effect on the CPI faced by its employees, a national union or even an international union would not be inclined to moderate its wage demands on that account. Under these conditions, the authors find that wages set at the national level positively depend upon the tariff level, explained by the fact that trade barriers protect national unions. Thus, tariff cuts oblige labor unions to set lower wages. Since the wage rates set internationally are substantially unaltered by the tariff, a fall in the tariffs themselves broadens the difference between the nationally and

internationally negotiated wages, and hence to an increasing incentive for trans-national labor union cooperation. Moreover, the authors conclude that the national wage is always lower than the international wage, only approaching the latter when the tariff tends to infinity. The rationale is that with low tariffs, a small increase in the domestic wage, taking as given the wage in the other country, will cause a reduction in the number of firms in the domestic industry. Since numerous domestic firms will exit the industry while, at the same time, many firms will enter in the foreign country, the national union, taking this into account, select a very low wage. Instead, the international union considers an overall wage rate increase and consequently perceives a less significant (total) employment effect of a wage raise. As a result, it sets a relatively high wage.

Another class of works has considered the effects of economic integration in the context of international oligopoly (duopoly) models with unionized labor markets, in which firms and unions interact strategically. Generally, these are partial equilibrium models<sup>5</sup> constructed taking in consideration a two-stage game structure solved in the backward fashion where:

- 1) there is full unionization and monopoly unions in the first stage maximize their rents over competitive wage either competing à la Bertrand or colluding between them: in this case there is interdependency between the wage levels in different countries; otherwise, unions and firms bargain over wages: in this case wage levels are determined independently in each country;
- 2) in the second stage firms choose the profit maximizing quantities (and hence employment) independently for each market (market segmentation), given the quantity of the other firm (Cournot competition assumption) and the wage resulting from the first stage (“right-to-manage”).

While the bargaining approach is rarely used when economic integration is analyzed in international trade, the monopoly union model is more common given that it allows for labor markets rivalry. Normally, this approach adopts a number of simplifying assumptions regarding the demand function and production technology. In general, it is assumed linearity in demand and production functions of a homogeneous/differentiated commodity. Labor is usually the unique factor of production with constant return to scale, in such a way that each worker produces one unit of the goods: that is, production and employment are equal. The market segmentation hypothesis, combined with the constant marginal costs assumption, implies that, in each market, the price for the goods depends entirely on the quantity in that country. It is assumed that the sector is relatively small respect to the economy, such that the effects of wage negotiations on the general price level index are ignored. Moreover, only equilibria in pure strategies are considered. This kind of approach is found in Naylor (1998, 1999), Straume (2002), Piperakis et al. (2003) and Strozzi (2007, 2008).

A formal model that sums up this strand of the literature could be represented by the following framework. There are two countries (1 and 2), which have different market sizes ( $s_1$  and  $s_2$ ). In each country operates a firm. Should firms want to export, they pay a variable “per unit” cost  $t \in [0,1)$  representing a basket of costs including tariffs, transaction, transportation and logistic. Economic integration within this framework is pictured as a marginal reduction in  $t$ , and it is assumed that its value is sufficiently low so that both firms can export. The two-stage game is solved by backward induction as usual. To lighten notation, the different markets are denoted by the indices  $i$  and  $j$  ( $i, j = 1, 2; i \neq j$ ). It follows that firm profits are given by:

$$\Pi_i = (p_{ii} - w_i)x_{ii} + (p_{ij} - w_i - t)x_{ij} \quad (12)$$

where  $p_{ii}$  is the prices of commodities in the domestic market and  $p_{ij}$  is the price for products in the foreign market,  $w_i$  is the wages paid by the firm  $i$ ,  $x_{ii}$  is the firm  $i$ 's production for

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<sup>5</sup> The papers of Dube and Reddy (2006) and Bastos and Kreickmeier (2009) represent few exceptions of general equilibrium models in an international trade context.

consumption in its domestic market while  $x_{ij}$  is the production for consumption in the foreign market. Inverse product demands are linear and take the following form

$$p_{ii} = a - \frac{b}{s_i}(x_{ii} + \gamma x_{ji}); \quad p_{ij} = a - \frac{b}{s_j}(x_{ij} + \gamma x_{jj}) \quad (13)$$

with  $a, b > 0$ , and where  $\gamma$  is the parameter which captures the degree of differentiation among goods  $x_i$  and  $x_j$ . In general, it is assumed that products are substitutes, implying that  $\gamma \in (0,1]$ : if  $\gamma \rightarrow 0$ , the goods are substantially independent; if  $\gamma = 1$ , they are perfect substitutes. Thus, when international trade occurs, this is of intra-industry type: in fact, depending on the specific models' assumptions, there are threshold values of  $t$  such that autarky (defined as a situation where a firm produces only for its domestic market) arises as game equilibrium. Union utility is given by the following version of a Stone-Geary utility function

$$U_i = (w_i - \bar{w})(x_{ii} + x_{ij}) \quad (14)$$

where  $\bar{w}$  is the reservation wage. In the second stage, Cournot competition in the product market takes place. Substituting equations (13) into (12), from the firms' maximization problem (subject to the non-negative constraints), the following optimal quantities (employment levels) are obtained

$$x_{ii} = \frac{s_i(2a - a\gamma + \gamma w_i + \gamma t - 2w_j)}{b(4 - \gamma^2)} \quad (15)$$

$$x_{ij} = \frac{s_j(2a - a\gamma + \gamma w_i - 2t - 2w_j)}{b(4 - \gamma^2)}. \quad (16)$$

The sum of the two labor demand schedules given by (15) and (16) represents the aggregate demand faced by union  $i$ . In the first stage, unions set their wage, taking as given the wage level in the other country. Substituting in (14) the optimal quantities, the union  $i$  maximization problem becomes

$$w_i = \arg \max_{w_i} \left\{ U_i = (w_i - \bar{w}) \left( \frac{s_i(2a - a\gamma + \gamma w_i + \gamma t - 2w_j)}{b(4 - \gamma^2)} + \frac{s_j(2a - a\gamma + \gamma w_i - 2t - 2w_j)}{b(4 - \gamma^2)} \right) \right\}$$

The maximization problem leads to an expression for union  $i$  reaction function from which it is derived the equilibrium wage level in each country, given by

$$w_i = \bar{w} + \underbrace{\frac{(2 - \gamma)(a - \bar{w})}{b(4 - \gamma)}}_{\text{product differentiation effect}} - t \underbrace{\frac{[s_i(8 - \gamma^2) - 2s_j\gamma]}{b(16 - \gamma^2)(s_i + s_j)}}_{\text{market size effect}} \quad (17)$$

Equation (17) indicates that the wage in equilibrium presents a rent over the competitive level composed of two parts. The first term, the "product differentiation effect", depends exclusively on the parameter  $\gamma$ , and it is unequivocally positive. The second term, "the market size effects", may

be either positive or negative. Economic integration (measured by the parameter  $t$ ) plays a role exclusively on the second term of the rent expression. From equation (17), it is directly derived

$$\frac{\partial w_i}{\partial t} < 0 \text{ if } s_i < \frac{s_j(8-\gamma^2)}{2\gamma}; \quad \frac{\partial w_i}{\partial t} > 0 \text{ if } s_i > \frac{s_j(8-\gamma^2)}{2\gamma} \quad (18)$$

Equations (18) allow to draw some results: closer economic integration may have a positive or negative effect on wage levels, depending both on market sizes and product differentiation. If goods are perfect substitutes ( $\gamma = 1$ ), the results of Piperakis et al. (2003) are obtained, according to whom if market size disparity is  $s_i < 3.5s_j$  and if trade costs are below a certain threshold, increasing economic integration (a reduction of  $t$ ) leads union  $i$  to increase wage demands. This is so because total employment in country  $i$  ( $x_{ii} + x_{ij}$ ) increases. If market size disparities are too large ( $s_i > 3.5s_j$ ), the reverse applies. What is the role played by product market differentiation? As long as  $\gamma$  approaches to zero, the right-hand sides of the inequalities increase, implying that economic integration leads unions to increase wage demands even if product markets have huge size differences. It follows that, if countries are specialized in production of relatively different goods, labor unions operating in larger countries should not be worried of increasing integration.<sup>6</sup> The previous results integrate those of Naylor (1998). Assuming symmetric countries and perfect substitutes (that is,  $s_i = s_j = \gamma = 1$ ), Naylor obtains that for levels of  $t$  allowing for intra-industry trade ( $0 \leq t \leq .311$ ),  $\partial w_i / \partial t < 0$ : an increase in economic integration will induce trade unions to set unambiguously higher wages. The reason is that when trade cost level decreases, a more severe competition amongst the participants in an international oligopoly takes place. Nonetheless, the firms' output increases: gains from more sales in the foreign markets counterbalance the disadvantage of higher competition in the home market. In this framework, labor demand becomes less elastic: even if a smaller number of workers are needed to satisfy domestic demand, firms require more workers to produce goods for export. Given that the latter effect is larger than the former, when intra industry trade takes place, employment grows due to the output expansion; and while firms may possibly suffer a loss in profits, unions will choose to set higher wages. Consequently, it is found that  $\partial U_i / \partial t < 0$ : further economic integration causes an unambiguous increase in labor unions' utilities due to a simultaneous raise in total employment and wage rates. In a subsequent work, Naylor (1999) extends his previous analysis to a more general framework, encompassing the Brander and Spencer (1988) model which considers the case of only one labor market unionized. It characterizes a full set of possible trade regimes in a two-country duopoly model with a homogeneous product and one union active in each labor market. The author takes in consideration the outcomes of two alternative union wage strategies. Naylor (1999) defines as a low-wage strategy a union wage setting such that both domestic production and exports are strictly positive. Instead, the high-wage strategy implies that a union set a wage level precluding exports. The main results are as follows: 1) where only one market is unionized, one-way trade occurs if union chooses a high wage, which depends on the exogenous rival wage and trade cost levels; when trade costs decreases, two-way trade arises; 2) in a symmetric unionized framework, intra-industry trade arises as equilibrium if trade costs are below a certain threshold values ( $0 \leq t \leq .311$ ); in that range increasing economic integration leads unions to set high wages, and their utility raises as trade costs fall; for sufficiently high trade costs ( $t \geq .354$ ), the autarky equilibrium arises; in an

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<sup>6</sup> Piperakis et al. (2003, Appendix) show that, if trade costs are above a threshold value, an increase in employment opportunities due to trade is not sufficient for the union in the larger market to equalize the utility loss due to a lower wage. Instead, the union in the smaller country finds always profitable to set a low wage assuring an employment compensation from the access into the larger market. This a notable difference respect to symmetric models of intra-industry trade: when market sizes are asymmetric, autarky may arise in equilibrium only in one country.

intermediate range ( $.311 < t < .354$ ) equilibrium in pure strategies is not existent; 3) when trade costs are sufficiently low ( $0 < t < .163$ ), the intra-industry trade equilibrium Pareto-dominates the collusive outcome: unions jointly get a higher level of utility allowing for international trade. For higher levels of trade costs ( $.163 \leq t \leq .311$ ), the union game presents the characteristics of a classical Prisoners' Dilemma where the collusive outcome Pareto-dominates the Nash equilibrium. Thus, there are incentives for unions to collude internationally.

Naylor (2000) extends the analysis of Naylor (1998, 1999). This model differs from the previous in that the home country is unionized, and the domestic monopoly union takes the foreign wage as given when setting its own wage. It is assumed that the wage rate in the home country is higher than the wage paid abroad. Labor is the unique factor of production with the usual assumption of constant marginal productivity. The model is a two-stage game, solved in the usual backward fashion. In the first stage, the domestic union set wages maximizing the following utility function

$$U_i = (w_i - \bar{w})^\theta l_i$$

where  $l_i = x_{ii}$  in case of no trade or one-way trade, and  $l_i = x_{ii} + x_{ij}$  in case of two-way trade, deciding among the high/low-wage strategies. In the second stage, differently from Naylor (1998, 1999), firms compete according to a conjectural variation model in the product market. The degree of market substitutability among goods is captured by the parameter  $\gamma$  in equation (13), whose range in this model is  $\gamma \in [-1, 1]$ : if  $\gamma = -1$ , the goods are complements. Depending on the trade cost level, no trade, one-way trade or two-way trade occurs in equilibrium. In the presence of high trade costs, neither the domestic nor the foreign firm undertake international trade. If trade costs decrease, one-way trade take place. This is because the foreign firm pays lower wages, and if trade costs are symmetric, exports are profitable only for the foreign firm. In a situation where trade costs are so high such that only one-way trade occurs, a decrease in trade costs leads the domestic union to reduce wage demands if goods are substitutes because of increasing international competition, while wages are increasing if goods are complements. Two-way trade takes place if trade costs further decrease. The key result is that now the domestic union increases wage demands independently from the degree of market substitutability among traded goods. However, the selection among the high/low-wage strategies does not exclusively depend on the trade regime. Although the strategic wage rate's choice depends on trade costs levels, it turns out these costs are affected by the degree of product market competition between firms, the level of product differentiation, the reservation wage and the weight assigned to the wage in the union preference.

To sum up, Naylor's works show that a marginal decrease in trade costs can increase wages even in those cases where reciprocal trade was already occurring before the decrease in trade costs. Thus, in Naylor's models the market expansion effect of increasing integration dominates the market discipline effect. However, wages under autarky are always higher than with reciprocal trade. High trade costs induce unions to choose a high-wage strategy, and for certain ranges, only one-way trade occurs. If trade costs fall below a critical threshold, unions switch their wage strategy towards a low-wage profile, and a further marginal decline in trade costs will increase wage rates.

Bastos and al. (2009), using an international duopoly model with only one country unionized, investigate the effects of the process of trade liberalization on collective bargaining outcomes when workers are represented by open shop unions. Product markets are supposed to be segmented, and union density in this model is exogenously given. The authors find that, when the union's density degree is at intermediate levels, higher wages may be negotiated in case of trade liberalization, even if no trade occurs in equilibrium. The reason for this result is that, under certain conditions, the prospects of imports from a foreign country in case of bargaining breakdown with unions will affect the firms' conflict payoff. Therefore, the "import threat" due to international competition improves the union position during negotiations and weakens the position of the domestic firm. Hence, the

firm will accept higher union wage claims in the presence of strong international competition. Moreover, they are able to show that union wages might be higher with free trade than in autarky. An extension of Naylor's (1998, 1999) analysis is represented by the work of Gürtzgen (2002). The framework is different: in her international unionized duopoly model with differentiated products, market competition takes place à la Bertrand. The author studies national labor markets interdependencies and the consequences of trade liberalization for union wages. Her analysis suggests that national wages are expected to be strategic complements (substitutes) if products are ordinary substitutes (complements). The main results are as follows. Bilateral trade liberalization always leads unions to set higher wages, increasing their utilities regardless of the nature of product rivalry: this result substantially confirms Naylor's findings. As regards unilateral liberalization, whereas foreign tariff reductions always leads to higher union wages and utilities, the impact on wages and union utility of a decrease in the domestic tariff depends on the nature of product rivalry. Scope for unions to adopt the collusive behavior within the context of a duopoly international trade game and conditions for collusive behavior to be supported as equilibrium of an infinitely repeated game framework are deeply analyzed in the works of Straume (2002) and Strozzi (2007, 2008). Both works are constructed upon the basic analytical framework of Naylor (1999) considering a two-stage game, two symmetric countries duopoly model with reciprocal dumping. Monopoly unions are first movers and in the first stage of the game set wages, while firms determine their production taking wages as given. While Straume (2002) investigates the case of perfect substitute goods, Strozzi (2007, 2008) encompasses these works introducing into the analysis a degree of complementary/substitutability between products. Depending on the high-low union wage strategy, different trade regimes are possible. Additionally, Strozzi (2007) considers two alternative unions' strategies in case of deviation from transnational collusion: a deviation strategy where the chosen wage is such that still allows for intra-industry trade (mild deviation); and a wage strategy such that the selected wage is so low as to induce the exit of the foreign firm from the domestic market (harsh deviation). A general result is that unions select the low-wage strategy when trade costs are relatively low while they choose the high-wage strategy when these are sufficiently high. In a repeated framework, unions are supposed to play a "trigger strategy", namely a strategy characterized by the Nash reversion to the competitive equilibrium whenever there is a deviation from the collusive wage-setting, although this is not the optimal form of punishment. The collusive agreement between unions is sustainable 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. The discounted factor is identical for both unions. The trigger strategy constitutes a sub-game perfect equilibrium in the infinitely repeated game when the following condition is satisfied

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

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, which happens if

$$\delta \geq \frac{U^D - U^C}{U^D - U^P} \quad (19)$$

The choice of the optimal collusive wage strategy depends on trade barriers and the possibility of firm collusion: in a repeated game framework, also firms have incentives to reach a collusive agreement assuring autarky. Using (12) and (13) (with  $a = b = s_i = s_j = 1$ ), and substituting the Cournot quantities obtained from profit maximization into (14) (with  $\bar{w} = 0$ ), the equilibrium wage in the union game is derived

$$w_{IT} = \frac{4 - 2\gamma - 2t + \gamma t}{2(4 - \gamma)} \quad (20)$$

with  $\partial w_{IT} / \partial t < 0$ , since  $\gamma \in (0, 1]$ . Further substitution of (20) into the union utility function yields

$$U_{IT} = \frac{(2 - \gamma)(2 - t)^2}{(2 + \gamma)(4 - \gamma)^2} \quad (21)$$

when both unions adopt a low-wage strategy allowing for intra-industry trade. Instead, if unions choose a high-wage strategy inducing only domestic production, it is obtained that in equilibrium

$$w_{Au} = \frac{1}{2} \text{ and } U_{Au} = \frac{1}{8}. \quad (22)$$

If union  $j$  plays the low-wage strategy, union  $i$  may respond playing either the low-wage strategy, allowing for intra-industry trade, or the high-wage strategy, which will end with one-way trade. Union  $i$  will select the low-wage strategy as long as  $U_{iL}(w_{jL}) > U_{iH}(w_{jL})$ . Instead, if union  $j$  chooses a high-wage strategy, union  $i$  may select either the low-wage strategy, which leads to one-way trade, or the high-wage strategy, inducing autarky. In this case, union  $i$  plays the high-wage strategy in response to the rival union high-wage strategy as long as  $U_{iH}(w_{jH}) > U_{iL}(w_{jH})$ . This leads to calculate the critical thresholds values of trade costs in determining the union strategy. Each union selects the low-wage strategy if  $t \leq 8(2 - \gamma)[(1 - \sqrt{2})/(\gamma^2 - 6\gamma + 4\sqrt{2}\gamma - 8\sqrt{2})]$ : evaluated at  $\gamma = 1$  (perfect substitutes) gives  $t \leq .311$ , the result obtained in Naylor (1999). Instead, a union chooses a high-wage strategy if  $t > 2 - 1/4(\gamma + \gamma^2 + \sqrt{32 - 12\gamma^2 + \gamma^4})$ : evaluated at  $\gamma = 1$  gives  $t \geq .354$ , the result obtained in Naylor (1999).

In case of firms' collusion, when unions fix the collusive wage and play a low-wage strategy, the wage rate and the utility level are given by

$$w_{IT,FC}^C = \frac{4t\gamma - 8\gamma - 8t + 16 - (2 + \gamma)\sqrt{2(4 + \gamma^2 - 4\gamma - 8t^2)}}{8(2 - \gamma)} \quad (23)$$

$$U_{IT,FC}^C = \frac{\sqrt{2(4 + \gamma^2 - 4\gamma - 8t^2)}}{32} \frac{4t\gamma - 8\gamma - 8t + 16 - (2 + \gamma)\sqrt{2(4 + \gamma^2 - 4\gamma - 8t^2)}}{(2 - \gamma)^2} \quad (24)$$

in the range  $0 < t \leq 1/74(4 + 3\sqrt{10})$ , and

$$w_{IT}^C = \frac{1}{2} - \frac{1}{4}t \quad (25)$$

$$U_{IT}^C = \frac{(2 - t)^2}{8(2 + \gamma)} \quad (26)$$

in the range  $1/74(4 + 3\sqrt{10}) < t \leq 2 - \sqrt{2 + \gamma}$ . In the first range, the wage level depend on trade costs and the degree of product differentiation. Strozzi shows that a reduction in  $t$  increases the

wage rate when traded goods are relatively well differentiated, while it decreases it when traded products are similar and trade costs relatively high. The reason for this result is due to the fact that a decrease in  $t$  has two effects on firm profits working in opposite directions: a negative, indirect effect due to a reduction in prices, and a positive, direct effect due to a reduction in costs. Instead, in the second range  $\partial w_{III}^C / \partial t < 0$ : a reduction in  $t$  unambiguously raises the collusive wage. Conversely, for  $t > 2 - \sqrt{2 + \gamma}$ , unions play the high-wage strategy. Hence, firms are induced to produce only for the domestic market: the autarky regime arises. These findings are obtained for the case of perfect substitute goods also in Straume (2002). However, in the presence of intra-industry trade with firms' incentives to collude, collusion unambiguously Pareto-dominates separate wage setting from the unions' viewpoint only when traded products are intermediate or high substitutes. A number of results arise from the analysis. First, the presence of union collusion across borders makes intra-industry trade more likely when traded goods are well differentiated. This could be seen differentiating the limit of trade costs, which yields  $d(2 - \sqrt{2 + \gamma})/d\gamma < 0$ : that is, the range of trade costs assuring intra-industry trade under union collusion is wider with differentiated goods. This occurs because the lower is the degree of substitutability, the lower in each country is the responsiveness of consumer demand to the relative prices of traded goods. The intuition is that, due to the presence of trade costs, foreign market penetration is rather more difficult when traded products are similar than when they are relatively well differentiated. Second, considering the two unions' deviation strategies from the transnational collusive agreement, Strozzi (2007) shows that in the presence of intra-industry trade between countries, a cheating union always prefers to fix a wage level which prevents exports from the foreign firm. The only exception is when traded goods are similar and international product markets not relatively well integrated: in such a case, the optimal deviation strategy is to set a wage rate allowing intra-industry trade. This is so because the sensitivity of consumer demand to relative prices is rather low when traded products are differentiated enough: the deviating union finds more advantageous to set a relatively low wage rate and completely monopolize the domestic market. At the same time, when traded goods are close substitutes and in the presence of relatively high trade costs, a cheating union prefers to set a relatively high wage, inducing intra-industry trade: trade cost levels plays an increasing role in consumer demand when this is more responsive to relative prices. Third, making use of the union payoffs under different strategies and (19), it is shown that, in the presence of intra-industry trade, the sustainability of collusion among unions depends both on the degrees of international product market integration and substitutability between traded goods. If trade barriers are relatively low, collusion is more difficult to be sustained the more integrated are product markets and the less similar are traded products: a reduction in  $t$  makes deviation an increasingly attractive option for unions. This is because economic integration increases the short-run gains from exports while the long-run punishment is not sufficiently harsh to avoid deviation. Moreover, for lower degrees of product differentiation a deviation is comparatively more profitable from the unions' point of view: the responsiveness of consumer demand to relative prices is smaller when product differentiation degree is relatively low. This implies that only a small reduction in wages is needed to assure a monopoly position in the domestic market. In addition, for relatively low degrees of product differentiation, the difference between union welfare under collusion and Nash reversion is comparatively smaller than in the case of perfect substitutes. Fourth, in the presence of intra-industry trade, trade liberalization does not affect the sustainability of union collusion when traded goods are sufficiently similar and trade costs relatively high: in this case collusion is easier the less similar are traded goods. The rationale resides in the fact that product differentiation reduces unions' welfare gains by defecting the collusive agreement: since it is difficult for a single firm to gain the rivals' market share in the presence of sufficiently differentiated traded products, deviation is not beneficial from the single union's point of view. Summarizing, the impact of international product market integration on unions' willingness to adopt collusive behavior depends both on the degree of product market integration (measured by the

trade cost level) and the relative substitutability among traded products. In particular, if countries are symmetric and trade cost levels are low enough, an increase in international product market integration makes transnational collusion among unions more difficult. At the same time, collusion in wage rates is easier when traded goods are similar.

The effects of product market integration on wage bargaining institutions is the subject of Santoni (2009). The work starts with an empirical analysis where it is found a negative relation between increasing market integration (measured by reduction in trade costs) and the level of bargaining. Then, the author constructs a theoretical one-country model to investigate how import competition affects the degree of centralization (and, therefore, the degree of unions' cooperation and firms' cooperation) in wage negotiations at the industry level. This work mainly differs from those of Driffill and van der Ploeg (1993, 1995) in the fact that the degree of bargaining centralization is endogenously determined. Product market is characterized by an unionized Cournot triopoly with linear demand functions and constant marginal costs, where two unionized domestic firms compete with a non-unionized foreign firm. The structure of the model is a three-stage game. In the first stage, for a given level of trade costs, the two unions and firms decide if bargaining should be conducted at decentralized/ centralized level, coordinating their activities; in case of coordination, both unions and firms incur a fix transaction cost. In the second stage, given the bargaining institution, rent maximizing unions and firms negotiate over wages. The asymmetric Nash bargaining solution is adopted, where the bargaining power is assumed to be symmetric across unions and firms, but different between unions and firms. In the last stage of the game, given the negotiated wages, domestic firms engage in product competition in the domestic market with the foreign firm.

The initial point of the analysis is a one-way trade for different degrees of product differentiation. In the case of substitute goods, two wage bargaining regimes arise as equilibrium: 1) full decentralization, that is, each union-firm pair bargains over wages separately; and 2) union centralization, that is, an industry-wide union negotiates the wage rate with the two firms. The bargaining regime arising in equilibrium depends on the tradeoff between unions' utility gains from centralization (which in turn is related to the relative union strength in bargaining, the degree of product substitutability and the generated domestic oligopoly rents), and the fixed costs of coordinating bargaining activities. Product market integration will make full decentralization a more likely outcome. This is so because lower domestic oligopoly rents cause to be less credible the commitment by domestic unions to higher wages deriving from the internalization of employment externalities: bargaining centralization is too costly in terms of employment losses. As regards firms, their preference is toward full decentralization. The reverse holds in case of complement goods: unions prefer a separate wage bargaining while firms prefer to centralize it. Once again, two wage bargaining regimes arises in equilibrium: 1) full centralization, that is, an industry-wide union negotiates over wages with an employers' association; and 2) firm centralization, that is, an employers' association bargains over wages with the two decentralized unions. In the presence of complement goods, increasing integration implies not only import penetration, but also increasing market rents for domestic firms. A similar situation arises in case of two-way trade in homogeneous goods: union centralization increases wages as well as market rents. In conclusion, product market integration has not a univocal effect on the degree of centralization at which negotiations will take place at the industry level: the market structure and the degree of product differentiation play an important role in determining the bargaining regime in equilibrium.

### **3.2 Labor unions and trade liberalization: integration of markets**

Another way to model trade liberalization is the method used by Huizinga (1993), Sørensen (1993), and Kikuchi and Amegashie (2003). In these models, economic integration is a discrete process with countries passing from autarky to complete product market integration.

In Huizinga (1993) and Sørensen (1993), two distinct markets consisting of single union-firm bargaining units merge into a fully integrated product market for the homogeneous goods with two bargaining units. Both models assume linearity in demand and production functions, with labor the only productive factor, and the absence of transportation or trade costs to sell the goods in the market. Another common feature is the structure of the model. This is a two-stage game solved by backward induction: wages are firstly fixed, and subsequently firms, taking wage rates as given, decide their production levels. Pre-integration wages are determined according to

$$w_i = \arg \max_{w_i} \Pi_i^{1-\alpha} U_i^\alpha \quad (27)$$

with  $i = 1, 2$ , where  $\Pi_i = (p_i - w_i)x_i$  is the firm profit function,  $x_i$  is labor,  $p_i(x_i) = a - bx_i$  is the price of the goods before integration,  $U_i$  is the union utility, and  $\alpha$  is the union's bargaining power. While Huizinga (1993) uses a union utility function as in (14) assuming monopoly unions ( $x_j = 0$  because each firm produces only for its domestic market before integration), Sørensen (1993) assuming a right-to-manage model uses an expected-utility function of this form

$$U_i = \frac{x_i}{l} w_i + \frac{l - x_i}{l} - 1$$

where  $l$  is the total labor force in the country,  $x_i$  are unionized workers and 1 is the reservation wage. After integration, the two markets merge. As a consequence, the two firms start competing in a Cournot fashion in the product market. The price in the integrated market becomes  $p(q) = a - bq$ , with  $q = (x_1 + x_2)$ ; firm profits now are  $\Pi_i = (p(q) - w_i)x_i$ . In the first stage, unions maximize their utility function subject to the new labor demand schedule.

Despite the differences between the two models, the conclusions are analogous: product market integration leads to a market size's enlargement, and in an increase in the number of the firms operating in the market, intensifying competition. This in turns implies a drop in prices and wage levels. Moreover, Huizinga (1993) gets that the wage reduction is more than offset by the increase in employment, so that net union utility increases. Thus, international integration is welfare enhancing from the unions' point of view.

Kikuchi and Amegashie (2003) focus on trade liberalization effects when the two economies are asymmetric. They assume that, in one country, there are few firms than in the other. In each country, an industry-wide union sets wages maximizing rents; firms choose employment. Product market competition is à la Cournot. The authors show that, in the absence of international trade, wages in the two countries do not depend on the number of firms, but prices in the small country are higher because market competition takes place among few firms. When trade liberalization occurs, the two markets become integrated, and all firms compete in the unique market. The effect on wages in the small country is that now their level is lower than in the large country: lower employment makes the union in the small country more responsive to competition disadvantages, reducing wages more. It follows that, depending on the market size differences among the two countries, it may be that the small country with a previous high price becomes a net exporter after the liberalization.

Nonetheless, these models do not consider any interaction between the two economies before integration occurs.<sup>7</sup> The incentives for international cooperation between labor unions are only briefly sketched: in particular, Huizinga (1993) concisely discusses the effects of "wage

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<sup>7</sup> Munch and Sørensen (2000) and Munch and Skaksen (2002) use a different approach that tries to encompass the two integration measures above described.

harmonization” by unions after that the two firms begin to compete in the integrated market. Wage harmonization leads unions to set wages at a level equal to that of pre-integration. It follows that union utility increases due to higher employment levels at the higher pre-integration wage rate.

Incentives for labor union cooperation in a context of integrated product markets are deeply explored in Borghijs and Du Caju (1999). The model has a basic set up. There is a single firm with two plants located in different countries. In each country, a labor union is active. The goods are sold in the integrated market without any extra cost of transportation. Unions have to pay some exogenous transaction costs to coordinate wage demands (collusive behavior) at trans-national level. The model is a two-stage game. In the first stage, monopoly unions (workers are fully unionized) maximize their rents over the competitive wage. In the second stage, the firm allocates optimally production, taking as given the wages set by unions. The inverse demand function for the integrated market is linear. Total output is produced by a single firm characterized by a decreasing return to scale technology in the single input, namely labor, given by  $x_i = \sqrt{l_i}$ , with  $i = 1, 2$  denoting the two countries. The firm’s maximization problem is

$$\Pi = [a - b(x_1 + x_2)](x_1 + x_2) - w_1x_1^2 - w_2x_2^2,$$

from which it is obtained  $\partial l_i / \partial w_i < 0$ ,  $\partial l_i / \partial w_j > 0$ , with  $i, j = 1, 2$ ;  $i \neq j$ : that is, the employment level in each plant depends negatively on its own wage and positively on the wage level in the other plant. It follows that if one union demands a wage rate too high, production is shifted to the other plant and then imported without extra costs. Two different wage settings are compared in the first stage: a separate setting, where each union fixes its own wage level competing against the other plant level union; and a collusive setting, where unions choose the common wage rate that maximizes their joint utility. With these assumptions, the union rent in equation (14) becomes

$$U_i = (w_i - \bar{w})(x_i^2) \tag{28}$$

in case of separate setting, and

$$U_c = (w_c - \bar{w} - \tau)(x_1^2 + x_2^2) \tag{29}$$

in case of collusive behavior, where  $\tau$  is the cost of coordinating union activities. From maximization of (28), the F.O.C. in case of separate wage setting yields

$$w_i = \bar{w} + \left( \bar{w} + \frac{bw_j}{b + w_j} \right) \tag{30}$$

while the collusive wage obtained from (29) is

$$w_c = 2(\bar{w} + b + \tau). \tag{31}$$

The main results are as follows. For coordination costs high enough, unions act as competitors on the labor market. Thus, they moderate their wage demands. Below the threshold value of transaction costs

$$\hat{\tau} = \frac{[\bar{w} + 2b - \sqrt{\bar{w}(\bar{w} + 2b)}]^2}{4\sqrt{\bar{w}(\bar{w} + 2b)}} \quad (32)$$

to cooperate turns out to be increasingly attractive for unions, which translates in a raise in wages and utilities. Further decreases in the value of  $\tau$  reduce wages; but the collusive wage is higher than the competitive one. Hence, by means of coordinated wage demands, labor unions can improve their position in negotiations with employers; that is, coordination provides a countervailing power to the impact of economic integration. Intuitively, in open economies high wage claims by individual unions lead to a decrease in competitiveness related to nearest countries. This is considered only when determining their own wage claim, without considering the positive spillover effects on the competitive position of other countries. Therefore, each union tends to moderate wages. In contrast, with a coordinated action, individual trade unions will consider this positive spillover effect of high wage demands on other countries. As a result, the joint initiative by trade unions increases the wage demand compared to decentralization. Hence, staying at the results of the model, incentives for unions to coordinate their activities across boundaries seem to exist also when production activities are spread over different countries.

#### 4. International production in unionized countries

The interaction among unionized labor markets and the activities linked to internationalization of production by firms, principally (but not exclusively) through FDI, has received in recent years an increasing attention.<sup>8</sup> A consistent body of studies in the economic literature explored the effect that unionized labor markets and their bargaining structures, as well as decreasing trade costs and competition from a non-unionized countries have in the strategic decision by MNE to enter in a market via green-field FDI,<sup>9</sup> alternatively or concurrently to export penetration.<sup>10</sup> These works developed either one-country set up (Bughin and Vannini, 1995, 2003; Leahy and Montagna, 2000; Skaksen and Sørensen, 2001; Mukherjee and Suetrong, 2007; Mukherjee, 2008; Mukherjee and

<sup>8</sup> Internationalization of productive activities can take forms diverse from FDI, like international outsourcing. Differently from FDI, international outsourcing does not imply that a firm invests in production capacities overseas. In fact, outsourcing is defined as a shift in control over production by means of contracts with non-affiliate firms, which develop for the contractor either part of existing productive processes or completely new activities. This kind of internationalization of production also has implications for unionized labor. On this issue, see the theoretical contributions of Zhao (2001), Skaksen (2004), Lommerud et al. (2009), Koskela and Stenbacka (2009, 2010), Zhao and Okamura (2010), König and Koskela (2011) and Rocha-Akis and Schöb (2011). See Kramarz (2004, 2008) in French manufacturing industries based on firm-level micro data, and Moreno and Rodriguez (2010) for Spain for the empirical analysis of the direct effects of outsourcing on unionized labor.

<sup>9</sup> The OECD definition of FDI is: “FDI reflects the objective of obtaining a lasting interest by a resident entity in one economy (“direct investor”), in an entity resident in an economy other than that of the investor (“direct investor enterprise”). It can cover the transfer of ownership, but also equity capital, reinvested earnings, other capital (e.g. loans)”. Hence, FDI is a term that covers a wide range of international capital movements, including inter-company loans, mergers& acquisition (M&A), and the establishment or expansion of foreign production sites, namely green-field FDI). This review limits the analysis to the effects of green-field FDI on unionized labor. However, within the process of economic integration, the liberalization of capital markets has involved a higher degree of openness in the market for corporate control. Since the late 1980s and all over the second half of the 1990s, international M&A represented a main form of FDI, especially in advanced economies. The fraction of cross border M&A has constantly increased, reaching in recent times significant figures. According to UNCTAD (2000, 2002, 2004, 2009), the whole value of worldwide cross-border M&A in 1999 added up to more than 80% of world FDI flows, and the share of international M&A was almost 31%. In 2008, despite the international financial crisis, the share of international M&A still represented almost 73% of world FDI inflows and 64.5% of world FDI outflows. The interested readers on the consequences of cross-border M&A on unionized labor markets are referred to the contributions of Straume (2003), Lommerud et al. (2005, 2006, 2008), Mukherjee and Zhao (2007), and Mesa-Sánchez (2010).

<sup>10</sup> Aloi et al. (2009) and Boulhol (2009) analyze in two-country models the effects of capital flows on unionized labor market using a broader concept of capital market integration.

Marjit, 2009), or two-country models; these are characterized either by an international oligopoly (Zhao 1995, 1998; Lommerud et al., 2003; Naylor and Santoni, 2003; Glass and Saggi, 2005; Ishida and Matsushima 2005, 2009) or the presence of a mass of monopolistically competitive firms in the product market (Eckel and Egger, 2009). Nonetheless, these models have some common features. Because of space limitations, not all of them are explored in depth, the choice of which is based solely on a decision to focus on their results. The framework is either a two or a three-stage game where:

- 1) at the first stage, the firm chooses whether to undertake FDI (a production facilities located in a host country), or to export their goods; or, alternatively, whether to invest in a foreign country;
- 2) depending on the hypothesis related to the scope of the bargaining, in the subsequent stages wages and employment are determined. In case of efficient bargaining, in the second and last stage of the game firms and unions simultaneously decide wage rates and employment; with a right-to-manage approach, in the second stage firms and unions bargain only over wages and then firms determine autonomously their production (and hence employment) levels.

Respect to models analyzing international trade, the bargaining approach in the wage determination is widely used in this literature, focusing on national wage bargaining rather than on the strategic interactions among unions in labor markets. The resulting wage derives from the relative bargaining power by national unions and their preferences over wage and employment. A direct consequence is that the cited contributions consider neither international labor market rivalry nor the possibility of transnational union cooperation. Union coordination may occur only at national level.

Bughin and Vannini (1995) and Zhao (1995) are pioneering works on the effects that unionization has on MNE decisions related to their production activities. Bughin and Vannini (1995) examine the strategic investment by a MNE in a host country in the presence of unemployment generated by union' bargaining power in wage negotiations. This is so because aggregate labor supply is exogenous and constant. Workers' mobility among firms in the relevant sector characterizes the labor market. This implies that also the competitive wage in the host country, which represents the "threat point" during the bargaining process, is endogenously determined. It is assumed that two firms, a local firm and a MNE, compete à la Cournot in the product market for homogeneous goods. The MNE chooses how to serve the relevant market: via export or building up a plant in the host country paying some fixed costs. Then, wage negotiations occur. Finally, production outcomes are realized. The model is solved in the usual backward fashion. If the MNE serves the host country market through exports, the union takes its wage rate as exogenous during the negotiation. In case of FDI, the authors make a distinction among two sub-cases. With full unionization, the local firm and the MNE are both unionized; with partial unionization, only the local producer is unionized while the MNE pays the competitive wage. In case of partial unionization, the labor demand of the MNE influences the competitive wage in the host country and, consequently, also the union threat point during wage negotiations is affected. Given this framework, the authors show that FDI lowers the host country's welfare. Unionized workers are indifferent between a MNE producing in the foreign country and exporting the goods to the host country or producing in the host country and being unionized. With an unionized MNE, host country's unemployment is unaffected. However, if the MNE produces locally and is not unionized, the host country's labor demand increases, unemployment decreases and the competitive wages paid by the MNE will reduce. As a consequence, the threat point of the union during negotiations is lowered. While full unionization deters the MNE in undertaking FDI, partial unionization boosts the incentive for FDI since union power in the rival's firm creates unemployment, and this lowers the competitive wage for the MNE, creating a cost advantage at the expense of the local producer.

Zhao (1995) investigates how unionization of labor markets may affect the strategic choice by firms concerning the start of international business. This author constructs a partial equilibrium model of intra-industry cross-hauling (that is, reciprocal) FDI with unionized duopoly and integrated product

markets. The model presents a two-stage game structure: in the first, firms choose independently whether they want to invest abroad; in the second, firms and national labor unions negotiate for wages and employment through an efficient Nash bargaining. The production function shows constant returns to scale, such that employment and production are exactly the same. In the two countries, the same technology is available. There are zero transportation costs across them. There might be trade, but this is not of intra-industry type since products are sold in one international integrated market. In the benchmark case, involving unionized labor markets without FDI, the profit for each firm equals  $\Pi = (p - w)q$ , with  $q = x, y$  the two homogeneous goods and  $p = p(x + y)$  the inverse world demand function, with  $p' < 0$ . Union utility is given by the following Stone-Geary function

$$U(w, q) = (w - \bar{w})^\theta q^\gamma$$

representing a more general expression of (14).  $\bar{w}$  is the reservation wage (equal across countries),  $(w - \bar{w})$  is the excess wage;  $\theta$  and  $\gamma$  are the elasticity of union utility to the rent over the reservation wage and employment, respectively. The union is wage (employment) oriented if  $\theta > \gamma$  ( $\theta < \gamma$ ), neutrally oriented when  $\theta = \gamma$ . Assuming that in case of disagreement both parties' fallback positions equal to zero, the generalized Nash product in each country is

$$G(w, q) = [(w - \bar{w})^\theta q^\gamma]^\alpha [(p - w)q]^{1-\alpha} \quad (33)$$

where  $\alpha \geq 0$  is the relative bargaining power of the union. This game is solved by choosing  $w$  and  $q$  such that  $G(\cdot)$  is maximized. It is obtained (imposing symmetry in F.O.C.)

$$w = gp + (1 - g)\bar{w} \quad (34)$$

$$w = kp + (1 - k)qp' \quad (35)$$

where  $g = \alpha\theta/(\alpha\theta + 1 - \alpha) \geq 0$ ,  $k = \alpha\gamma/(\alpha\gamma + 1 - \alpha) \leq 1$ , and  $p$  is the relevant demand, namely the residual demand for each country. For example, if  $x$  is home production, then  $p = p(x + \bar{y})$ , where  $\bar{y}$  is the production level from bargaining in the foreign country. Total differentiation of the profit function and union utility leads to the contract curve for each country

$$\frac{\gamma}{\theta}(w - \bar{w}) = w - p - p'q \quad (36)$$

Differentiation of (36) gives the slope of the contract curve

$$\frac{dw}{dq} = \frac{2p' + p''q}{1 - \gamma/\theta} > (<) 0 \quad \text{if } \theta < (>) \gamma$$

Conditions (34) and (36) determine the equilibrium wage. If the union is employment (wage) oriented, the contract curve is positively (negatively) sloped, and the equilibrium will be with low (high) wages and high (low) employment levels. Except for the cases that the union is neither with bargaining power ( $\alpha = 0$ ) nor interested in wage rents ( $\theta = 0$ ), the wage outcome lies always above the reservation wage and decreases firm profits. Thus, unionized labor increases the wage

rate. It follows that firms have incentives to undertake FDI to reduce union bargaining power. However, also unions could gain because of increased employment opportunities from FDI.

In the case of reciprocal FDI, profits equal to  $\Pi_i = (p - w)x_i$  for home production and  $\Pi_i^* = (p - w^*)y_i$  for foreign production, with  $i = 1, 2$  and  $x = x_1 + x_2$ ,  $y = y_1 + y_2$  the sum of the output of firms 1 and 2 in the two countries. The firms participate with headquarters in negotiations, which occur simultaneously in the two countries. This situation could be exemplified by the presence of an agent in each country representing the total interest of the firm during the bargaining. It is also assumed that the agents of the same firm cannot communicate between them. Hence, the Nash product in the home country is

$$G(w, x_1, x_2) = U^\alpha (\Pi_1 + \Pi_1^* - \bar{\Pi}_1^*)^\beta (\Pi_2 + \Pi_2^* - \bar{\Pi}_2^*)^{1-\alpha-\beta}, \quad (37)$$

where  $\alpha$ ,  $\beta$ ,  $1 - \alpha - \beta$  are the bargaining power of the home union, home firm and foreign firm, respectively;  $\Pi_1$ ,  $\Pi_2$ ,  $\Pi_1^*$  and  $\Pi_2^*$  are the branch profits,  $U$  is the union utility,  $\bar{\Pi}_1^* = [\bar{p}(y_1 + y_2) - w^*]y_1$  and  $\bar{\Pi}_2^* = [\bar{p}(y_1 + y_2) - w^*]y_2$  are the foreign branch profits when the bargaining at home fails. In this case, production takes place only in the foreign country and eventually it is exported towards the home country. Therefore, the world price is  $\bar{p}(y_1 + y_2)$ . Similarly, the Nash product in the foreign country is

$$G(w^*, y_1, y_2) = (U^*)^\alpha (\Pi_2 + \Pi_2^* - \bar{\Pi}_2)^\beta (\Pi_1 + \Pi_1^* - \bar{\Pi}_1)^{1-\alpha-\beta}, \quad (38)$$

where  $\bar{\Pi}_1 = [\bar{p}(x_1 + x_2) - w]x_1$  and  $\bar{\Pi}_2 = [\bar{p}(x_1 + x_2) - w]x_2$  are the home branch profits when the bargaining in foreign fails: in this case, the MNE can produce only at home during strikes, and eventually export production towards the foreign country. The world price now is  $\bar{p}(x_1 + x_2)$ . This implies that, in the bargaining process, firms increased their outside option, improving their position face unions and lowering the negotiated wage rate. In fact, taking the symmetric solution in first order conditions, maximization of (37) and (38) gives

$$w = g(2p - \bar{p}) + (1 - g)\bar{w} \quad (39)$$

$$w = k(2p - \bar{p}) + (1 - k)(p + (x + y)p') \quad (40)$$

Now, since  $p < \bar{p}$  (because of the reduction in world output in case of a failure in bargaining in one country), it follows that  $2p - \bar{p} < p$ . The contract curve for each country is

$$\frac{\gamma}{\theta}(w - \bar{w}) = w - p - p'(x + y), \quad (41)$$

and its slope is positive (negative) if  $\theta < (>) \gamma$ . Thus, the negotiated wage in the case of reciprocal FDI is lower with respect to the wage when firms are not MNE (since  $\bar{p}' > p'$ ). However, reciprocal FDI decreases the wage in both countries with respect to the benchmark case, but the employment in equilibrium increases (decreases) depending whether the union is wage (employment) oriented.

Analyzing the asymmetric case (only one firm invests overseas while the rival does not), the author shows that this is the preferred situation for the investing firm. Profits are even higher with respect to the case of reciprocal FDI. However, the non-FDI firm loses market shares in its own country, experiencing a decrease in profits. Thus, both firms have a dominant strategy in investing abroad. Under the symmetry assumption, the Nash equilibrium of this non-cooperative game is unique: Invest-Invest for both firms. Cross-hauling FDI arises in equilibrium. As regard welfare, in the presence of wage oriented unions, employment increases in case of reciprocal FDI, implying higher welfare levels. Instead, with employment oriented unions both employment and welfare decrease. Therefore, from a policy point of view, whether FDI is welfare enhancing depends on the union preferences. Nevertheless, wages turn out to be always lower in the presence of FDI than without investment.

Instead, Zhao (1998) constructs a general equilibrium model analyzing the impact of FDI on the determination of wages and employment in the presence of unions. Applying a Nash bargaining process to model labor-management negotiations at the industry level similar to Zhao (1995), the author shows that FDI depresses the negotiated wage in the unionized sector independently of whether or not the union is wage or employment oriented. Wages decrease because of two effects. First, there is the threat point effect: that is, in case of a strike, the investing firm can produce abroad. As a consequence, firms' position during the bargaining process is stronger and the negotiating wages reduced. Second, the two firms jointly negotiate with the industry union in one round, internalizing the external effect of changes in wages and quantities levels on each other; this reduces wages (i.e., the collusive effect). He also finds that if the union is employment oriented or if it equally cares about employment and wages, FDI reduces union employment and the competitive wage in the non unionized sector. However, if labor-management negotiations are firm specific, but the union remains industry-wide, then FDI increases the employment alternatives of the union at the same time as it benefits the MNE. The threat point for the union in case of a strike increases because now the union may extract part of the rents from the non-striking firm. The threat point effect of the firms is unaffected; nonetheless, with firms bargaining separately, the collusive effect disappears. Both effects together increase wages. Finally, if union organization is also shifted to firm-level, the consequence is that the union's threat point during the bargaining process lowers. Firms' situation remains unaltered, and this will reduce the negotiated wage rate. Finally, the author discusses the case of the international union cooperation: the intuition is that, if cooperation occurs, the unions' relative bargaining power will increase since their outside options will improve.

The issue of intra-industry FDI investigated by Zhao (1995) represents also the subject of Naylor and Santoni (2003). The authors build up a three-stage game model where in the first stage firms invest abroad only if they are willing to pay a fixed cost; otherwise they can only sell in their domestic market. Since Naylor and Santoni (2003) focuses their study on the market for services (involving production *in loco*), the possibility to serve a foreign market through exports is ruled out by assumption. Product markets are national (segmented) rather than global (integrated). Wage bargaining (like in (27)) with decentralized unions takes place under a right-to-manage model, and a degree of products' substitutability (see (13)) is present. Competition in the product market is of the Cournot type. It is found that the main driving force for reciprocal FDI is not to weaken unions' bargaining positions but the capture of foreign market shares. Nonetheless, a higher union strength in a potential host economy makes less likely the possibility that FDI will be undertaken. In fact, the symmetric bargained wage in equilibrium within a country is

$$w_i = \bar{w} + \frac{\alpha(2 - \gamma)(a - \bar{w})}{(4 - \alpha\gamma)} \quad (42)$$

with  $i = 1, 2$  denoting the two countries. From (42), it is directly derived that  $\partial w_i / \partial \alpha > 0$ : an increase in the union bargaining power translates in higher wages. This in turns implies that firm profits in the potential host country, given by

$$\Pi_{ij} = \frac{2(2 - \alpha)(a - \bar{w})}{(2 + \gamma)(4 - \alpha\gamma)}, \quad i, j = 1, 2; i \neq j \quad (43)$$

will be lower as long as the union bargaining power increases ( $\partial \Pi_{ij} / \partial \alpha < 0$ ). With the additional assumption of symmetry between countries, the authors are also able to show that, as long as the product substitutability increases, the FDI game between firms may assume the characteristics of a Prisoner's Dilemma Game. With low firms' bargaining power and high product substitutability, autarky is more advantageous. Product substitutability intensifies product market competition, decreasing profits; and with lower firms' bargaining power, the negotiated wages are higher, especially in duopoly. Therefore, under these circumstances, firms are more likely to prefer autarky. However, one of the firms may still find gainful to invest abroad if the rival firm does not. The investing firm benefits from sales in the foreign product market and does not suffer competition in the domestic market; that is, each firm has a dominant strategy over FDI. However, this hurts the rival firm. Thus, the classical Prisoner's Dilemma logic applies. If the scale of fixed costs is adequately low, both firms will invest abroad, and reciprocal FDI will arise in equilibrium.

The analysis of the effects of different union organization levels as well as different negotiation levels on the incentives of a MNE in undertaking FDI in a country and the impact on host country's welfare is also a key focus in the work of Leahy and Montagna (2000). The framework, however, is different from Zhao (1995). In Leahy and Montagna (2000), a MNE can invest in the unionized domestic country, where  $n$  symmetric local firms are already active in the product market. The demand function is linear. Labor is the unique factor of production, but the MNE is assumed more productive than local firms. In the first stage, the MNE decides if to locate a production facility in the host country or not. In the second stage, monopoly unions, with a constant bargaining power across firm, chooses the wage rate. The cases of decentralized unions (fixing firm specific wages), as well as one central union (with central or firm specific wages), are considered. In the third stage, firms decide employment (and, hence, output levels), according to the right-to-manage approach. Two sub-cases are analyzed: the MNE has no product market interaction with local firms (i.e., a platform for export FDI); the MNE and local firms compete in quantities either in the host country or in a foreign country. If no product market interaction occurs, the centralized wage is lower than the decentralized wage paid by the MNE because the labor market creates a link between the domestic firms and the MNE. It follows that unions limit the rent appropriation from the MNE to save employment levels in the less efficient domestic firms. Higher productivity levels in the MNE do not always ensure higher centralized wages: a trade off between the wage rate and the employment level is present. Thus, the MNE benefits from industry wide wages. Consequently, the "conventional" claim that a MNE always prefers decentralized wage negotiations is not supported. The welfare level in the host country is higher with the presence of the MNE than without, irrespective of the degree of centralization in negotiations. However, given that decentralized wages are higher than the industry-wide wage, divergences among the host country government and the MNE may arise concerning the bargaining level.

If there is product market interaction, the results change. The centralized wage is higher than the decentralized wage, at least for a large number of firms and low productivity levels. This result contrasts the case of non-market interaction. This is so due to the cooperative behavior by the centralized union which internalizes product market externalities. Concerning host country's welfare, the presence of a MNE lowers domestic welfare independently of the bargaining level. In case of no domestic sales, inward FDI always reduces welfare for  $n > 1$ . Low product market competition and productivity levels make the welfare cost of the MNE entry in the export sector

higher under decentralized bargaining, but for high MNE's productivity levels, the opposite holds true: centralized bargaining is more costly. The MNE extracts profits from the local firms and repatriates these rents to its home country. Nevertheless, the authors show that if the MNE invests, the MNE and the host Government in some cases have a common interest about centralized bargaining. In case of domestic sales, inward FDI ensures welfare gains under the decentralized bargaining, but a conflict of interest among the host country Government and the MNE may arise about centralization. Finally, in case of a centralized union fixing firm specific wages, the MNE's welfare value is positive if firms compete in the host country market while it is negative if firms compete in a foreign product market, with welfare losses lower than decentralized and standard centralized regimes. However, in case of product market interaction, the union exploits the higher MNE's productivity levels and charges a wage level higher than that of the local firms. Summarizing, the MNE prefers centralized bargaining unless in the case of centralized firm specific wages and lower productivity advantages; in case of domestic competition, host country's welfare is expected to decrease because of inward FDI, since the MNE captures rents from local producers.

Bughin and Vannini (2003) extend the study of Leahy and Montagna (2000) concerning the relation between unionization and FDI, and welfare effects in an oligopoly market structure taking into account also an efficient bargaining model in negotiations. A Cournot-Nash duopoly model for homogeneous goods, with labor unique factor of production and constant marginal costs, is analyzed. One firm is domestic, while the other is a MNE. The product demand is linear, and decentralized unions maximize rents taking as given the exogenous foreign wage level in negotiations. The MNE should decide between FDI and exports (no trade costs are considered) as market entry option in the domestic country. These authors compare the welfare effects under the right-to-manage and the efficient bargaining models. The main findings are as follows. The efficient bargaining may be a sufficient condition for inward FDI to improve domestic welfare, provided that union relative bargaining power is not too high to deter the MNE's market entry. Labor costs are not the unique key variable in the MNE choice among export and FDI; profit arbitrage matters, especially under efficient bargaining because of rent sharing with the unions. Finally, conflict of interest among the host country and the MNE may arise as regards the preference over FDI. During the negotiations, unions may support the domestic government in term of favoring FDI; however, this effect is stronger with the right-to-manage model than with efficient bargaining, unless the union strength is too high: in this case, the MNE does not undertake FDI because the rent sharing effect overcomes the typical output expansion effect occurring under efficient bargaining.

The work of Mukherjee and Suetrong (2007) also focuses on the influence that different unionization structures has on the firms' decision to make FDI. Differently from Leahy and Montagna (2000), these authors investigate this issue in a two-country model: the "domestic" country is unionized, while the labor market in the "foreign" country is perfectly competitive. The relevant product market for the homogeneous goods is the foreign one, and firms compete à la Cournot. The unionized domestic firms decide whether to serve the foreign country through exports or to undertake FDI, paying exogenous sunk costs. The number of firms engaging in FDI is endogenously determined. Wages are set either by decentralized firm-level unions, or uniformly by one industry-wide union. The main results are as follows. If all firms export, the centralized wage is always higher than the decentralized wage. The same result holds for a given number of firms undertaking FDI. However, the authors show that incentives for outward FDI are lower with decentralized than with centralized wage negotiations. Thus, when firms actively decide over FDI, if the investing firms' number under centralization is greater than under firm-level wage settings, decentralization may lead to higher wages and union utility than the industry-wide wage setting.

Mukherjee (2008) questions why MNEs often use both export and FDI as means to penetrate foreign markets. In his model, a MNE is located in its domestic country. The factor of production is only labor. Wages in the domestic country are perfectly competitive and exogenous, while in the foreign country wages are endogenously determined by a monopoly labor union which fixes firm specific wage rates. The MNE exports the goods to serve the foreign country, which is the relevant

product market; there are neither tariffs imposed by the foreign country's Government, nor transportation costs. In addition, the MNE can undertake a FDI in the foreign country, paying some fixed costs. In the foreign country, there is a local firm which also pays union wages and competes à la Cournot with the MNE. The timing of the game is as follows. In the first stage, the MNE chooses among FDI, export, or both. In the second stage, the MNE commits to its export level. This represents to a certain extent a long run decision. The author's rationale for this structure resides in the MNE's capacity choice in its domestic plant: the MNE builds production facilities in the home country, and this is a long-term decision. On the other hand, this can be profitable for the MNE because this leads to a first-mover advantage: the MNE can credibly threaten to export a positive quantity. In the third stage, the host country union sets wages before the MNE decides the production quantity in the foreign country. Finally, both firms choose quantities and compete in the foreign product market. Given this game structure, it follows that if wage rates are too high abroad, the MNE will produce at home. Instead, with low wages, the union in the foreign country may be able to attract FDI. Mukherjee shows that the MNE chooses its market entry strategy in relation to the market size. The MNE uses only FDI and does not export in the presence of a small product market. In that case, the union selects lower wage rates than in the domestic country to attract the MNE. For an "intermediate" market size, the MNE chooses to serve the foreign market partially with FDI and exports: the MNE uses FDI and exports as complements. Using the threat of supplying the foreign market at least partly with exports, the MNE induces the foreign union to lower wages. Finally, in a large market, union wages are lower in the domestic country than in the host country. Therefore, the MNE chooses only the export option.

Mukherjee and Marjit (2009) investigate how firm productivity affects the export-FDI decision of a MNE to serve a foreign country when labor is unionized. The model is rather simple: there is only one firm and one union. Both the domestic and the foreign labor markets are unionized. In the first stage, the firm chooses between export and FDI. In the second stage, a rent-maximizing union and the firm bargain over wages. In the third stage, output is realized. The unions' bargaining power, as well as labor productivity, is symmetric among countries. The only difference is in the reservation wage, which is supposed to be higher in the foreign (host) country. The demand in the relevant market, the foreign country, is linear. If the firm chooses to export, it pays a constant per unit transportation costs; if it undertakes FDI, it incurs in sunk costs of building a production facility abroad. The main result is that, with unionized labor markets, there are situations where a firm choosing exports is more productive than foreign investors; this occurs even if the wage rate in the foreign country is higher than in the domestic country. For extremely low and high productivity levels, foreign investors are more productive than exporters, while the opposite holds for intermediate productivity levels. This is so because of the interdependence among trade costs, sunk cost of the investment and the negotiated wage rate, and their effects on output decisions.

The choice among exports and FDI in a context of trade liberalization is the subject investigated in a class of papers pioneered by the work of Lommerud et al. (2003). As in Naylor (1998, 1999), trade liberalization is depicted by a marginal reduction in trade costs when production is exported from one country to another. In their model, there are two countries: the domestic country is unionized, while the foreign country is non-unionized and pays exogenous competitive wages. At the beginning, there is one firm in each country. In the domestic country operates a rent-maximizing monopoly union. The market segmentation's hypothesis applies. The demand for the homogeneous goods is linear. Both firms incur in tariffs when they export. While the foreign firm can only export, the firm in the domestic country may choose among three options. It can stay local, exporting its production. It may undertake a partial FDI in the non-unionized country to serve that market, producing in both countries: in this case, the domestic firm pays some sunk costs to set up a plant abroad. Finally, it can completely relocate in the foreign country, closing domestic plants and exporting production back toward the domestic country. The authors suppose that total relocation is more expensive than the partial. The model is a three-stage game. In the first stage, the domestic firm decides whether to relocate, partially or locally, in the foreign country. In the second stage, the

domestic union set the wage rate. Finally, in the third stage, firms act as Cournot competitors in both markets. Like in Naylor's works, the union wage strategy differs depending on trade cost levels, and for sufficiently low values of these costs, a marginal decrease of trade barriers implies an increase in the wage level. This is so because access to the foreign market is now easier (product market expansion effect) for the domestic firm, and this implies an increase in the domestic labor demand. At the same time, competition in the domestic country becomes more severe: the foreign firm increases exports. Nonetheless, the net effect is positive, and the domestic union responds setting higher wages, capturing part of the oligopoly rents, and thus obtaining a higher utility. However, high domestic wages give a strong incentive for making FDI. This holds both for partial FDI because domestic wages still increase but there are few workers employed in the domestic country; and for complete relocation, because exporting back to the domestic unionized country turns out to be cheaper. It follows that trade liberalization, in combination with strong unions, may induce firms to undertake FDI to success a distributional conflict. With a tariff reduction, the FDI level increases, union rents decrease and the other gains are not sufficient to offset these losses. In addition, profit shifting from domestic owners in the unionized countries to owners in the foreign non-unionized country reduces the overall domestic welfare.

Differently from Lommerud et al. (2003), Glass and Saggi (2005) determine endogenously the equilibrium FDI regime without considering the effects of trade liberalization. In their international oligopoly model, two firms producing homogeneous goods are located in two different countries. Markets are segmented and differ in sizes. The demand function is linear, and each firm may supply the foreign market via FDI or alternatively via exports. Per unit trade costs are supposed sufficiently low such that downstream firms may always export their production. Both firms require one intermediate good that a local upstream monopolist supplier provides. Local suppliers can be interpreted as labor unions. By assumption, one unit of the final good needs one unit of the intermediate. The model is a three-stage game, and the timing is as follows. First, firms in the downstream market decide as regards FDI or exports. In the second stage, the upstream suppliers (unions) fix simultaneously prices (wages); finally, Cournot competition in the downstream market takes place. If markets are of similar sizes, reciprocal FDI arises in equilibrium: to invest is a dominant strategy. This decreases global welfare because the indirect (wages affect the downstream firms' costs, and, therefore, employment levels) competition among the two monopolistic input suppliers is eliminated. This is so because the upstream prices (wages) are set after the downstream firms' decision of producing in both countries. Furthermore, one-way FDI increases the wage rate in both countries. In the FDI host country, wages increase because the demand for labor increases, and the local union may claim a higher wage. However, wages increase also in the domestic country. Falling demand for labor in the domestic country has a negative effect on wages (demand effect); but there is also a strategic effect at work: the foreign labor union's reaction function shifts outward implying an increase in the foreign wage. Domestic wage increases due to wage complementarity, and the strategic effect can dominate the demand effect; that is, in this model, outward FDI acts like a cost-raising strategy.

Ishida and Matsushima (2005) propose a slightly different version of Lommerud et al. (2003). In their duopoly model, two firms are initially located in one unionized country and can export their homogeneous goods to another foreign country, competing à la Cournot in both product markets. Each firm has to pay a per unit transport costs for their export quantities. Two rent maximizing firm specific unions fix wages in the home country, while firms may freely choose quantities. By assumption, only one of the firms has the option to invest abroad. When this firm sets up a new production facility in the foreign country, the new plant is also unionized. Within this framework, the authors argue that, at first glance, the decision to undertake an FDI may increase the competitive position of the investing because of saving in transport costs, while the rival firm without this option may suffer. Counter intuitively, their analysis shows that the profits of the exporting firm can increase if the trade cost levels to the other market are sufficiently high. This is so because, to facilitate its firm to improve the competitive position in the foreign product market,

the union operating in the exporting firm will cut its own wage rate by a sufficient amount to counterbalance the negative effect represented by the elimination of the transportation costs of the international firm. More intense competition can be beneficial for the exporting firm which experiences an increase in its profits because of the rival decision of undertaking FDI. Even more paradoxically, when some fixed costs of setting a new plant abroad are considered, in some cases the more efficient firm ends up with lower profits with respect to the exporting firm.

Instead, Ishida and Matsushima (2009) investigate the welfare and policy implications of outward FDI in an unionized oligopoly. In their duopoly model, two firms are initially located in their domestic country, which is unionized with firm specific monopoly unions. The foreign country pays exogenous perfectly competitive wages. Labor is the sole factor of production with a constant return to scale technology. Markets are segmented, and firms compete à la Cournot therein. If firms export, they incur in trade costs. Firms decide sequentially how to serve the foreign market: the first firm may set up a plant in the foreign country, relocating production; the second firm chooses whether to follow the rival. There are no fix costs to build up a production facility in the foreign country. The authors show that, in the presence of domestic competition, the second FDI always has a negative effect on domestic welfare when the markets' sizes are similar. Most of the time, the asymmetric case with one FDI is socially desirable. This is so because the second union lowers its wage when the first firm invests overseas: the competitive situation for the second firm located in the home country is weakened. The second union is induced to decrease wages to facilitate its firm in remaining in a competitive position in the foreign market. Since wages for the second firm are lower for all workers, it will produce at low costs for the home market, improving its domestic competitive position. Consequently, the first union can not increase the wages for domestic workers as much as it would like. Even if the first firm makes high profits in the foreign country, domestic output would be reduced if home wages increase. This, in turn, lowers employment in the first firm and hence its union utility. Summing up, the first FDI will moderate domestic wages, and the price goes down; consumer surplus increases and this gain offset the unions' utility losses: overall national welfare increases. Nevertheless, if the second firm is also involved in outward FDI, wages rise in the home country. The reason is that, in this situation, both unions extract a higher share of domestic rents from their firms. This reduces output in the home market, prices increase, consumer surplus declines, and domestic welfare decreases. However, Ishida and Matsushima show that the welfare losses of two outward FDI are mainly not the consequence of lower union utility but rather from lower consumer surplus. Unions can benefit under certain conditions from the second FDI since wage rivalry tends to disappear and wage gains may offset employment reduction, increasing union utility.

In spite of the differences in the underlying assumptions and purposes of study, these models, most of the time, achieves this result: when firms may invest in a foreign country, they improve their outside option in the bargaining process. Thus, unions' position in negotiations is put under pressure inducing a moderation in wage claims.<sup>11</sup> Though, the subject of the international union cooperation in this context, mainly in the form of wage coordination, is lacking and not explored.

## **5. The impact of internationalization on labor unions: review of empirical studies**

Up to date, the economic literature presents a large body of empirical works (principally focused on OECD countries) investigating the effects of increasing economic integration on labor markets outcomes in terms of wage and employment levels.<sup>12</sup> However, the consequences of

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<sup>11</sup> The idea that MNE can strategically exploit the spread of productive activities across countries to improve their bargaining positions and avoid the creation of encompassing unions was originally expressed by Horn and Wolinsky (1988) and further developed by Leahy and Pavelin (2004).

<sup>12</sup> Radulescu and Robson (2008), and McGuinness et al. (2010), investigate the inverse causal effect (how unionization and collective bargaining systems affect the firms' internationalization choices in the form of FDI). Using cross-national time-series data from mid '70s to 1997 for 19 OECD countries (among these, 14 European economies: Austria,

internationalization for organized labor have been mainly investigated indirectly.<sup>13</sup> Based on micro-data, few recent papers have analyzed the direct effects on the European labor unions' outcomes.<sup>14</sup> These are the works of Brock and Dobbalaere (2006), Dumont et al. (2006, 2010), Abraham et al. (2009), Boulhol et al. (2011), and Dobbalaere and Mairesse (2011).

Brock and Dobbalaere (2006) investigate the impact of internationalization on the unions' bargaining power in the Belgian manufacturing sectors. The authors' analysis theoretically grounds on an efficient bargaining model with risk neutral unions. They use data from an unbalanced panel of annual company accounts of all Belgian firms for the period 1987-1995, collected by the National Bank of Belgium. The methodology strategy is a two-stage estimation procedure. In the first stage, the authors proceed with the estimation of the unions' bargaining power by regressing the negotiated wage for fifteen sectors. Two approaches are used. In the first one, they get a unique estimate of the union bargaining power for all sectors over all years. In the second approach, they obtain yearly estimates of the union bargaining power for each sector. Then, in the second stage, they regress the estimated union bargaining power on different measures of trade, FDI, technology and a set of control variables. The main results are the following. The authors find little evidence as regards international trade and inward FDI affecting the unions' bargaining power. Instead, there is evidence that technological changes positively influence it. According to these authors, there are several reasons that could explain these findings. One possible explanation is that international economic integration may affect the unions' bargaining power of different skill groups in a different way: some workers become more essential in the production process, and labor costs might be declining because of technological improvements. A second reason may be that other, more direct, channels than the unions' bargaining power affect labor market outcomes, such as the firms and workers' outside options during negotiations.

The paper of Dumont et al. (2006) studies how international trade affected the bargaining power of labor unions in eight sectors of five EU countries (Belgium, France, Germany, Italy and U.K.). These authors also make use of a two-step estimation procedure, based on a rent-sharing theoretical framework. Using company level data, in the first stage they estimate for each country the sector level unions' bargaining power. The authors simultaneously test the bargaining regime and the unions' preferences to determine if it exists a wage-employment tradeoff due to internationalization. In the second stage, they regress the estimated union bargaining power on two groups of variables. The first group reflects the level of international competitiveness, distinguishing among import competition from OECD and Newly Industrialized Countries. The second group considers other potential determinants of the union bargaining power such as the industry concentration and capacity rate, the ratio of R&D expenses for patenting revenues, and the skill ratio. The key findings of their empirical investigation are as follows. In every country, the results show that unions have some bargaining power during negotiations; this is higher in France and Germany, intermediate in Belgium, and lower in Italy and U.K. In almost all sectors and countries, unions and firms seem to bargain according to the labor-hoarding model, with some exception in favor of the

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Belgium, Denmark, Finland, France, Germany, Ireland, Italy, the Netherlands, Norway, Spain, Sweden, Switzerland, and the UK), Radulescu and Robson (2008) find strong evidence that a high level of union density (used as proxy for union bargaining power) reduces the incentives for a MNE in selecting a country as a potential location for FDI. Instead, in case of close substitutes goods and MNE having productivity advantages respect to domestic firms, higher degrees of bargaining coordination moderates the negative impact that a high level of union density may have on the expected inward FDI: a country may be more attractive for FDI due to the reduction of output at the expenses of domestic firms. Making use of a linked employer-employee data set, the empirical investigation of McGuinness et al. (2010) gets similar results for Ireland.

<sup>13</sup> For a general review see Molnar et al. (2007) and references therein. As regards European countries, recent empirical analysis on the indirect effects of internationalization on unionized workers are, i.a., Guadalupe (2007) for U.K., Biscourp and Kramarz (2007) for France, and Martins and Opramolla (2009) for Portugal based on firm-level data. Instead, based on linked employer-employee data, Schank et al. (2007) for Germany, Lundin and Yun (2009) for Sweden, and Du Caju et al. (2011) for Belgium.

<sup>14</sup> Notable empirical contributions investigating the impact of internationalization on labor unions for countries outside the EU are Abowd and Lemieux (1993) for Canada; Bojas and Ramey (1995), and Gaston and Trefler (1995) for U.S.

efficient bargaining (mainly in Germany). Thus, employment enters into the bargaining process. Unions are predominantly wage oriented. These results suggest that a wage-employment tradeoff due to increasing foreign competitiveness exists. The authors find evidence that import competition affects negatively the union bargaining power. The impact is equivalent if imports come from OECD and Newly Industrialized Countries. This, in turns, lowers negotiated wages. However, the estimates suggest that increasing internationalization does not affect unions' preferences over wages.

Abraham et al. (2009) investigate the impact of European and global economic integration on labor and product markets in Belgium, focusing on manufacturing firms. Based on a production function approach with efficient bargaining model and risk-neutral unions, the authors use firm-level data for the period 1996-2004 for a simultaneous estimation of price-cost margins (index of product market power) and union bargaining power, and they investigate the effects of various aspects of globalization such as import penetration, outsourcing and direct investments on them. The analysis proceeds first with an estimate of the average measures of the mark-up and union bargaining power for the whole manufacturing sector. Then, a detailed analysis for each industry follows. The authors find that there is a strong, positive correlation between the union bargaining power and product market power. In other words, unions get higher rents in those sectors with higher mark-ups while the opposite occurs in more competitive industries (international competition diminishes firms' rents). As regards the impact of internationalization, they investigate how import competition from different origins affects the firms' market power and the unions' strength, differentiating among imports from EU-15, imports from 10 new-EU members, imports from OECD countries other than EU-25, and finally imports from countries outside OECD (low-wage countries). The results indicate that lower mark-ups and union bargaining power characterize those sectors with higher import penetration, especially from low-wage countries. However, the bargained wages increase in those industries with imports of intermediate goods from abroad. The rationale is that the firms importing intermediates have to specify their amounts, quality and characteristics in advance to their foreign contractors. Thus, when the negotiations among unions and firms occur, the formers may have hold-up opportunities, increasing their bargaining power.

Dumont et al. (2010) examine the effects of internationalization and technological change on unions' bargaining positions representing different classes of workers, low skilled and high skilled. The theoretical basis for their two-stage empirical analysis is an efficient bargaining model in which two separate unions, one for low skilled and one for high skilled workers, bargain independently with the firm. The authors make use of firm-level data for ten Belgian manufacturing sectors in the period 2000-2008. They first estimate the labor bargaining power and the relative wage preference for the two groups of workers. Then the estimated parameters are regressed on a set of possible explanatory variables to determine both the internationalization and technological change's impacts for each skill group. The main findings are as follows. In the period under consideration, the bargaining power of low-skilled workers deteriorated while that of the high-skilled improved. Concerning the technological aspect, R&D intensity seems to have a positive impact on the bargaining power of low skilled workers. This is the only statistical relevant result. As regards the internationalization aspect, import competition decreased the mark-ups and the bargaining power in those sectors more exposed to international trade, especially from low-wage countries. In addition, offshoring and the presence of foreign subsidiaries had further negative impacts on the bargaining positions of low skilled workers. Instead, the union bargaining power of the high skilled group is unaffected by economic integration. In every sector, both unions are wage oriented, but the internationalization influences it for both types of unions. The results indicate that imports of close substitutes and offshoring of similar skill intensity activities, weaken the unions' wage orientation; the opposite mechanism applies when imports and offshoring of production activities are skill complementary. Thus, the effect of internationalization on labor unions is skill specific. In short, this work suggests that economic integration more than technological change increased skill

premium (wage inequality); and the reason resides in the different impacts of international integration on the unions' bargaining position for the two groups of workers.

Boulhol et al. (2011) explore the pro-competitive effects of trade in product and labor markets in U.K. manufacturing sectors. As Abraham et al. (2009), they base the empirical investigation on a theoretical production function with an efficient bargaining approach. However, they exploit a more general framework as regards the unions' preferences toward risk. The authors use data from two firm-level surveys for 20 industries in the period 1998-2003. They proceed their empirical study with a two-stage estimation strategy. In the first stage, they simultaneously estimate price-cost margins and union bargaining power per sectors, and for three subsets of firms' size and three sub-periods. They find that both decreased along the period considered. In the second stage, they relate the estimated markups and union bargaining power of each industry to trade variables such as the share of imports in the demand for each sector (making a distinction between developed and developing countries), the ratio of exports over total sales, plus other product and labor market variables. The results of the second step show that the imports from developed countries significantly lower the markup and the union bargaining power of those industries exposed to foreign competition. Instead, exports weakly increase the union bargaining power. These findings define that international trade has an impact working in two opposite directions on price-cost margins. However, according to the authors' estimates, the labor market discipline effect (the reduction of the union bargaining power) counterbalanced for one half the product-market discipline effect from imports (the reduction of the mark-ups to marginal costs). Additionally, they find that firms with a smaller size have lower mark-ups, and their workers are in a relatively weak position during negotiations.

Finally, also Dobbalaere and Mairesse's (2011) study grounds on a theoretical production function model with efficient bargaining. These authors estimate price-cost margins and union bargaining power in 38 French manufacturing industries over the period 1978-2001, making use of an unbalanced panel of 10646 firms. The main objective of the paper is the estimation of average price-cost mark-ups and the extent of rent sharing parameters, first for manufacturing as a whole, and then for each industry, looking for across and within industries heterogeneity. As regards the impact of internationalization, the analysis of the single sectors shows that, in those industries facing high import competition, the estimated mark-up and union bargaining power is lower than the median value of the entire manufacturing, while the opposite occurs in the protected sectors.

To sum up, exploiting different data sources and empirical methodologies, these studies seem to indicate that international integration is likely to weaken the unions' bargaining positions, confirming most of the theoretical models' predictions. Surprisingly, despite the actual evidences reported in the introduction, no empirical studies analyzed the effectiveness of cross borders unions' cooperation to counterbalance the impact of internationalization during the negotiation processes.

## **6. Conclusions**

Economic integration has significant consequences for labor markets in Europe. The theoretical literature stresses that product market integration usually lowers the relative bargaining power of labor unions. One reason is that high wage demands cause more substantial job losses in those industries exposed to international competition. In other words, European integration increases the sensibility of labor demand to wages, inducing unions to wage moderation. Moreover, the integration of capital markets in Europe allows firms to locate more easily their activities among different places. Thus, firms may avoid excessive wage demands by shifting production among different plants. This threat of relocation improves the relative bargaining position of firms respect to unions, leading to lower negotiated wages.

By means of internationally coordinated wage claims, unions may improve their position during negotiations with employers. Coordination provides a countervailing power to the impact of product and capital markets integration. With some differences, this seems to be possible in those sectors

characterized by intra-industry trade and the presence of large MNE having production facilities spread over different countries.

Although attractive, transnational wage coordination by European labor unions is far to be implemented. Numerous obstacles prevent it. A first one is that employers' associations oppose negotiations at the EU level, since the construction of a European platform for wage determination would reduce their relative bargaining position. Second, there are substantial differences among EU countries with respect to labor union practices: differences in union density, coverage, the degree of centralization and coordination in bargaining. Besides, there are differences related to the timing of wage bargaining and the labor unions' role in national policy discussions. Such diversities cause international coordination to be expensive because of less flexibility; and coordination implies operational costs associated with meetings, information gathering, and so on. In addition, cooperation is harder to reach as long as the number of the unions involved in the process increases. It may be complicated to sign agreements and organize activities to achieve some common results without considering collateral problems like cultural, traditional and customary diversities between countries, leadership positions, and the pursuit of national interests. Moreover, there exist other structural asymmetries representing obstacles to international wage coordination. There is a large variety of labor market regulations between EU countries, such as minimum wages, unemployment benefits, employment protection legislation, labor taxation, and labor market policy. These asymmetries increased after the 4<sup>th</sup> enlargement towards Central and Eastern European Countries. To agree upon a shared agenda among unions could become difficult; and a common policy may not be optimal for some individual members. This holds true also for blocs of economic integration other than the EU. Asymmetries are present into the Mercado Común del Sur's (MERCOSUR) custom union, which, however, provides for a fund to realize long term projects aiming at the structural convergence among member countries (Argentina, Brazil, Paraguay and Uruguay). Structural differences can be observed in the countries associated to the ASEAN Free Trade Area (Brunei, Indonesia, Malaysia, the Philippines, Singapore, Thailand, Vietnam, Laos, Myanmar and Cambodia), whose aim is to lower gradually to zero most of their import duties among them. The 1994's North America Free Trade Agreement (NAFTA), whose objective was to remove barriers to trade (tariff and non tariff) and investment between Mexico, the U.S. and Canada, exhibits as well striking differences in the labor market regulations, unionization structures and wage levels between the signatory states.

Unions' transnational activities ensuing the economic integration process received attention only in recent times, despite its significance in the analysis of the impact of internationalization on labor markets and their institutions. This survey reported some notable contributions that have helped a better understanding of this phenomenon. Nonetheless, many aspects still have to be fully explored. As mentioned, one subject is the presence of large asymmetries among countries. Another topic is the analysis of labor unions' behavior regarding the international disintegration of productive activities, subsequent to capital market liberalization and according to perceived comparative advantages, in particular by MNE. The theoretical literature focused more on the effects of trade liberalization rather than the internationalization of production on unions' cooperation. However, workers in every regional economic bloc equally perceive the concerns related to the spread of activities across countries. Finally, the prospect of further international labor union cooperation may influence the firms' strategic decision related to international business. This, in turn, may affect both wage and employment's paths; but also the productive structures and the industrial organization of the integrated areas. To relate these issues to the peculiarities of each regional bloc of economic integration needs a focus wider than the present work. This is left for future research.

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Corrigendum to  
“The strategic choice of union-oligopoly bargaining agenda”  
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## 1. Introduction

Bughin (1999) investigates the optimal strategic choice of bargaining scope in labor negotiations for different market structures (duopoly vs. monopoly with threat of potential entry) and different constraints on the choice of bargaining scope: committed bargaining (the incumbent first chooses its bargaining scope; the entrant then is obliged to the same bargaining scope as the incumbent) or flexible bargaining (the entrant can choose its own bargaining scope). The main results of Bughin (1999) are: 1) in a duopoly context with blockaded entry and committed bargaining, oligopoly firms choose to bargain only over wages with firm discretion over employment (Right-to-manage model, RTM) rather than to bargain over both wages and employment (efficient bargaining model, EB), in clear conflict of interest with unions; 2) in a duopoly context with blockaded entry and flexible bargaining, however, in equilibrium both firms choose EB; 3) this result also holds for the case of potential entry; 4) in the case of potential entry with committed bargaining, the incumbent may choose EB over RTM as entry deterrence mechanism for low enough union bargaining power. Bughin uses sub-game perfect Nash equilibrium as equilibrium concept.

Extending Bughin’s framework to a conjectural variation model, this note shows that results 2) and 3) do not hold whatever is the degree of competitiveness of the industry. This is due to an erroneous computation of mixed oligopoly outcomes. The next section and the Appendix derive the correct results and the subsequent implications.

## 2. The model and the results

Following Bughin (1999), entry in an industry is modeled as a variation from a monopoly to a duopoly market structure. Firm 1 is the incumbent, Firm 2 the potential entrant. Each firm produces a homogeneous good, using only labor as input. Production is characterized by a CRS technology such that one unit of labor,  $l$ , is required to produce one unit of output,  $q$ . The demand is given by

$$p = 1 - Q \tag{1}$$

where  $p$  is the market price ( $a$  is normalized to 1) and  $Q = \sum_i q_i = (\sum_i l_i)$ ,  $i = 1, 2$ , is total production. Firm’s profits are given by

$$\Pi_1 = (1 - Q - w_1)l_1 \tag{2}$$

$$\Pi_2 = (1 - Q - w_2)l_2 - G \tag{3}$$

for firm 1 and 2, respectively.  $G$  represents an exogenous fixed cost for the potential entrant.

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Table 1: Unionized monopoly and oligopoly outcomes. For mixed duopoly, the first lower script denotes the agenda selected, while the second indicates the competing firm's agenda.

Monopoly	$q$	$w$	$\Omega$	$\Pi$
RTM	$\frac{(2-\alpha)}{4}$	$\frac{\alpha}{2}$	$\frac{\alpha(2-\alpha)}{8}$	$\left[\frac{(2-\alpha)/4}{4}\right]^2$
EB	$\frac{1}{2}$	$\frac{\alpha}{2}$	$\frac{\alpha}{4}$	$\frac{(1-\alpha)}{4}$
Oligopoly				
RTM - RTM	$\frac{(2-\alpha)(2+\phi)}{(2\phi+4-\alpha)(3+\phi)}$	$\frac{\alpha(1+\phi)}{(2\phi+4-\alpha)}$	$\frac{\alpha(2-\alpha)(1+\phi)(2+\phi)}{(3+\phi)(2\phi+4-\alpha)^2}$	$\frac{(2-\alpha)^2(1+\phi)(2+\phi)^2}{(2\phi+4-\alpha)^2(3+\phi)^2}$
EB - EB	$\frac{1}{(3+\phi)}$	$\frac{\alpha(1+\phi)}{(3+\phi)}$	$\frac{\alpha(1+\phi)}{(3+\phi)^2}$	$\frac{(1-\alpha)(1+\phi)}{(3+\phi)^2}$
EB - RTM	$q_{EB,RTM} = \frac{(2\phi+\alpha+4)}{2(3+\phi)(2+\phi)}$	$w_{EB,RTM} = \frac{\alpha(1+\phi)(2\phi+\alpha+4)}{2(3+\phi)(2+\phi)}$	$\Omega_{EB,RTM} = \frac{\alpha(1+\phi)(2\phi+\alpha+4)^2}{4(3+\phi)^2(2+\phi)^2}$	$\Pi_{EB,RTM} = \frac{(1-\alpha)(1+\phi)(2\phi+\alpha+4)^2}{4(3+\phi)^2(2+\phi)^2}$
	$q_{RTM,EB} = \frac{(2-\alpha)}{2(3+\phi)}$	$w_{RTM,EB} = \frac{\alpha(1+\phi)}{2(2+\phi)}$	$\Omega_{RTM,EB} = \frac{\alpha(2-\alpha)(1+\phi)}{4(3+\phi)(2+\phi)}$	$\Pi_{RTM,EB} = \frac{(2-\alpha)^2(1+\phi)}{4(3+\phi)^2}$

It is assumed that firms take their production decisions according to a conjectural variation model (see Dowrick, 1989; De Fraja, 1993). Let thus define  $\phi \in (-1,1)$  as  $\phi = dq_j(q_i)/dq_i$ : when  $\phi = 0$ , as in Bughin (1999) the model collapses in the Cournot model; for  $\phi$  above zero, firms in the industry behave in a more collusive fashion, while for  $\phi$  below zero the industry is more competitive. Both firms are unionized, and unions are supposed to maximize the following objective function

$$\Omega_i = w_i l_i \quad (4)$$

The structure of bargaining is firm-specific. The bargaining solution is modelled by the generalized Nash Product

$$NP = (\Omega_i)^\alpha (\Pi_i)^{1-\alpha} \quad (5)$$

where the parameter  $\alpha \in (0,1)$  captures the parties' relative bargaining strength, which is assumed to be equal across bargaining units.

The game is solved in the backward fashion to derive sub-game perfect Nash equilibria. As in Bughin (1999), the sequence of moves is as follows: the incumbent first opts for its bargaining agenda; then, the potential entrant, on the basis of its possibilities, chooses whether to enter in the industry. Finally, wages are negotiated simultaneously with employment in case of EB; or before output decisions in case of RTM.

Making use of equations (2)-(4) and solving the Nash Product in (5), straightforward computations allow to derive the results in Table 1, where monopoly and duopoly outcomes are reported. Concerning duopoly, each bargaining combination is considered. As in Bughin (1999), suppose that in the mixed duopoly case Firm 1 adopts EB while Firm 2 adopts RTM. There are then two possible options for how the rules of the game should be specified:

A) Stage 1: Firm 2 and Union 2 bargain over the wage. Stage 2: Firm 2 chooses employment and Firm 1 and Union 1 bargain over wage and employment;

B) Stage 1: Firm 1 and Union 1 bargain over wage and employment while Firm 2 and Union 2 bargain over the wage. Stage 2: Firm 2 chooses employment.

The two games lead to different outcomes. As in Bughin (1999), it is used the case A: that is, Firm 1 and Union 1, when bargaining over wage and employment, can observe the wage that resulted from bargaining between Firm 2 and Union 2.<sup>15</sup> Findings in Table 1 equal those of Bughin (1999,

<sup>15</sup> I am extremely grateful to an Associate Editor of this journal for suggesting this clarification.

Tables 2 and 3 with  $a = 1$  in eq. (1) and  $\phi = 0$ ), except for mixed duopoly (EB-RTM) outcomes. In particular, Table 2 in Bughin (1999) presents two mistakes: the wage level in the EB firm and the employment level in the RTM firm are wrongly evaluated. So, also firm profits and union utilities for mixed oligopoly in Table 3 of Bughin (1999) are erroneously computed. The Appendix provides the correct extensive derivations.

Consider first the case of blockaded entry, that is, oligopoly is the given market structure. Concerning firms, profits in the (EB-EB) case are lower than under (RTM-RTM). Therefore, under “*committed bargaining*”, the first mover will choose RTM. Instead, under “*flexible bargaining*”, despite the fact that the firm choosing EB has higher negotiated wages and produces larger output when the competitor is a RTM firm for mixed oligopoly (therefore suggesting no conflict of interest among the firm and its union), profits for the RTM firm are higher than those of the EB firm.

This is so because, given the common price for the good in the product market and lower bargained wages, margins for the RTM firm are higher than the EB firm. Moreover, lower production levels and wages for the RTM firm guarantee in general lower total costs. This in turn has a crucial effect: if the incumbent anticipates that the potential entrant has the flexibility to choose its bargaining agenda, the first-mover firm will plausibly select the RTM. In other words, firms will end up with RTM since this type of negotiation represents the dominant strategy (see Appendix). Instead, from the unions’ point of view, EB is the dominant strategy. These results may be summarized in the following proposition.

**Proposition 1:** *In a unionized oligopoly, RTM is the dominant strategy for firms, both under flexible and committed bargaining; this is in explicit conflict with the unions’ interests since EB is their dominant strategy as regards the bargaining agenda.*

Proposition 1 states that, whatever is the entry mode in the industry, a conflict of interest among the parties will arise as regards the bargaining agenda. Thus, Bughin’s assertion that industry equilibrium is EB for each firm under an unionized oligopoly with flexible bargaining does not hold.

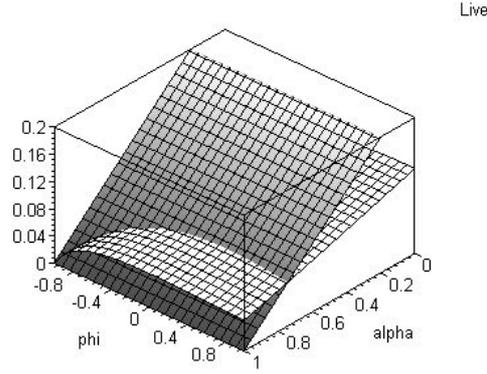
When it is considered the threat of entry, under “*flexible bargaining*” the incumbent still choose RTM, again in conflict with its union. Therefore, Bughin’s (1999) statement in proposition 2 that the threat of market entry reinforces EB as an equilibrium strategy is not valid. In fact, if the first mover selects EB, the entrant will deviate toward RTM which ensures higher profits respect to the rival firm in mixed oligopoly. Nevertheless under “*committed bargaining*”, as Bughin (1999) underlines, if fixed costs are such that

$$\frac{(1 - \alpha)}{4} < G < \frac{(2 - \alpha)^2 (1 + \phi)(2 + \phi)^2}{(2\phi + 4 - \alpha)^2 (3 + \phi)^2}$$

duopoly exists under RTM, but the incumbent will remain a monopolist if it chooses EB. In this case, the incumbent may commit to EB in deterring market entry. EB monopoly profits of firm 1 are higher than RTM duopoly profits if  $\Delta\Pi(\alpha, \phi) > 0$ . As Figure 1 shows,  $\forall \phi \in (-1, 1)$  there are values of  $\alpha \in (1/2, 1)$  such that this condition holds. As expected, EB is more powerful as deterrence mechanism the more competitive is expected the potential entrant. Since EB is constantly the union’s most preferred agenda, bargaining parties have a common interest in selecting EB. Proposition 2 summarizes these results.

**Proposition 2:** *Threat of market entry under “flexible bargaining” strengthens the RTM argument for the incumbent firm without eliminating the internal conflict with its union concerning the bargaining agenda. However, if the union’s relative bargaining power is low enough, under “committed bargaining” EB is a market entry deterrent which is more effective the more intensive is expected competition in the industry.*

Figure 1: Monopoly profits under EB (grey) vs. oligopoly profits under RTM (white) in the  $(\alpha, \phi)$  – space



## Appendix

### Mixed duopoly outcomes and firms' RTM strategic dominance

Equilibrium outcomes under mixed oligopoly are here derived. Assume that Firm 1 negotiates with its union under EB, while Firm 2 bargains with its union under RTM. Using equations (1), (2) and (4), the maximization problem in (5) for the firm/union bargaining unit 1 is given by

$$\max NP_1(w_1, q_1) = (w_1 q_1)^\alpha [(1 - q_1 - q_2(q_1) - w_1)q_1]^{1-\alpha}. \quad (\text{A.1})$$

First order conditions lead to the following expressions

$$w_1 = \alpha(1 - q_1 - q_2) \text{ (rent sharing curve)} \quad (\text{A.2})$$

$$w_1 = 1 - q_2 + q_1[\alpha(1 + \phi) - (2 + \phi)] \text{ (contract curve)} \quad (\text{A.3})$$

Equating (A.2) and (A.3), it is obtained

$$q_1 = \frac{(1 - q_2)}{(2 + \phi)} \quad (\text{A.4})$$

which is firm 1 production as function of the rival firm's output.

The firm/union bargaining unit 2 under RTM chooses  $w_2$  to maximize

$$\max NP_2(w_2) = (w_2 q_2)^\alpha [(1 - q_1(q_2) - q_2 - w_2)q_2]^{1-\alpha} \quad (\text{A.5})$$

taking as given  $w_1$ ,  $q_1$  and firm's 2 optimal output response. Given eq. (3), the first order condition for firm 2 determines the following firm's 2 reaction function

$$\frac{\partial \Pi_2}{\partial q_2} = 0 \Rightarrow q_2 = \frac{(1 - q_1 - w_2)}{(2 + \phi)} \quad (\text{A.6})$$

Substitution of (A.6) into (A.4) yields

$$q_1 = \frac{(1 + \phi + w_2)}{(3 + 4\phi + \phi^2)} \quad (\text{A.7})$$

that is, firm's 1 output as function of the rival firm's wage rate. Putting (A.7) into (A.6), it is obtained

$$q_2 = \frac{[1 + \phi - (2 + \phi)w_2]}{(3 + 4\phi + \phi^2)} \quad (\text{A.8})$$

the firm's 2 optimal output response as function of  $w_2$ . Inserting (A.7) and (A.8) into (A.5), first order condition yields to

$$w_2 = \frac{\alpha(1 + \phi)}{2(2 + \phi)} \quad (\text{A.9})$$

the optimal firm/union bargaining unit 2 wage rate under RTM. This is consistent with Bughin's (1999) result in Table 2. Substituting back (A.9) into (A.7), it is obtained

$$q_1 = \frac{(2\phi + \alpha + 4)}{2(3 + \phi)(2 + \phi)} \quad (\text{A.10})$$

which is firm's 1 equilibrium output ( $q_{EB,RTM}$  in Table 1). Also this result is in line with Bughin's (1999) finding in Table 2. Further substitution of (A.9) into (A.8) leads to

$$q_2 = \frac{(2 - \alpha)}{2(3 + \phi)} \quad (\text{A.11})$$

representing the correct value of firm's 2 production in equilibrium ( $q_{RTM,EB}$  in Table 1), different from Bughin's (1999) result in Table 2,  $q_2 = 2(2 - \alpha)/3$  ( $\alpha = 1$  in eq. (1) and  $\phi = 0$ ). Finally, putting (A.10) and (A.11) into (A.2), the negotiated wage rate in firm 1 is obtained

$$w_1 = \frac{\alpha(1 + \phi)(2\phi + \alpha + 4)}{2(3 + \phi)(2 + \phi)} \quad (\text{A.12})$$

different from Bughin's (1999) result in Table 2,  $w_1 = \alpha(4 + \alpha)/12(1 + \alpha)$  ( $\alpha = 1$  in eq. (1) and  $\phi = 0$ ). Straightforward substitutions in equations (2)-(4) yield all the other expressions reported in Table 1.

To see that RTM is the dominant strategy from the firms' viewpoint, payoffs in Table 1 are compared. RTM is a dominant strategy if  $\Pi_{RTM,RTM} - \Pi_{EB,RTM} > 0$  and  $\Pi_{RTM,EB} - \Pi_{EB,EB} > 0$ . Using results in Table 1, it is obtained that

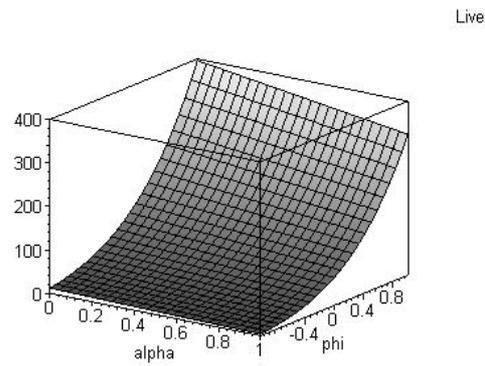
$$\Pi_{RTM,RTM} - \Pi_{EB,RTM} > 0 \Rightarrow \frac{\alpha^2(1 + \phi)N}{(3 + \phi)^2(2 + \phi)^2(\alpha - 2\phi - 4)^2} > 0 \quad (\text{A.13})$$

where  $N = 4\phi^4 + 32\phi^3 + (104 - 8\alpha)\phi^2 + (160 - 32\alpha)\phi - \alpha^2 - 32\alpha + \alpha^3 + 96$ . Analytical inspection of (A.13) reveals that  $\Pi_{RTM,RTM} - \Pi_{EB,RTM} > 0$  if  $N > 0$ . Figure 2 shows that in the relevant  $(\alpha, \phi)$ -space this always holds true. From Table 1 it is also derived

$$\Pi_{RTM,EB} - \Pi_{EB,EB} > 0 \Rightarrow \frac{\alpha^2(1 + \phi)}{(3 + \phi)^2} > 0 \quad (\text{A.14})$$

which is always positive in the relevant  $(\alpha, \phi)$ -space.  $\square$

Figure 2: Behavior of the  $N$  function in the  $(\alpha, \phi)$  – space .



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# Unionized Monopoly Regulation: Strategic Trade vs. Domestic Competition Policies

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**Abstract:** This note analyzes the differences between strategic trade and domestic competition policies to regulate a unionized monopoly. In the presence of an industry-wide union, the entry of a domestic competitor does not reduce labor market distortions, while strategic trade policy reduces both labor and product markets distortions. The fixed cost for the domestic entrant and the foreign union sensitivity to employment determine which policy should be implemented to maximize national welfare.

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## 1. Introduction

Which policy should a welfare-maximizing government adopt to regulate a unionized monopoly? Competition policy ensures market accessibility and contestability; it is mostly reliant on the competence of national governments. Trade policy assures competition from imports, allowing goods and services to flow freely within a country. The rules governing trade policy are in general supranational, the result of political issues at multilateral World Trade Organization (WTO) negotiations. Nonetheless, consistent with WTO obligations, each country may apply a tariff on imports, provided that this is lower than a certain level negotiated in WTO rounds.

Both policies increase product market competition. However, the impact on national economies is different because these policies operate through diverse channels. This note aims at analyzing this precise subject in the presence of national labor market institutions like industry-wide unions.

The framework is basic. From a situation where a monopolist dominates an industry in autarky, the domestic government has to choose whether to regulate it via market contestability, with the entry into the market of a firm; or via strategic trade policy, allowing imports from a unionized foreign country and applying an optimal tariff. The main results are as follows. Competition policy allows the domestic union to set the same wage as in autarky because it remains in a monopoly position in the labor market. On the other hand, strategic trade policy leads to wage moderation, since the national union suffers the foreign union's rivalry over jobs. The choice between the two policies for the government depends on the amount of the initial fixed cost for the entrant and the employment orientation of the foreign union. If the foreign union is sufficiently low employment-oriented and the fixed cost for the entrant is low, the competition policy dominates the strategic trade policy. As the foreign union sensitivity increases, the threshold level of the fixed cost making the entry profitable lessens, and the strategic trade policy dominates the competition policy.

This note relates to Vandebussche and Konings (1998) and Vandebussche (2000). These works analyze the differences between trade and competition policies. However, this note differs from the previous works in several aspects. Firstly, in the case of trade policy, the foreign wage is not exogenous: the foreign union sets its wage endogenously, competing over jobs with the domestic union, as in Naylor (1998). Secondly, it models explicitly the presence of tariff barriers and, therefore, the implementation of strategic trade policy, elements which are absent in Vandebussche and Konings (1998) and Vandebussche (2000). Thirdly, in this model, entry is costly. Thus, the fixed cost for the entrant alters the feasibility of the two policies.

The remainder of this note is as follows. Section 2 presents the formal model. Section 3 analyzes the policy implications on national welfare. Section 4 closes.

## 2. The Model

This section develops a partial equilibrium model to analyze the effects of domestic entry vs. strategic trade policy on national welfare in order to regulate a unionized monopoly.

In the Home country, there are two sectors: a perfectly competitive and an imperfectly competitive sector. In the imperfectly competitive sector, a monopolist operates, producing goods denoted  $x$ , using only one factor of production, labor,  $l$ , with linear technology and constant return to scale. Thus, each worker produces one unit of the goods,  $l = x$ : output and employment are equal. In the imperfectly competitive sector, an industry-wide monopoly union is active. The labor supply in the economy is assumed large enough to avoid corner solutions. Any labor required by, or freed up from the monopolized sector, is supplied or absorbed by the perfectly competitive sector, which acts as a buffer, where workers get the competitive wage, here normalized to zero. The product demand is linear. The Home government seeks to introduce competition in the monopolized industry. This may occur through: 1) the *competition channel*, namely the entry of a national firm in the sector considered. The entrant faces a fixed cost, denoted by  $F$ . The entrant's workforce ends under the

umbrella of the industry-wide Home union;<sup>16</sup> 2) the *trade channel*, namely the Home incumbent faces import competition in the Home market from a Foreign exporter producing the same goods, denoted  $y$ . Imports are initially zero due to a prohibitive tariff. However, the Home government chooses a tariff on imports, lower than the prohibitive one, to maximize domestic welfare. In other words, the national government strategically sets a tariff to extract part of the Foreign exporter's rents. In all cases, the sector moves from a monopoly to a duopoly. The structure of the Foreign labor market is similar to that of the Home country, but the Foreign union differs from the Home union in employment sensitivity. Lower scripts 1 and 2 refer to incumbent and entrant, respectively. The model is a three-stage game solved in the usual backward fashion. In the first stage, the Home government chooses the policy to regulate the unionized monopoly, setting the optimal tariff, in the case of strategic trade policy. In the second stage, unions set wages. In the third stage, firms compete à la Cournot in the Home market, determining production and employment levels (right-to-manage model). The analysis focuses on the Home country.

## 2.1 The benchmark: monopoly in autarky

First, let us consider the benchmark case of monopoly in Home. The monopolist produces goods facing the following linear demand schedule

$$p_H = 1 - x_{1H}$$

where  $x_{1H}$  denotes the incumbent's production. The monopolist's profit maximization problem is

$$\Pi_{1H} = (1 - x_{1H} - w_H)x_{1H} \quad (1)$$

where  $w_H$  is the industry-wide wage fixed by the Home union. Taking as given the monopoly quantity, the Home union maximizes the total wage bill

$$\Omega_{1H} = w_H x_{1H}. \quad (2)$$

The integral under the product demand function gives the measure of the consumers' surplus,  $CS_H$ . Thus, the Home welfare is

$$NW_H = \Omega_{1H} + \Pi_{1H} + CS_H.$$

Table I summarizes the results.

## 2.2 Eliminating monopoly: domestic competition channel

The first policy option to regulate the unionized monopoly sector is market contestability, allowing the entry of a domestic firm. The industry passes from a monopoly to a duopoly. In this case, the demand function in the Home country is

$$p_H = 1 - x_{1H} - x_{2H}$$

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<sup>16</sup> There is, in theory, the option of the entry of an international competitor. However, since the international entrant will repatriate profits to the country of origin, under the hypotheses of this paper the Home government will always prefer a domestic entry to an international one.

where  $x_{1H}$  and  $x_{2H}$  are the incumbent and the entrant production levels, respectively. As a consequence, the profit function for the incumbent is

$$\Pi_{1H} = (1 - x_{1H} - x_{2H} - w_H)x_{1H}, \quad (3)$$

while for the entrant it is

$$\Pi_{2H} = (1 - x_{1H} - x_{2H} - w_H)x_{2H} - F. \quad (4)$$

Regarding the labor market, the utility function is

$$\Omega_H = w_H(x_{1H} + x_{2H}). \quad (5)$$

This is due to the presence of the industry-wide union setting a unique wage for Home workers. Table I reports the relevant findings.

### 2.3 Eliminating monopoly: international trade channel

Trade policy opens the country to imports. This is the alternative policy to regulate monopoly, which generates an international duopoly. As regards labor markets, now wages are interdependent: unions compete against each other over jobs. The Home government sets an optimal tariff on imports to extract part of the Foreign exporter's rents and maximize domestic welfare. The product demand is

$$p_H = 1 - x_{1H} - y_{2F}$$

where  $x_{1H}$  and  $y_{2F}$  are the incumbent production and imports from the Foreign country, respectively. The profit function of the Home incumbent firm is

$$\Pi_{1H} = (1 - x_{1H} - y_{2F} - w_H)x_{1H} \quad (6)$$

while the Foreign exporter's profits are

$$\Pi_{2F} = (1 - x_{1H} - y_{2F} - w_F - t)y_{2F} \quad (7)$$

subject to the constraint that  $y_{2F} \geq 0$ , where  $w_F$  is the Foreign union's industry-wide wage rate. Note that the Foreign exporter is the "entrant" in the relevant Home product market via trade. Therefore, imports have index 2. The Foreign firm pays a tariff  $t$  to export in Home. Thus, the Home government gets tariff revenues from imports computed in the national welfare. To analyze the impact of a different Foreign union orientation on Home outcomes, the utility function is (5) for the Home union, while the Foreign union has this utility function

$$\Omega_F = w_F y_{2F}^\phi \quad (8)$$

where  $\phi \in [0, \infty)$  is the union sensitivity to employment (Dube and Reddy, 2006). Cournot competition between the two firms in Home leads to the following quantities

$$x_{1H} = (1/3)(1 + t + w_F - 2w_H), \quad y_{2F} = (1/3)(1 - 2t + w_H - 2w_F).$$

Table I Summaries of the relevant variables in Home country

	Wage	Production	Price	Union utility	Profits	Consumers' surplus	National Welfare
Monopoly	$\frac{1}{2}$	$\frac{1}{4}$	$\frac{3}{4}$	$\frac{1}{8}$	$\frac{1}{16}$	$\frac{1}{32}$	$\frac{7}{32}$
Domestic Competition	$\frac{1}{2}$	$\frac{1}{3}$	$\frac{2}{3}$	$\frac{1}{6}$	$\frac{1}{18} - F$	$\frac{1}{18}$	$\frac{5}{18} - F$
International Trade, Strategic Trade Policy	$\frac{7(3+2\phi)}{(49+41\phi)}$	$\frac{14(3+2\phi)}{3(49+41\phi)}$	$\frac{35(3+2\phi)}{3(49+41\phi)}$	$\frac{2}{3} \left[ \frac{7(3+2\phi)}{(49+41\phi)} \right]^2$	$\left[ \frac{14(3+2\phi)}{3(49+41\phi)} \right]^2$	$\frac{1}{18} \left[ \frac{(42+53\phi)}{(49+41\phi)} \right]^2$	$\frac{(72+73\phi)}{6(49+41\phi)} *$

\*NW= Union Utility + Profits + Consumer surplus + tariff revenues

Putting Cournot quantities into the utility functions, the unions' maximization problems are

$$w_H = \arg \max_{w_H} \left\{ \Omega_H = (1/3)w_H(1+t+w_F-2w_H) \right\}, \quad w_F = \arg \max_{w_F} \left\{ \Omega_F = (1/3)w_F(1-2t+w_H-2w_F)^\phi \right\}$$

for the Home and the Foreign union, respectively. The solutions lead to the reaction functions

$$w_H = (1/4)(1+w_F+t), \quad w_F = (1/2)[(1+w_H-2t)/(1+\phi)]. \quad (9)$$

Combining the expressions in (9), the Bertrand competitive equilibrium wage in Home country is

$$w_H = [3+2\phi(1+t)]/(7+8\phi) = \Phi. \quad (10)$$

Condition  $y_{2F} \geq 0$  and the equilibrium wage in Home establish that international trade occurs if

$$\bar{t} \leq 5/7 \approx .714. \quad (11)$$

For  $t > \bar{t}$ , the tariff is so high that domestic imports are zero: the Foreign firm cannot export. Note that the tariff barrier is independent of the parameter  $\phi$ . Using equation (10), it is possible to derive the following expressions for Home production, prices, union utility, profits and consumers' surplus

$$x_{1H} = (2/3)\Phi; \quad p_H = (5/3)\Phi; \quad \Omega_H = (2/3)\Phi^2; \quad \Pi_H = [(2/3)\Phi]^2; \quad CS_H = (2/9)\{\Phi - [3\phi(3-t)]/(7+8\phi)\}^2.$$

Therefore, in the first stage of the game, the Home government sets the optimal tariff to maximize domestic welfare to solve this problem

$$t = \arg \max_t \left\{ NW_H = [(46+60t-82t^2)\phi^2 + (68+90t-98t^2)\phi + 36]/[3(7+8\phi)]^2 \right\}$$

whose solution is

$$t^* = (15/2)[(3+2\phi)/(49+41\phi)] \quad (12)$$

The optimal tariff depends on the Foreign union's sensitivity to employment, with  $dt^*/d\phi < 0$ : the higher the sensitivity to employment, the lower the Foreign wage and, therefore, the price of the

imported goods. Since the rents of the Foreign exporter are lower, the National government sets a lower tariff. From (11) and (12), it can easily be verified that, for  $\phi \in [0, \infty)$ ,  $t^* < \bar{t}$ : no matter how much the Foreign union cares about employment, there is always an optimal tariff, lower than the prohibitive level, that the domestic government can set to extract part of the Foreign exporter's rents. Substitutions of (12) into the relevant values for the Home country lead to the results in Table I.

### 3. Policy implications and welfare

Increasing market contestability (the entry of a national firm: the competitive channel) and the opening to international trade (the trade channel) in the monopoly sector of the Home economy are means of introducing competition. Both channels imply a shift from a monopoly to a duopoly in the product market. However, if an industry-wide union operates in the Home country, the impact of the two policies are different. In the case of competitive policies, the new entrant creates job opportunities, but the wage level remains unchanged because the overall workforce is under the domestic umbrella of the union. As a consequence, union utility rises, the price falls because of increased market competition, and this, in turns, results in an increased consumer surplus. Monopolist profits are squeezed. The welfare level is higher than in the case of autarky. The key factor in the competitive policy for the Home government resides exclusively in the likelihood of undertaking the initial investment  $F$  to enter into the market. In this analysis, the sunk cost of the investment for the domestic competitor is  $0 \leq F \leq 1/36$ . A different case is that of the strategic trade policy: introducing competition via exports exposes Home workers to wage competition from the Foreign country. As a consequence, Home wages are lowered. This can be summarized as follows.

*Result 1:* Trade policy reduces Home wages. Wage competition is fierce when the employment orientation of the Foreign union increases.

Proof: Under strategic trade policy, the Home wage in (10) is lower than  $w = 1/2$ , the wage under competition policy, for  $\phi \in [0, \infty)$ . Differentiation of (10) evaluated at  $t^*$  with respect to Foreign union employment sensitivity yields  $\partial w_H / \partial \phi|_{t^*} = -175 / (49 + 41\phi)^2 < 0$ : an increase in the Foreign union's employment sensitivity depresses Home wages.  $\square$

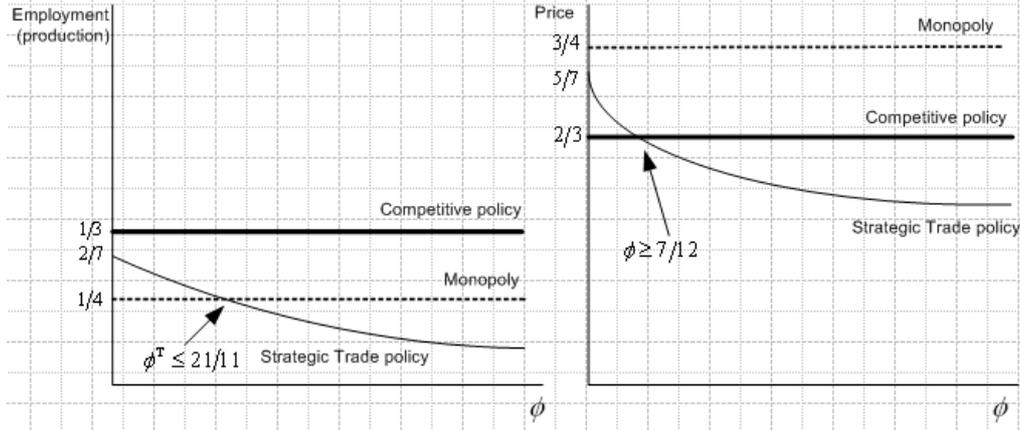
While strategic trade policy induces wage moderation, the effects on production (and employment) are not so clear cut.

*Result 2:* Strategic trade policy creates more jobs with respect to autarky if  $\phi \leq \phi^T = 21/11$ . However, for  $\phi \in [0, \phi^T]$ , Home employment  $x_{1H}^* \in [2/7, 1/4] < x_{1H} = 1/3$ : employment under competitive policy is always higher than with strategic trade policy.

Proof: Directly from Table I.  $\square$

Strategic trade policy creates new job opportunities only if the Foreign union attaches to employment a value lower than the threshold  $\phi^T$ . In particular, for  $\phi = 1$  (identical employment orientations for Home and Foreign unions),  $x_{1H} = 7/27 \approx .26$ . From Result 1, it follows that the Foreign union employment sensitivity induces wage moderation in Home. This factor, in normal cases, translates to *increasing* employment. However, as the Foreign union sensitivity increases, Foreign wages decrease more rapidly than Home wages. This, in turn, increases the demand for imports, driving down the price in Home. Nonetheless, the presence of a tariff does not assure that,

Figure 1 *Employment and price in the imperfectly competitive sector of the Home economy under the different policies*



under strategic trade policy, the price level is the lowest affordable.

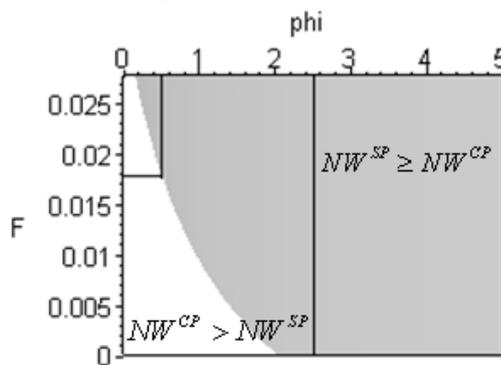
*Result 3:* If  $\phi \geq 7/12$ , the price with strategic trade policy is lower than with competitive policy.

Proof: Directly from Table I.  $\square$

The price under strategic trade policy is lower than under competitive policy if the Foreign union is sufficiently employment-oriented: in that case, the demand for imports is relatively strong. Since  $7/12 \approx .58 < 1$ , this situation also occurs when unions are symmetrical. Figure 1 exemplifies Results 2 and 3. As regards the Home union, the simple payoffs comparison in Table I shows that the utility level under strategic trade policy is lower than under competition policy,  $\forall \phi \in [0, \infty)$ . The rationale is clear: the competition policy creates more jobs than the strategic trade policy, and workers of the domestic entrant become union members, getting the same wage rate as in monopoly.

Both policies aim at regulating the monopolized sector. The competition policy clearly reduces the incumbent's profits; however, these can be higher with the trade policy than in autarky. A corollary of Result 2 is that the Home incumbent's profits with strategic trade policy are higher than under monopoly if  $\phi^* \leq \phi^T = 21/11$ : this is simply because  $\Pi_{1H} = (x_{1H})^2$ . Moreover, consumers benefit from a low price and higher demand than in monopoly. A corollary of Result 3 is that consumers' surplus in Home is higher under strategic trade policy than under competitive policy if  $\phi \geq 7/12$ . The Home government's choice about the regulation policy of the monopoly industry should consider the national welfare as a whole, which depends on the fixed cost of entry and the Foreign union sensitivity. Figure 2 shows the Home national welfare in the  $(F, \phi)$ -space.

Figure 2 *Home National Welfare*



Notice that, on the vertical axis,  $F \in [0, 1/36]$ . It can easily be derived that  $NW^{CP} > NW^{SP}$  if  $F < F^T = (1/18)[(29 - 14\phi) / (49 + 41\phi)]$ , while  $NW^{SP} \geq NW^{CP}$  for  $F \geq F^T$ , where the upper scripts stand for “competition policy” and “strategic trade policy”. As can also be observed from Figure 2,  $dF^T/d\phi < 0$ : a high sensitivity to employment of the Foreign union lowers the Foreign wage and increases the Home imports, lowering the profitability of the industry and, therefore, the amount of the fixed cost that can be sustained by the potential entrant. Hence, for the Home government it is advantageous to introduce competition by promoting market contestability policies only if the cost of the initial investment is sufficiently low. The fixed cost, in turn, is low if the Foreign union sensitivity over employment is also low. In this case, domestic competition increases Home production, and the reduction in price generates an increase in consumers’ surplus so as to offset the losses in tariff revenues, despite wages being higher than with strategic trade policy. In particular, for  $\phi = 1$  (Home and Foreign unions symmetrical), it can be verified that competition policy ensures a higher national welfare than the strategic trade policy if  $0 \leq F < 1/108$ . Analytical inspection of the welfare components reveals the rationale: for  $0 \leq F < 1/108$ ,  $\Pi^{SP} - \Pi^{CP} < \Omega^{CP} - \Omega^{SP}$ , while, for  $1/108 \leq F \leq 1/36$ , it occurs that  $\Pi^{SP} - \Pi^{CP} \geq \Omega^{CP} - \Omega^{SP}$ . In other words, if the fixed cost is below  $F < 1/108$ , the union rent differential, under the two policies, more than offsets the profit differential. Simple arithmetic allows the evaluation that, in this specific case, the cost of the entrant’s initial investment should not be larger than 1/3 (33%) of the profits.

On the other hand, when  $F \geq F^T$ , despite the fact that market entry is still profitable for the domestic competitor, the Home government adopts the strategic trade policy. The monopoly sector is regulated by trade openness, the Home union faces wage competition from the Foreign union, and hence moderates its wage demand, driving down the price and increasing consumers’ surplus. Nevertheless, the Home government recovers additional revenues by applying the optimal tariff, extracting rents from the Foreign exporter. These revenues are large enough to increase the overall national welfare, and can be subsequently redistributed to those economic agents affected by the choice of implementing the strategic trade policy. The Home government has to consider all these elements in taking the appropriate decision to afford the highest national welfare level.

#### 4. Conclusions

This note has analyzed the effects on domestic welfare of two different policies that a government may apply to introduce competition in a unionized monopolized industry: competition and strategic trade and policies. Both policies shift the product market from monopoly to duopoly: the former, through market contestability; the latter, via import competition. The competition policy allows the domestic industry-wide union to maintain the same wage as in monopoly. On the other hand, trade openness leads to wage moderation: the Home union competes over jobs with the Foreign one. As a result, the impact of the two policies on price, employment and welfare differs.

The domestic government implements the competition policy if the foreign union has a sufficiently low employment sensitivity and the cost of the initial investment for the entrant is low. As the foreign union sensitivity increases, the value of the threshold of the fixed cost which makes entry into the Home market profitable lowers. As a consequence, the government prefers the strategic trade policy, which ensures a national welfare level higher than that of the competition policy.

The findings of this work relate to the simplifying hypothesis that the Home union’s employment sensitivity is invariable. This assumption should be relaxed to obtain a better evaluation of the policy effects on the national economy. Additionally, Bertrand competition in the product market may alter some of the results, requiring further research.

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## The sustainability of unions' wage coordination in an integrated economy

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**Abstract:** In a symmetric two-country duopoly model with integrated product markets, this paper investigates the incentives for unions to coordinate wage demands in the presence of transaction costs, and the sustainability of unions' wage collusion. Contrary to conventional wisdom that wage collusion is always welfare-detrimental, this work shows that wage coordination in the presence of low minimum wages may lead, from a social point of view, to a Pareto superior outcome with respect to separate wage settings with relatively high minimum wages.

**Keywords:** international production, wage coordination, labour unions, sustainability.

**Biographical notes:** Domenico Buccella is a PhD Candidate at the University of Siena, Italy. He developed part of this paper when he was a Visiting Scholar at the University of Graz, Austria. His research mainly focuses on industrial organization, collective bargaining, and the effects of product market integration and firms' internationalisation upon labour unions.

## 1 Introduction

Closer economic integration in regional and global spheres has been the course of action characterising the last decades of modern history. International trade and foreign direct investment (FDI) have been among the fastest worldwide expanding economic activities due to increasing removal of trade restrictions and deregulation of international capital markets. Nowadays, FDI leads the process of internationalisation of production, whose principal actors are Multinational Enterprises (MNEs). Undertaking direct investments, MNEs control plants in several locations, organising business on an international basis. Looking at the European experience, of all the inward FDI's flows into the European Union (EU), the EU's member countries themselves originate the bulk: as for the period 2003-2006, the average of inward intra-EU FDI flows was 76% (European Commission, 2008).

As suggested by Horn and Wolinsky (1988a), firms may exploit the MNEs' organisational structure strategically to avoid the creation of encompassing unions. Consequently, a major concern for organised labour is that MNEs are able to obtain concessions in terms of wage demands. Public opinion asks unions to take care of national interest, preserving existing jobs and economic activities, and trying to promote further domestic employment. In this context, an increasing number of unions have shown interest in coordinating activities across boundaries to recover bargaining positions. The ongoing integration process in the EU seems to encourage transnational cooperation. The exchange of information on wage levels, working conditions and employment policies in different countries, as well as shared rules in collective bargaining, are all practices already present in Europe. At first, these initiatives occurred at the cross-industry level – e.g., since 1998 the European Trade Union Confederation (ETUC) has annually provided the “guideline for collective bargaining at the European level”.<sup>17</sup> Nevertheless, the figures concerning transnational agreements in industries characterised by the presence of large MNEs have steadily increased in recent years: from 92 in 2005 to 147 in 2007, two thirds of which related to European MNEs' activities within the EU itself (ETUC, 2008). Most of the time, initiatives for cooperation of collective bargaining at cross-border level take place at inter-regional and industry levels between unions in neighbouring EU Member States, “areas where economic, territorial, monetary and social conditions are similar (in particular in the countries of the euro zone)” (ETUC, 2008; Eichhorst et al., 2011).

“Frictions” in the process of economic integration affect union collusion: trade costs in the intra-industry trade literature; coordination costs in the labour markets. Straume (2002) and Strozzi (2007, 2008) address the analysis of union collusion in a standard reciprocal dumping model of trade with segmented markets; this paper investigates the topic in a duopoly model of international production in an integrated product market. This model builds on the model of Borghijs and Du Caju (1999), but it extends their analysis in several ways. This work presents, in a partial equilibrium model, a two-stage game where, in the first stage, industry-wide monopoly unions set wages, while, in the second stage, firms compete à la Cournot in the product market. This paper assumes industry-wide unions to catch the evidence, reported in Table 1, that, for several countries of the EU (most notably the “old” 15 EU Member States), the key collective bargaining level is at sectoral level.

The focus is on the impact of labour market integration. Recently, communication technologies became a fundamental tool to structure permanent information exchanges and consultation processes for wage coordination.

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<sup>17</sup> See European Commission (2009) for a review on cross-border coordination activities concerning collective bargaining.

**Table 1** Union density and Collective Bargaining level in the EU, 2009

Country	Proportion of employees in union (%)	Key level of collective bargaining
Austria	32%	Industry
France	8%	Industry and company
Belgium	54%	National (sets framework)
Slovenia	41%	Industry
Finland	74%	Industry – but much left to company negotiations
Portugal	20%	Industry
Sweden	71%	Industry – but much left to company negotiations
Netherlands	22%	Industry
Denmark	67%	Industry – but much left to company negotiations
Italy	33%	Industry
Spain	16%	Industry – at both national and provincial level
Germany	20%	Industry
Luxembourg	40%	Industry and company (varies with sector)

Source: Fulton, L. (2011), based on national EIRO Industrial relations profile and ICTWSS Database.

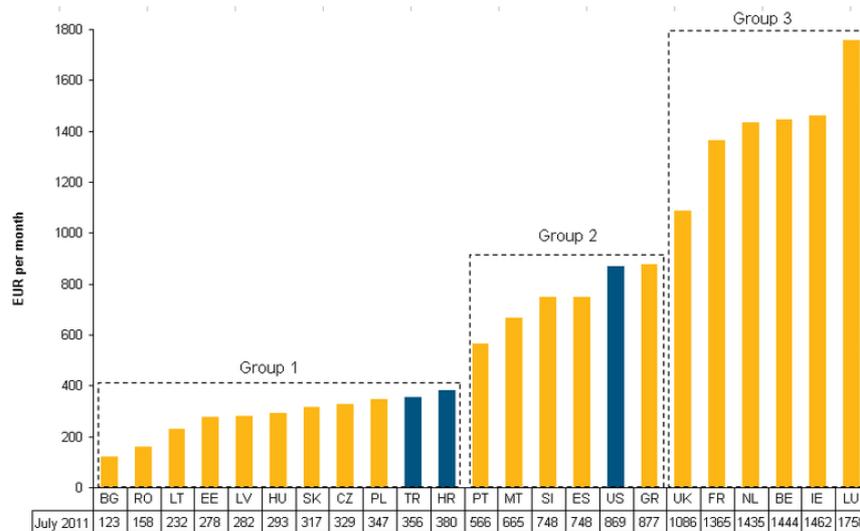
For example, the EMF - EMCEF - ETUF-TCL's<sup>18</sup> Eucob@n virtual network, realised in 2006, provides a shared collection of data on collective bargaining for their affiliates. These technologies are likely to decrease the scale of unions' transaction costs. As generally assumed in the received literature, workers in the oligopoly sector are fully unionised. Of course, this does not mean that workers in the whole economy are unionised. In fact, as Table 1 shows, the proportion of employees in labour unions varies considerably across the EU, and some countries are characterised by low rates of union density. Nevertheless, this assumption aims to capture the idea that, despite the low union densities, in some industrial sectors unions are as strong as if the whole labour force were unionised (for example, the German IG Metall in metalworking). Similar to Horn and Wolinsky's (1988b) contribution, this work considers the impact of the market interactions and product characteristics on unions' strategic behaviour by adding one firm and introducing a degree of product differentiation, ranging from substitute to complement goods. As in Straume (2002) and Strozzi (2007; 2008), this paper develops a dynamic version of the unions' game to study the sustainability of their collusive behaviour, though in an entirely different context. Furthermore, while Straume (2002) considers only perfect substitute goods, and Strozzi (2007; 2008) broadens the analysis to goods which are substitutes but not perfect substitutes, this paper takes into account both substitutes and complement goods. With respect to trade models, where product market integration makes unions' collusion more difficult to sustain, the findings of this work show that a clear-cut relation between increasing labour market integration and transnational union collusion does not exist. Since 20 out of 27 EU member countries have statutory minimum wages (see Figure 1), this paper investigates also how minimum wage levels affect the unions' collusive behaviour.

It was found that, for low minimum wages, the union collusion is relatively easy to maintain for intermediate values of coordination costs, while extremely high and extremely low levels make collusion hard to sustain. However, for minimum wages high enough, union collusion is always advantageous as labour market integration becomes more integrated. Nonetheless, union collusion is always more sustainable when minimum wages are relatively low.

The work also analyses the implications for social welfare. In contrast to the conventional wisdom that union collusion is always welfare-damaging, a key result is that wage coordination, under certain circumstances, may lead to higher welfare levels than in the presence of autonomous wage

<sup>18</sup> Abbreviations stand for European Metalworkers' Federation; European Mine, Chemical and Energy Workers' Federation; and European Trade Union Federation - Textiles Clothing and Leather, respectively. These are three of the 12 European Industries Federations operating within the ETUC.

**Figure 1** Statutory minimum wages in the EU (Member and Candidate Countries) and the US, July 2011



Source: Eurostat (2011).

Notes: Group 1: low level of minimum wages between 100 EUR and 400 EUR a month, Bulgaria, Romania, Lithuania, Estonia, Latvia, Hungary, Slovakia, the Czech Republic, Poland (Member States), Turkey and Croatia (Candidate Countries). Group 2: Portugal, Malta, Slovenia, Spain and Greece (Member States) and the United States, intermediate level of minimum wages, from just over 550 EUR to just below 900 EUR a month. Group 3: six Member States: United Kingdom, France, the Netherlands, Belgium, Ireland and Luxembourg, minimum wage above 1 000 EUR per month. Excluded from the data collection: Germany, Cyprus and the Former Yugoslav Republic of Macedonia (statutory minimum wages limited to specific groups defined e.g. by sectors or by professions); Denmark, Italy, Austria, Finland, Sweden, Iceland, Norway and Switzerland (no statutory national minimum wages, sectoral level agreements widely applied with erga omnes applicability, and therefore “de facto” minimum wages).

setting. The intuition is the following. In the presence of low minimum wages, unions have strong incentives to collude. A “central” social planner (the “EU Commission”) may adopt a policy intervention (for example, a Directive) with the objective of introducing some measures to increase the minimum wages in order to prevent collusion. However, “too” high minimum wages with separate wage settings might have a negative impact on global welfare larger than a collusive wage with low minimum wages. Although these findings cannot be directly compared with the received literature (due to the differences in the reference frameworks), this paper may help to shed light on the recent developments of unions’ collusive practices.

The rest of the paper is organised as follows. Section 2 shortly reviews the theoretical literature related to unions’ wage coordination in the context of international integration, considering the strategic interactions among economic actors in the product and labour markets. Section 3 presents the formal model of international production in unionised countries, analysing the different wage settings outcomes’ in the static version of the game. Section 4 develops the dynamic game among unions to investigate the sustainability of transnational coordinated wage demands. Section 5 examines the welfare implications. Section 6 closes.

## 2 Literature review

In spite of its relevance, the analysis of incentives and scopes for union cooperation in a context of economic integration started only relatively recently. The current paper focuses on this precise subject. Surprisingly, the topic of wage coordination policies (the main form of union cooperation) has received attention in a limited number of theoretical works. Horn and Wolinsky (1988b) investigate, in a general “right-to-manage” bargaining model with bilateral monopoly relations

between firms and unions (input suppliers), how the industry's market structure and the demand relations among the final products affect wages (input prices) and profits. The authors show that, under the assumptions of linear cost and demand functions, and in the absence of competition among unions (input suppliers), the collusive wage is higher (lower) and employment levels are lower (higher) than the separate setting if products are substitutes (complements). The model of Horn and Wolinsky (1988b) is not directly addressed to international economic issues. Nevertheless, their framework can be interpreted as two national union-firm bargaining units with firms competing à la Cournot in an integrated product market.

First theoretical contributions related directly to the effects of economic integration on labour markets, analysing the wage and employment outcomes as well as incentives for unions to cooperate internationally in the face of increasing trade competition in product markets, are the works of Driffill and van der Ploeg (1993, 1995). Driffill and van der Ploeg (1993) analyse the effects of removing tariffs and trade barriers on the wage setting behaviour of utilitarian monopoly unions using a macroeconomic two-country model of international trade. In each country, firms produce homogeneous goods and specialise in the production of their own exportable. The domestic and the foreign goods are imperfect substitutes in consumption. Labour factor is immobile. The authors consider three types of unions: decentralised unions, centralised trade unions and international trade unions. In the case of decentralised unions, they are so small that the effect of raising wages on the consumer price index is ignored. Centralised unions internalise the effects of raising wages on CPI. Centralised unions, when cooperate with unions abroad, internalise the adverse effects of a wage increase on the utility of unions abroad, and, in equilibrium, cause lower wages than centralised unions and increase employment. That is, an international "hump-shaped" relationship between wages and the degree of corporatism emerges. The authors also shows that the removal of trade barriers makes unions more likely to want to cooperate with unions abroad.

Driffill and van der Ploeg (1995) face the same issues addressed in their previous work adopting a different setting. They show that the results strongly depend on the hypotheses lying behind the models. A two-country model of intra-industry trade in differentiated goods is used where in the product market monopolistic competitive firms operate. The production function exhibits increasing returns to scale. The authors consider a utilitarian monopoly union in an industry which represents a small fraction of the economy, and they make a distinction between national and international unions. Under these conditions, the authors find that wages set at the national level positively depend upon the tariff level, explained by the fact that trade barriers protect national unions. Removal of trade barriers reduces monopoly power in labour markets. This pushes wages down and increases employment and the number of firms in the differentiated goods industry. The national wage is always lower than the international wage, only approaching the latter when the tariff tends to infinity. The removal of trade barriers appears strongly to increase the incentive for national unions to cooperate internationally, and this undermines the benefits of trade liberalisation for non-union members.

Huizinga (1993), Naylor (1999), Straume (2002), and Strozzi (2007, 2008) also explicitly consider cross-border wage coordination in an international trade framework. Huizinga (1993) allows for the integration of two distinct union-firm bargaining units into a unified market with two bargaining units. Product market integration leads to an enlargement of the market size, and in an increase in the number of the firms operating in the market, intensifying competition. This, in turns, implies a decrease in prices and wage levels. Moreover, Huizinga (1993) gets that the wage reduction is more than offset by the increase in employment, so that net union utility increases. Thus, international integration is welfare enhancing from the unions' point of view. The author also briefly sketches the effects of post-integration wage harmonisation. Unions, after integration, face an increased labour demand. Wage harmonisation eliminates competition for employment and unions may demand the

wage level equal to the pre-integration wage. Thus, unions gain from economic integration, given that union employment increases for an unchanged wage rate.

On the other hand, in a symmetric two-country duopoly model with homogeneous products, segmented markets and reciprocal dumping, and one union active in each labour market, Naylor (1999) characterises the full set of possible trade regimes. The author considers a two-stage game where monopoly unions are first movers and, in the first stage of the game, set wages, while firms, in the second stage, compete à la Cournot and determine their production levels taking wages as given. Naylor (1999) shows that unions find it advantageous to establish an international agreement for some trade cost levels, colluding over a wage rate which induces an autarky regime in equilibrium. The works of Straume (2002) and Strozzi (2007, 2008) analyse in depth the scope for unions to adopt collusive behaviour. They start from Naylor's (1999) framework, and examine which conditions support collusion as equilibrium of an infinitely repeated game. While Straume (2002) investigates the case of perfect substitute goods, Strozzi (2007, 2008) introduces into the analysis a degree of complementary/substitutability between products. In particular, Strozzi (2007, 2008) shows that the sustainability of transnational implicit collusion depends both on the trade cost levels and the degree of substitutability among goods. If trade costs are relatively small, a reduction in trade barriers (the measure of increasing economic integration) makes tacit collusion more difficult to sustain; product differentiation strengthens this effect. Instead, in the presence of sufficiently high trade costs, a decrease in their level does not influence the sustainability of union collusion, which turns out to be easier the less similar the goods.

Zhao (1998) and Borghijs and Du Caju (1999) also consider the labour market effects of transnational union coordination. These authors focus on international productive activities. Zhao (1998) builds up a two-country model with union-management efficient bargaining and integrated product markets to study the impact of FDI on wage and employment outcomes. The author's conclusion is that if unions cooperate, their bargaining power increases because the outside option in negotiations will improve. Borghijs and Du Caju (1999) analyse the prospects for union cooperation in the context of international production by considering an integrated product market. The model has a basic set up: a single firm with two plants in different countries, with labour the unique factor of production with a decreasing return to scale technology. Workers are assumed to be fully unionised and, to coordinate activities, they pay some per-member transaction costs. Lower transaction costs indicate increasing labour market integration. The model is a two-stage game. In the first stage, monopoly unions maximise their rents over the competitive wage. In the second stage, the firm allocates optimally production, taking as given the wages set by unions. The inverse demand function for the integrated market is linear. The authors show that, for coordination costs large enough, monopoly unions are better off competing with each other while, for transaction costs lower than a threshold value, wage coordination becomes an attractive option, leading to higher wages. Hence, if transaction costs are sufficiently small labor unions can improve their position in negotiations with employers by means of coordinated wage demands. Therefore, coordination provides a countervailing power to the impact of economic integration. A further decline in these costs reduces the collusive wage; however, this remains higher than the wage under separate settings.

Eckel and Egger (2012) also investigate whether unions can improve their position in negotiations by cooperating internationally, focussing on company-level bargaining. They aim at giving an explanation of why it is hard for unions to counter-react to the damaging shift in bargaining position as a consequence of the internationalization of productive activities, and why there exists little evidence for union cooperation in multinational enterprises. The authors develop a two-country model where a multinational negotiates with local (plant-level) unions over wages and employment (efficient bargaining model). The multinational produces homogeneous goods and sells it as a

monopolist facing (identical) linear product demands in both countries. The main results are as follows. They show that cooperation for unions is undoubtedly beneficial if the preferences regarding wages and employment are similar across countries. However, if these preferences are different, the threat of relocations by multinationals make one union better off and the other worse off, and these distributional effects can hamper cooperation.

### 3 A model of international production in unionised countries

This section develops a partial equilibrium model of international oligopoly in unionised countries. In an economic bloc, there are two countries, A and B. In each country, the economy presents two sectors: a perfectly competitive sector, and an imperfectly competitive sector. In the imperfectly competitive sector, two firms, denoted 1 and 2, are active. Each firm has a plant in both countries. There are some exogenous fix costs large enough such that neither the incumbent firms start-up new production facilities nor a potential entrant will enter into the industry: the market structure is blockaded. Firms produce differentiated goods: firm 1 goods  $x$ , firm 2 goods  $y$ . Labour is the only factor of production, with decreasing returns to scale. By assumption, the labour supply is sufficiently large to avoid corner solutions. An industry-wide union operates in each country, and the industry's workforce is fully unionised. The perfectly competitive sector represents a buffer, where workers can always find employment at the minimum wage fixed by national governments. This sector produces undifferentiated goods  $z$  which represent the numéraire goods. Firms in the imperfectly competitive sector act as Cournot competitors in the integrated product market. There may be trade. This is not of the intra-industry type, given the integrated market hypothesis. When trade occurs, transportation costs equal zero. Thus, production may shift across plants, and the firms eventually export back the goods without extra costs. The model is a two-stage game, solved by backward induction. In the first stage, rent-maximising monopoly unions set wages. The unions' optimal wage strategy will depend on the wage setting. Unions may select either to coordinate wage demands, or to act in a separate way. In the second stage, firms interact in the product market and realize output, taking wages as given.

Following Singh and Vives (1984), the representative consumer of the economy maximises the following quasi-linear utility function

$$U = \bar{U}(q_1, q_2) + z = a(q_1 + q_2) - \frac{1}{2}(q_1^2 + 2cq_1q_2 + q_2^2) + z \quad (1)$$

where  $\bar{U}(q_1, q_2)$  is the quadratic utility deriving from the consumption of the differentiated goods,  $q_1 = x_A + x_B$  is the consumption of firm 1's goods,  $q_2 = y_A + y_B$  is the consumption of firm 2's goods, and  $z$  is the linear utility deriving from the consumption of the numéraire goods. As in Horn and Wolinsky (1988b),  $c \in (-1, 1)$  parameterizes the degree of product differentiation: if  $c < 0$ , the products are complements; when  $c > 0$ , they are substitutes. The consumer's maximisation problem yields the inverse demand schedules for each product

$$p_i = a - q_i - cq_j \quad i, j = 1, 2 \quad i \neq j, \quad (2)$$

where  $a > 0$  is a positive parameter. Firms' production functions are  $x_A = y_A = \sqrt{n_{iA}}$  and  $x_B = y_B = \sqrt{n_{iB}}$ ,  $i = 1, 2$ . Therefore, firms' profits are:

$$\Pi_1 = p_1(x_A + x_B) - w_A x_A^2 - w_B x_B^2, \quad \Pi_2 = p_2(y_A + y_B) - w_A y_A^2 - w_B y_B^2 \quad (3)$$

where  $w_A$  and  $w_B$  are the wage rates paid in A and B, respectively. Union utilities are

$$\Omega_A = (w_A - \varpi)n_A, \quad \Omega_B = (w_B - \varpi)n_B, \quad (4)$$

where  $n_A = n_{1A} + n_{2A}$  and  $n_B = n_{1B} + n_{2B}$  are total employment levels in countries A and B, respectively. In this model, the interpretation of  $\varpi > 0$  is that of a common minimum wage fixed by national governments in observance of an EU directive, and hence exogenous for unions.

### 3.1 Stage 2: Cournot competition between firms

In the second stage of the game, the firms compete à la Cournot in the product market. Given symmetry, let us consider firm 1's profit maximisation problem

$$\max_{x_A, x_B} \Pi_1 = \max_{x_A, x_B} [(a - (x_A + x_B) - c(y_A + y_B))(x_A + x_B) - w_A x_A^2 - w_B x_B^2] \quad (5)$$

from which first-order conditions yield the following reaction functions

$$x_A = \frac{(a - c q_j)w_B}{2(w_A + w_B + w_A w_B)}, \quad x_B = \frac{(a - c q_j)w_A}{2(w_A + w_B + w_A w_B)}.$$

The optimal allocation of production among the plants is, therefore,

$$x_A^*(w_A, w_B) = \frac{aw_B}{2w_A w_B + (2 + c)(w_A + w_B)}, \quad x_B^*(w_A, w_B) = \frac{aw_A}{2w_A w_B + (2 + c)(w_A + w_B)}.$$

Similar results hold for firm 2. As expected,  $x_A/x_B = y_A/y_B = w_B/w_A$ : the marginal costs of production for each firm across the two countries are equal. Given total production, this represents the necessary condition, so that total production cost is minimised (and hence profit maximised). Allocation of production directly implies the following labour demands in each plant

$$n_{iA}^*(w_A, w_B) = \left[ \frac{aw_B}{2w_A w_B + (2 + c)(w_A + w_B)} \right]^2, \quad n_{iB}^*(w_A, w_B) = \left[ \frac{aw_A}{2w_A w_B + (2 + c)(w_A + w_B)} \right]^2 \quad (6)$$

for  $i = 1, 2$ , with  $\partial n_{iA}/\partial w_A < 0$ ,  $\partial n_{iA}/\partial w_B > 0$ ,  $\partial n_{iB}/\partial w_A > 0$ ,  $\partial n_{iB}/\partial w_B < 0$ : employment levels in each plant depend negatively on the domestic wage and positively on the competing country's wage rate.

### 3.2 Stage 1: Unions' optimal wage strategy with separate settings

In stage 1, unions set wages to maximise rents. The analysis starts with the separate wage settings: each national union establishes a wage for its industry, taking as given the wage rate in the other country. In other words, unions play the Bertrand-Nash wage strategy. Given symmetry, let us consider union A's problem. Given the labour demand in (6) and the utility function in (4), the union chooses  $w_A$  such that

$$w_A = \arg \max_{w_A} 2(w_A - \varpi) \left( \frac{aw_B}{2w_A w_B + (2+c)(w_A + w_B)} \right)^2. \quad (7)$$

This maximisation problem leads to

$$w_A = 2\varpi + \frac{(2+c)w_B}{2(1+w_B)+c}$$

representing union's A reaction function. A similar result holds for union B. Solving the non-linear system, the equilibrium wage rate is

$$w^S = w_A = w_B = \varpi + \varphi$$

where  $\varphi = \sqrt{\varpi} \sqrt{\gamma}$ , and  $\gamma = \varpi + 2 + c$ . Differentiation shows  $\partial w^S / \partial \varpi > 0$  and  $\partial w^S / \partial c > 0$  (upper script stands for Separate): an increase in the minimum wage and a decrease in the degree of product differentiation imply an increase in the wage rate. Further substitutions lead to the employment levels at each plant, given by  $n_{iA}^S = n_{iB}^S = [a/2(\varphi + \gamma)]^2$  for  $i = 1, 2$ . The Appendix provides all the other relevant expressions.

### 3.3 Stage 1: Unions' collusive wage setting

Let us consider the case of collusive behaviour by unions. In this model, collusion stands for unions achieving an agreement over a common wage that maximises their joint utility, namely the sum of their utilities (*efficient union collusion*). In other words, unions coordinate wage demands. However, unions incur an exogenous (symmetric) transaction cost per member  $\tau \geq 0$  to coordinate their activities (definition of the optimal wage strategy for all workers), and for the sharing of information.<sup>19</sup> These costs may counterbalance collusive gains (Borghijis and Du Caju, 1999). Transaction costs may arise for the organisation of workshops, or for reciprocal participation of national bargaining policy experts as observers during negotiations, and for funding coordination activities of cross-border industry-wide unions' federations. A reduction in transaction costs (for example, because of the use of communication technologies) is the measure to describe increasing labour market integration. Unions now maximise the following utility function:

$$w^C = \arg \max_{w^C} (w^C - \varpi - \tau)(n_A + n_B). \quad (8)$$

First-order conditions yield

$$w^C = w_A = w_B = \varpi + \gamma + 2\tau$$

with  $\partial w^C / \partial \varpi > 0$  and  $\partial w^C / \partial c > 0$  (upper script indicates Collusion). Further substitutions allow evaluation of the employment levels at each plant, given by  $n_{iA}^C = n_{iB}^C = [a/4(\gamma + \tau)]^2$ , for  $i = 1, 2$ . The Appendix presents the other relevant variables' values.

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<sup>19</sup> The application of per-member fees to affiliate unions is the main source used by industry-wide European Union Federations, such as the EMF, EMCEF, ETUF-TCL and the EPSU, to finance their activities.

### 3.4 Union deviation

Let us now consider the case of union deviation. Deviation means undercutting the collusive wage to increase production in the plants located within the country, regardless of the incurrence of transaction costs. By paying these fees, the cheating union “signals” an interest in coordination, and then deviates. The optimal deviation wage will be lower than the collusive wage. For example, if the union in country A cheats, then the maximisation problem is characterised as follows:

$$w_A = \arg \max_{w_A} (w_A - \varpi - \tau)n_A(w_A, w_B^C). \quad (9)$$

First-order conditions lead to

$$w_A^D = \frac{4\{(\gamma - 1) + 3\varpi + 2[\varpi(\gamma - 2) + \tau(c + \tau)] + 4\tau(1 + \varpi)\} + c^2}{\varpi + 3\gamma + 4\tau}$$

with  $\partial w^D / \partial \varpi > 0$  and  $\partial w^D / \partial c > 0$  (upper script indicates Deviation). Substitution of the optimal wage under deviation leads to the evaluation of the employment levels at each plant in country A,  $n_{iA}^D = [a(\varpi + \gamma + 2\tau) / 2(3\varpi + \gamma + 4\tau)(\gamma + \tau)]^2$ , for  $i = 1, 2$ . The Appendix reports the union utility's value under the deviation strategy.

### 3.5 Unions and wage coordination

This section analyzes the unions' position with respect to wage coordination. Applying the above results, it can be checked that in equilibrium union collusion leads to higher wages and lower employment levels for every degree of product differentiation: that is,  $w^C - w^S > 0$  and  $n^S - n^C > 0 \quad \forall c \in (-1, 1)$ , where  $n^S = n_A^S + n_B^S$  and  $n^C = n_A^C + n_B^C$ .

Under the assumptions of linear cost and demand functions, Horn and Wolinsky (1988b) show that, in a general “right-to-manage” bargaining model with bilateral monopoly relations, in the absence of competition among unions (input suppliers) the collusive wage is higher (lower) and employment levels are lower (higher) than the separate setting if products are substitutes (complements). These findings also hold true in trade models with the same cost and demand structures, where monopoly unions have full bargaining power and compete with each other over wages (Strozzi, 2007; 2008). In the present context, the collusive agreement always determines a higher wage and lower employment. This is so for two reasons. Firstly, with a convex cost function, the conventional substitutability (complementarity) among products does not necessarily imply the strategic complementarity (substitutability) between them. Secondly, monopoly unions set wages for all workers in the industry, internalising both the positive externalities created by an increase in wage rates when unions operate independently (Davidson, 1988; Horn and Wolinsky, 1988b), and the effects of product differentiation on wage and employment levels. This can be demonstrated as follows. In the case of individual wage setting, if the union in A fixes a higher wage at the plants within the country, employment in B increases: in fact,  $\partial n_A / \partial w_A < 0$  and  $\partial n_A / \partial w_B > 0$ . This means that, in the labour market, workers in A compete against workers in B. A similar result holds for union B. Instead, in the case of wage collusion,  $\partial n_A / \partial w^C < 0$  and  $\partial n_B / \partial w^C < 0$ : employment in each country depends negatively on the coordinated wage demand, and competition among workers in the labour market disappears.

Unions' payoffs differ according to the wage setting. Transnational coordination is advantageous if  $\Omega^C \geq \Omega^S = (\Omega_A^S + \Omega_B^S)$ , that is, if the overall union utility under collusion is higher than the sum of the national union utilities under separate settings. Comparison of the payoffs leads to the following proposition.

**Proposition 1:** *The collusive outcome Pareto-dominates the separate wage setting if  $\tau \leq \tau^*(\varpi, c) = \gamma(\varpi + \gamma - 2\phi)/4\phi$ .*

Therefore, unions face a Prisoner's Dilemma: national industry unions have incentives to coordinate wage demands, getting higher utility levels from mutual cooperation, but wage coordination transpires to be beneficial only if the transaction costs are not excessively high. Further analytical inspection yields the following results.

**Corollary 1:** *An increase in the minimum wage and the degree of product differentiation lowers the threshold of the transaction costs for union coordination: formally,  $\partial \tau^*/\partial \varpi < 0$  and  $\partial \tau^*/\partial c > 0 \quad \forall \varpi \in (0, \infty) \wedge c \in (-1, 1)$ .*

Proof: see the Appendix.

For low values of the minimum wage, the threshold of the costs for union cooperation tends to be high, approaching infinity as long as  $\varpi \rightarrow 0$ . That is, wage coordination is likely when  $\varpi$  is small. The intuition is the following. In the presence of low minimum wages, unions are willing to pay relatively high fees because the gains in terms of rents over the minimum wage from cooperation are large enough to overcome the cost of coordinating activities. As  $\varpi$  increases, the unions' coordination benefits related to wage rents decrease, and, thus, smaller transaction costs are sufficient to prevent collusion. Instead, an increase in product differentiation ( $c \rightarrow -1$ ) reduces the value of the coordination fees' threshold for collusion profitability. That is, as products become more differentiated, the wage coordination Pareto-dominates the autonomous wage setting for a smaller range of transaction costs. In other words, union collusion is more advantageous when products are substitutes rather than complements. The next proposition supports this intuition.

**Proposition 2:** *If  $\tau \leq \tau^*$ , a decrease in transaction costs increases the incentives for collusion, with gains from coordination larger when products are substitutes.*

Proof: Differentiation of the union utility differential  $\Omega^C - \Omega^S$  with respect to coordination costs yields  $\partial(\Omega^C - \Omega^S)/\partial \tau = -a^2/4(\gamma + \tau)^2 < 0$ . Further differentiation with respect to  $c$  yields  $\partial^2(\Omega^C - \Omega^S)/\partial \tau \partial c = a^2/2(\gamma + \tau)^3 > 0$ : unions perform better when products are similar rather than complements.

Thus, incentives for transnational wage coordination exist. For transaction costs sufficiently low, unions find advantageous coordination, no matter what the degree of product differentiation is. However, the findings have shown that the unions' position is exemplified by a classic- Prisoner's Dilemma. The next section investigates the conditions for the sustainability of wage coordination as equilibrium of the unions' game.

#### 4 The sustainability of transnational union coordination

The scope and incentives' analysis for cross-border union collusion applies to a situation where unions bargain repeatedly. In a two-stage game, the infinitely repeated bargaining process may

implement collusion, with repetition providing in itself the channel through which cooperation arises, independently from the presence of legal agreements. The purpose is to study which conditions make it advantageous for unions to coordinate wage demands, and the role of labour market integration on their collusive behaviour.

With four players, the set of possible strategy combinations is large. For this paper's objectives, a simplifying assumption is needed: firms do not collude, acting always as Cournot competitors. In a repeated framework, this is a strong assumption because firms also have collusive incentives. However, the hypothesis is retained to isolate the effects of unions' coordinated wage claims. This can also be interpreted as if there is an effective Antitrust Authority watching over product markets. The dynamic game specifies the following. By assumption, labour markets are already sufficiently well integrated at the beginning of the game. In the first period,  $t = 0$ , union  $i$  selects to coordinate wage demands with the other union and plays the collusive strategy. Subsequently, in every period  $t > 0$ , the union cooperates if and only if in all preceding periods both unions coordinated their wage strategies. So long as unions cooperate, they incur transaction costs. However, union  $i$  captures an immediate utility gain by deviating unilaterally from the collusive agreement, even if it pays the transaction costs in periods  $t > 0$ . As previously seen, deviation implies a wage cut inducing firms to relocate part of their production in the country where the union makes concessions. If in any of the previous periods one union broke the collusive agreement, in the successive period the other union does not cooperate, and plays the Bertrand–Nash wage resulting from the separate setting, without paying any transaction costs. Such a situation reflects unions' adoption of a trigger strategy.<sup>20</sup> Collusion can be sustained only if it is backed by some dynamic threats, such that the one-period gain from cheating will be lower than the discounted expected value from punishment, that is, the reversion to a separate setting. The discount factor is assumed identical for both unions. Therefore, for each union, collusion is sustainable in a repeated framework if

$$\delta_i \geq \frac{(\Omega_i^D - \Omega_i^C)}{(\Omega_i^D - \Omega_i^S)}, \quad i = A, B \quad (10)$$

where  $\Omega_i^C = \Omega_i^C(w_i^C, w_j^C)$  is the utility level obtained with collusion,  $\Omega_i^D = \Omega_i^D(w_i^D, w_j^C)$  is the utility level deriving from the one-period defection, and  $\Omega_i^S = \Omega_i^S(w_i^S, w_j^S)$  is the utility derived from punishment, with  $i, j = A, B; i \neq j$ . The right-hand side of expression (10) determines the discount factor threshold for the sustainability of union collusion. This condition implies that unions will behave in a collusive fashion as long as they do not discount too much the future, and the immediate gains from unilateral deviation are comparatively low. Given symmetry, the insertion of the relevant payoffs into equation (10) leads to

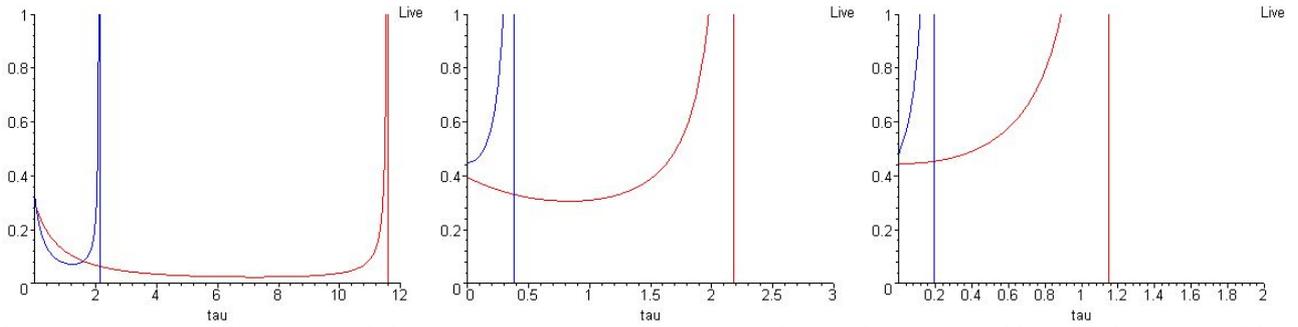
$$\delta \geq \delta^* = \frac{(c+2)^2(\varphi + \gamma)^2}{4[\gamma(\varpi + \gamma)(\varpi + \gamma + 2\tau)^2 - \varphi\Psi]}, \quad (11)$$

with

$$\Psi = 8\varpi^2[\varpi + 2(2 + c + 2\tau)] + \varpi[40\tau(2 + c + \tau) + 9(c + 2)^2] + 8\tau^2(2\tau + 6 + 3c) + (c + 2)^2(11\tau + c + 2).$$

<sup>20</sup> The trigger strategy is the simplest and most frequently applied punishment strategy. Straume (2002), and Strozzi (2007, 2008) remark that this is not necessarily the optimal punishment strategy, as Abreu (1988) holds.

**Figure 2** Relationship between the discount factor threshold and coordination costs.



Graphs are depicted for  $\varpi = .01$  (left),  $\varpi = .14$  (centre) and  $\varpi = .5$  (right), and  $c = .99$  (red line) and  $c = -.99$  (blue line).

The interpretation of the expression of the discount factor threshold is not immediately intuitive due to analytical complexity. Therefore, the discussion on the role played by transaction costs on the sustainability of collusion uses analytical tools and numerical simulations.

Corollary 1 has shown that an increase in the minimum wage,  $\varpi$ , and the degree of product differentiation,  $c$ , lower the critical level for the coordination costs,  $\tau^*$ , which makes collusion advantageous. The same can be observed in Figure 2, which depicts the discount factor threshold,  $\delta^*$ , as a function of the transaction costs,  $\tau$ , for given levels of  $\varpi$  and  $c$ . As these parameters increase, the vertical lines representing the thresholds for transaction fees (red vertical,  $\tau_{sub}^*$ ; blue vertical,  $\tau_{com}^*$ ; lower scripts stand for substitute and complement, respectively) move towards the axes' origin. Differentiation of equation (11) with respect to transaction costs yields

$$\partial\delta/\partial\tau = [(c+2)^2(\gamma+\phi)^2N]/\Delta^2,$$

where

$$\Delta = \Delta(\varpi, c, \tau) \text{ and } N = 4[\varphi\Upsilon - 4\gamma(\varpi + \gamma)(\varpi + \gamma + 2\tau)],$$

with  $\Upsilon = \{8\varpi[4\varpi + 5(c + 2 + \tau)] + 48\tau(c + 2 + \tau) + 11c^2 + 44(c + 1)\}$ . The sign of this derivative depends on the sign of  $N = N(\varpi, c, \tau)$ . Numerical simulations show that  $\partial\delta/\partial\tau \geq 0$  if  $\varpi \geq \varpi_{sub}^* \approx .517$  when  $c \rightarrow 1$  (substitutes), and  $\varpi \geq \varpi_{com}^* \approx .174$  when  $c \rightarrow -1$  (complements). Hence, labour market integration (a fall in  $\tau$ ) makes collusion unequivocally more sustainable when minimum wages are higher than certain critical levels, with product differentiation lowering these critical values. The rationale is that a reduction of coordination costs makes the short-run deviation unappealing, while the long-run punishment becomes harsher. Thus, under these circumstances, collusion is an increasingly viable option for unions.

For minimum wages lower than the critical values  $\varpi_{sub}^*$  and  $\varpi_{com}^*$ , the discount factor threshold presents a U-shaped relation. As coordination costs increase, the discount factor threshold initially decreases, then remains at a low level within a certain range (wider with substitute than with differentiated goods), and then, when coordination costs are close to the critical limit of  $\tau^*$ , transnational coordination is increasingly hard to be sustained. This is explained as follows. For a given level of product differentiation, in the presence of well integrated labour markets ( $\tau$  close to zero), the transaction fees are so low that deviation is not onerous for each union. Therefore,

deviation from the collusive wage may be an attractive option, while the punishment is not sufficiently harsh. If the labour market becomes less integrated ( $\tau$  increases), gains from deviation are lessened (the cost of a deviation being relatively high), and the Nash reversion is a more severe punishment. Finally, if coordination fees approach  $\tau^*$ , the incentives to deviate from collusion are high, while the punishment is not harsh enough to avoid unions' deviation. This last result is quite intuitive: unions are close to the coordination cost levels which makes the separate wage settings more advantageous than the coordinated wage demands.

From Figure 2, two other remarkable observations arise. Firstly,  $\tau^*$  decreases as products are more differentiated (from Corollary 1). After numerical simulations, it was found that, if minimum wages are lower than  $\varpi \approx .04$ , there is a range  $0 \leq \tau < \tau_{com}^*$  such that the discount factor threshold for collusion in the presence of high complement goods may be lower than with substitute goods (Figure 2, left box). That is, collusion is easier to sustain when products are well differentiated. An explanation for this result may be that there exist parameter combinations such that the impact of the wage-differential gains from deviation on unions' welfare is larger when goods are complements than substitutes. Nevertheless, as  $\varpi$  increases, gains from unilateral deviation with substitute goods are revealed to be comparatively smaller (and the long-run punishment harsher), making deviation not advantageous: collusion with substitute goods is more sustainable than with differentiated products.

Secondly, for  $\varpi \geq \varpi_{sub}^*$  (substitutes) and  $\varpi \geq \varpi_{com}^*$  (complements), a reduction in unions' coordination costs unambiguously reduces the discount factor threshold, making collusion more sustainable. Nonetheless, it should be noted that, even if for  $\varpi < \varpi_{sub}^*$  and  $\varpi < \varpi_{com}^*$  at relatively low values of transaction costs it occurs that  $\partial\delta/\partial\tau \leq 0$  (labour market integration implies that the unions' collusive behaviour is less sustainable), the discount factor threshold is always lower than in the case of  $\varpi \geq \varpi_{sub}^*$  and  $\varpi \geq \varpi_{com}^*$ : that is,  $\delta_{sub}^* \Big|_{\varpi < \varpi_{sub}^*} < \delta_{sub}^* \Big|_{\varpi \geq \varpi_{sub}^*}$  and  $\delta_{com}^* \Big|_{\varpi < \varpi_{com}^*} < \delta_{com}^* \Big|_{\varpi \geq \varpi_{com}^*}$ . In other words, union collusion is more sustainable if minimum wages are sufficiently low. In the absence of coordination costs, it can be shown that the discount factor threshold takes values in the range  $\delta|_{\tau=0} \in (1/4, 1/2)$  for  $\varpi \in (0, \infty) \wedge c \in (-1, 1)$ , approaching its upper limit for  $\varpi \rightarrow \infty$ .

In the present context, the analysis has shown that there is no clear-cut relation between increasing labour market integration and transnational union collusion. For low minimum wages, the collusive behaviour among unions is more easily sustained for intermediate values of coordination costs than in the presence of extremely high and extremely low costs. For minimum wages high enough, as labour markets become more integrated, union collusion is always advantageous. However, the union collusion is always more sustainable when minimum wages are relatively small. These results complement those obtained in the intra-industry trade literature. Strozzi (2007, 2008), extending the analysis of Straume (2002) (which is limited to the case of perfect substitute goods,  $c = 1$ ), finds that with segmented markets and zero transaction costs between unions, the sustainability of implicit collusion depends both on trade barriers and the degree of substitutability among goods, namely for  $c \in (0, 1)$ . If trade costs are relatively low, further trade liberalisation makes deviation an increasingly attractive option for unions. Moreover, deviation is relatively more beneficial from the unions' viewpoint when goods are differentiated. On the other hand, when intra-industry trade occurs, but trade barriers are relatively high, a reduction in trade costs does not affect the sustainability of implicit collusion, which is easier the less similar the goods. In this case, the

discount factor threshold ranges from  $\delta = 1/2$  (almost independent goods) to  $\delta = 9/17$  (perfect substitutes), representing the lowest threshold values for collusion. The analysis also takes into account the possibility of collusion among firms in the product market. However, a general result arising from Strozzi's (2007, 2008) works is that increasing product market integration always makes union collusion more difficult to sustain. To sum up, this discussion shows that the results related to the sustainability of wage coordination policies are very sensitive to the underlying assumptions of the model (integrated vs. segmented markets; constant vs. decreasing return to scale; only substitute products vs. complement and substitute products).

The fact that, in recent years, unions' transnational agreements have been growing, notably in sectors of the EU characterised by a large presence of MNEs, may point to the fact that coordination costs for union activities are falling. These findings may help to shed light on the fact that wage coordination is emerging as a gradually viable option for unions, suggesting that the integration of the labour markets in some industries is increasing.

## 5 Union coordination and welfare

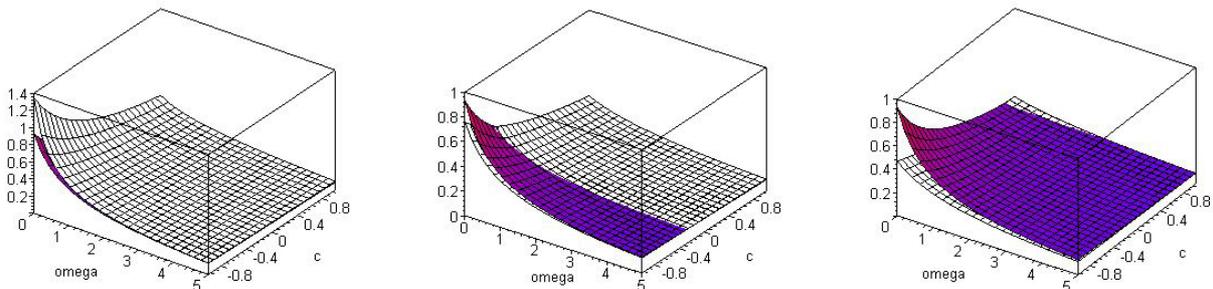
As previously seen, if unions implement collusion, a transnational agreement improves workers' conditions because their welfare share is higher than under a separate wage setting. Now, the question arises: is union collusion always an undesirable outcome from the social viewpoint? The answer to this question is noteworthy for its redistributive implications.

Global welfare is defined by the sum of consumers' surplus, profits and union utilities; formally

$$GW = U - \sum_i p_i q_i + \sum_i \Pi_i + \Omega_A + \Omega_B \quad i, j = 1, 2 \quad i \neq j. \quad (12)$$

The "EU Commission", at central level, may implement a "Directive" with the objective of increasing minimum wages in order to prevent wage coordination. Corollary 1 states that an increase in  $\varpi$  lowers the threshold for unions to coordinate their activities, making collusion less likely. Nevertheless, two observations are needed. Firstly, such an intervention has the effect of lowering the welfare level: in fact,  $\partial GW^S / \partial \varpi < 0$  in the relevant  $(\varpi, c)$ -space (see Appendix). This occurs because an increase in  $\varpi$  has a pass-through effect on higher prices, implying a reduction in consumers' surplus, and firms suffering from higher wages. Unions' rents do not offset these welfare losses. Secondly, for given transaction costs in the economy, a change in  $\varpi$  to prevent union collusion does not necessarily imply that  $GW^S > GW^C$ .

**Figure 3** Global Welfare in the  $(\varpi, c)$ -space



Notes: Black and white refers to  $GW^S(\varpi')$ , colour to  $GW^C(\varpi, c)|_{\bar{\tau}=\bar{\tau}^*}$ . Plots refer to  $\varpi' = \varpi + .1$  (left),  $\varpi' = \varpi + .5$  (centre) and  $\varpi' = \varpi + 1.1$  (right).

Suppose that the minimum wage in the economy is  $\varpi$  and the unions' coordination costs are equal to the threshold,  $\bar{\tau} = \tau^*(\varpi, c)$ . An increase in the minimum wage to  $\varpi' = \varpi + \varepsilon$  implies that  $\bar{\tau} > \tau^*(\varpi', c)$ , preventing collusion. However, it may be that for some combinations of  $(\varpi', c)$ ,  $GW^C(\varpi, c)|_{\bar{\tau}=\tau^*} < GW^S(\varpi', c)$ , while the configuration of other parameters leads to  $GW^C(\varpi, c)|_{\bar{\tau}=\tau^*} \geq GW^S(\varpi', c)$ , as Figure 3 shows.

If the magnitude of  $\varepsilon$  is sufficiently large, the overall negative impact on welfare of the higher wage  $w^S(\varpi', c)$  under separate settings is larger than the collusive wage  $w^C(\varpi, c)|_{\bar{\tau}=\tau^*}$ . The graphs also highlight that, when  $\varepsilon$  increases, the welfare level under collusion begins to be higher than the welfare level under separate settings when goods are complements ( $c < 0$ ). The reason is that, the higher the degree of product differentiation, the lower the collusive wage, and the smaller the relative negative effect of collusion on consumers' surplus and firms' profits.

**Proposition 3:** *In an integrated product market, if unions' coordination fees are equal to the threshold value, a "social planner" intervention aiming at increasing the minimum wage in the economy may lead to the social welfare under wage collusion being higher than the social welfare in the presence of separate national wage settings.*

The results derived here in terms of welfare analysis are not appropriately comparable with the received literature because the models' structures are diverse. However, some noteworthy differences arise. Strozzi (2007, 2008) finds that, for  $c \in (0,1)$  (substitute goods, but not perfect substitutes), wage collusion is unambiguously advantageous from the unions' viewpoint, whatever the degree of product differentiation and the level of trade costs. This is the case because in these works unions do not incur in any transaction costs to coordinate wage demands. The relative welfare losses due to collusion increase as product markets become more integrated, and if traded goods are close to perfect substitutes these are comparatively larger than when a certain degree of differentiation is present. The reason is that, with goods close substitutes, the collusive wage is higher than with the presence of some degree of differentiation; therefore, consumers and firms suffer more. Thus, union collusion is always welfare-damaging for trading countries. The present work finds that collusive unions are not always welfare-detrimental, for the reasons explained above. However, in line with previous works, it is found that the negative impact of collusion on welfare is smaller with complement products than with substitutes because, in this case, collusive wages are lower. Moreover, in Strozzi's (2007, 2008) models, policy makers have no intervention tools to avoid the occurrence of collusive behaviour among unions. Instead, this paper allows the "EU Commission" (the "central" social planner) to use the minimum wage as an economic policy instrument to avoid collusion. Separate wage settings at low values of  $\varpi$  ensure the highest level of social welfare. This is exactly the situation where a collusive agreement by unions is likely to arise as equilibrium. Nevertheless, "too" large increments in the minimum wage due to the "EU Commission Directive" may be welfare-detrimental. This is because "too" high minimum wages under separate settings may impact negatively on global welfare more than a collusive wage in the presence of low minimum wages. The potential solution to this puzzle might be a political one. First, the "EU Commission" should give up intervening at the central level by adopting a Directive on the minimum wages. Then, to achieve overall welfare improvements in the presence of relatively low minimum wages, in each country, unions should voluntarily renounce the right to coordinate wage demands in favour of national governments' commitments in adopting redistributive policies after the national bargaining round. In other words, the main policy insight is that the "central" social planner may improve the global welfare of the integrated economic area via coordinated national fiscal policies rather than with a centralised intervention in the labour market.

## 6 Conclusions

This work analyses the sustainability of unions' cross-border wage coordination policy in the context of international production within an integrated economy, and the consequences on social welfare. It presents a two-stage game model of international duopoly with differentiated products to investigate unions' positions towards wage coordination. In the presence of coordination costs (a measure of the labour market integration), unions may face a Prisoner's Dilemma: below a threshold value, the collusive outcome Pareto-dominates the separate wage setting. Hence, incentives for national unions to coordinate wage demands exist. In a repeated framework, the transaction cost level, the minimum wage and the degree of product differentiation, are all elements affecting the sustainability of union collusion.

From the welfare analysis, some policy insights follow. A transnational agreement between unions improves workers' conditions: unions are able to capture a higher share of welfare. An increase in the minimum wage lowers the threshold for coordination costs, making gains from cooperation smaller. This induces unions to implement individual wage setting, and the collusive outcome is more difficult to reach. The implication of this policy is that, as long as the minimum wage increases, the social welfare decreases; it may occur that in some cases welfare under coordinated wage demands is higher than under separate settings. Pareto improvements could be obtained through a political solution: unions may give up coordinated wage demands in favour of subsequent national government redistributive policy.

These findings are based on peculiar hypotheses related to functional forms, monopoly unions and symmetry in unions' preferences. A more general bargaining framework, as well as asymmetries in preferences over wages and employment, represent further extensions that could change the results. Moreover, a deeper analysis is needed to determine the public policy instruments required to implement welfare redistribution at national levels, to avoid the transnational coordination of wage policies among unions.

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## Appendix

■ Global equilibrium expressions of the relevant variables in the separate and coordinated wage settings follow.

□ **Separate wage setting (S)**. Equilibrium employment level, total union utility, total profits, consumers' surplus and global welfare in *S* are

$$\begin{aligned}
 n^S &= [a/(\varphi + \gamma)]^2 \\
 \Omega^S &= \varphi [a/(\varphi + \gamma)]^2 \\
 \Pi^S &= (\varpi + \varphi + 2) [a/(\varphi + \gamma)]^2 \\
 CS^S &= (c + 1) [a/(\varphi + \gamma)]^2 \\
 GW^S &= (2\varphi + \gamma + 1) [a/(\varphi + \gamma)]^2
 \end{aligned}$$

□ **Coordinated wage setting (C).** Equilibrium employment, total union utility, total profits, consumers' surplus and global welfare in  $C$  are

$$\begin{aligned} n^C &= [a/2(\gamma + \tau)]^2 \\ \Omega^C &= (\gamma + \tau)[a/2(\gamma + \tau)]^2 \\ \Pi^C &= [\varpi + \gamma + 2(1 + \tau)]/2 [a/2(\gamma + \tau)]^2 \\ CS^C &= (c + 1) [a/2(\gamma + \tau)]^2 \\ GW^C &= [3(\gamma + \tau) + 1][a/2(\gamma + \tau)]^2 \end{aligned}$$

□ **Union deviation (D).** Expressions for national employment level and union utility under deviation follows.

$$\begin{aligned} n_i^D &= 1/2 [a(\varpi + \gamma + 2\tau)/(3\varpi + \gamma + 4\tau)(\gamma + \tau)]^2 \quad i = A, B \\ \Omega_i^D &= a^2 (\varpi + \gamma + 2\tau)^2 / 2(\gamma + \tau)(\varpi + 3\gamma + 4\tau)(3\varpi + \gamma + 4\tau) \quad i = A, B \end{aligned}$$

■ Proof of Corollary 1 follows.

*Proof.* The expression for the derivative of the threshold for transaction costs  $\tau^*$  with respect to the minimum wage is

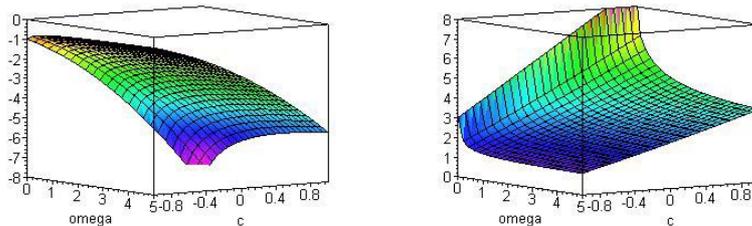
$$\partial \tau^* / \partial \varpi = -[4\varpi(\varphi - \varpi) - (c + 2)(\gamma - 3\varpi)] / 8\varpi\varphi$$

while the expression for the derivative of the threshold for transaction costs with respect to the degree of product differentiation is

$$\partial \tau^* / \partial c = (3\gamma - 4\varphi + \varpi) / 8\varphi.$$

The sign of these derivatives depends on the sign of the numerators of the relative expressions. Given the analytical complexity, Figure A.1 depicts their behaviour, which shows that  $\partial \tau^* / \partial \varpi < 0$  (left), and  $\partial \tau^* / \partial c > 0$  (right) in the relevant range of analysis  $\varpi \in (0, \infty) \wedge c \in (-1, 1)$ . □

Figure A.1: Numerator functions of the partial derivatives  $\partial \tau^* / \partial \varpi$  (left) and  $\partial \tau^* / \partial c$  (right) in the  $(\varpi, c)$ -space



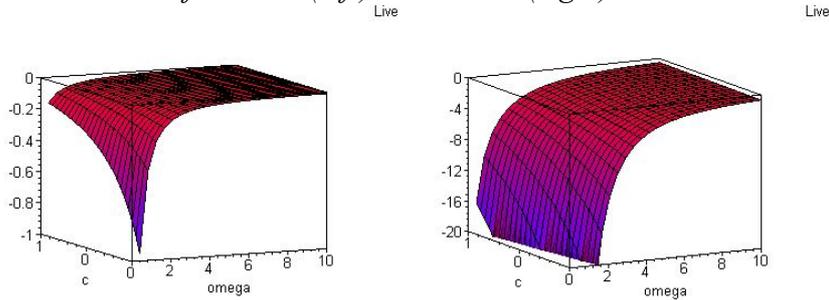
- Sign of the derivative of global welfare with respect to minimum wage.

The derivative of global welfare in the separate wage setting with respect to the minimum wage is

$$\partial GW^s / \partial \varpi = -a^2 [(\varpi + \varphi)(3\gamma - c) + \varpi(c + 1) + \gamma] / (\varphi + \gamma)^3 \varphi$$

The sign of this derivative depends on the sign of the numerator, whose analytical expression is not easy to interpret. Figure A.2 plots the behaviour of the numerator function which shows that it is negative in the relevant range of analysis, approaching the value of 0 from below for  $\varpi \rightarrow \infty \forall c \in (-1,1)$ . □

Figure A.2: Numerator function of the partial derivative  $\partial GW^s / \partial \varpi$  in the  $(\varpi, c)$ -space for  $a = 1$  (left) and  $a = 10$  (right)







# Internationalization of Firms' Activities and Company Union Wage Strategies

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**Abstract:** In a two-country oligopoly model with a homogeneous product, this paper analyzes firms' decisions concerning international activities (trade vs. Foreign Direct Investment, FDI) in the presence of company-wide unions. Equilibrium regimes depend on the interdependence of exogenous integration costs, endogenous union wage strategies and firms' strategic interactions. The paper derives the full set of production structures arising in equilibrium when internationalization is a viable option: symmetric (intra-industry trade or reciprocal FDI), multiple symmetric (intra-industry trade and reciprocal FDI) and asymmetric regimes (a multinational which coexists with an exporting firm) exist.

JEL no. F16; F21; F23; J51; L13.

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

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## 1. Introduction

Two results emerge as the most evident consequences of the process of economic integration occurring at the European level. Firstly, 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). Secondly, the creation of the European Monetary Union (EMU), concluding with the introduction of the Euro in 2002. 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 in trade costs in product markets, exemplify this course of action. Further developments and improvements in the Financial Service Action Plan (FSAP) and the financial market integration within the EU itself have driven a significant growth in the figures related to intra-industry trade (IIT) (see European Commission, 2008a) and intra-EU foreign direct investments (FDI) (see Jovanović, 2006; European Commission, 2008b).

The EU economic background offers an ideal “humus” for the internationalization of firms’ activities. At the same time, as long as product and capital markets become more integrated, major actors in European labor markets, as trade unions, start taking into account a broader perspective in their activities. Some of the European Commission’s legislative initiatives, such as the approval of the 1994 European Working Councils (EWC) directive<sup>21</sup> and the 2001 European Company (Societas Europaea, SE) directive, which advanced the practice of informing and consulting the workforce in transnational contexts, are shifting towards the company level the key level of collective bargaining in many industrial sectors. However, depending on the degree of market integration and the presence of productive activities organized internationally, there are remarkable distinctions between industries. Company-level negotiations are prominent in those sectors characterized by a high incidence of Multinational Enterprise (MNE) operations. In recent years, unions exploited the potential of the European Works Councils more intensively during company-wide bargaining processes. For example, in the banking sector, Danish trade unions received the mandate to negotiate on behalf of all employees working in the Danske Bank Work Council (EIROnline, 2009). The European Metalworking’s Federation (EMF) and UNI Europa Graphical (UEG), two cross-border industry level federations, devised a procedure to receive the mandate in representing the overall workers’ side throughout company-wide transnational agreements. Since the formulation of this internal procedure, the EMF has utilized it with at least five MNE (Areva, Schneider, Daimler-Chrysler, John Deere and ArcelorMittal) (Eurofound, 2009; Gennard, 2009a). The creation of cross-border unions is another response to company-wide negotiations. In 2009, a “pioneering trans-boundary seafarers’ union”, Nautilus International, was launched, based in the UK and the Netherlands. It represents a wide range of personnel working in the shipping sector, at sea, on inland waterways, and ashore. The cross-border union is the result of a merger process following several years of closer cooperation between Nautilus NL and Nautilus UK, including joint industrial negotiations with companies employing British and Dutch workers (Gennard, 2009b).

The figures related to the cross-border company agreements are likely to increase steadily. In fact, among the total of transnational agreements achieved in recent years, two thirds concern the activities of European MNEs within the EU itself (ETUC, 2007).<sup>22</sup> Company-level negotiations across boundaries may affect bargaining outcomes and, therefore, the firms’ choice related to the internationalization of their activities. As Horn and Wolinsky (1988) suggest, firms would like to take strategic advantage of a MNE organizational structure to avoid the creation of an encompassing union. Might the prospect of a unique workers’ representative body within a company affect the firms’ internationalization strategies? Focusing precisely on this issue, this

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<sup>21</sup> Recently revised in 2009: Directive 2009/38/EC of the European Parliament and of the Council of 6 May 2009 on the establishment of a European Works Council or a procedure in Community-scale undertakings and Community-scale groups of undertakings for the purposes of informing and consulting employees, OJ EU L. 122 of 16.5.2009.

<sup>22</sup> On collective bargaining in MNEs, see Eurofound (2009), and European Commission (2011).

paper develops a two-country duopoly model where an organized workforce seeks to gain part of the rents generated in the product market. The crucial difference, with respect to previous theoretical models, is the presence of company-wide unions, which negotiate on behalf of all workers, independently from the fact that they are located in different countries. This reflects the situation of negotiations among unions operating in Works Councils with the general management of firms pursuing international business. In exploring this topic, this work tries to depict the latest evidence as regards union coordination in MNEs, attempting to give some plausible predictions about potential developments of international business in the EU environment.

In a symmetric two-country oligopoly model with the presence of company-wide workforce representatives, the interdependence of exogenous integration costs (sunk and trade costs), endogenous union wage strategies, and the strategic interaction in the product market, influence the firms' choice concerning the start of international activities (export vs. FDI). The main results are as follows. A rich set of the productive structure regimes will take place in equilibrium for the international oligopoly. While the presence of symmetric regimes (intra-industry trade or FDI) is a natural consequence, a novel result is that, for some combinations of integration costs, multiple equilibria are possible, exemplified by symmetric (IIT and RFDI) and asymmetric regimes (the coexistence of a MNE with an exporting firm). RFDI regime is one equilibrium of the game also applicable for low values of trade costs, when IIT is feasible. The rationale for this result resides simply in the firms' strategic product market interactions. Nevertheless, if the scale of the sunk costs is large enough, IIT is the unique equilibrium of the game. This is so because the company-wide unions set wage rates when firms invest higher than in the case of exports: high wages and sunk costs are not sufficient to counterbalance the trade cost savings.

This paper relates to a body of literature analyzing, within different contexts, the implications of international economic integration on labor market outcomes in the presence of unions. Nonetheless, few works have investigated how this process affects the unions' strategic behavior and how the unions' behavior may in turns affect firms' strategic choices related to international activities. The first group of authors examining how international integration affects the wage formation in the presence of unionized countries is Huizinga (1993), Sørensen (1993), Naylor (1998, 1999), Borghijs and Du Caju (1999), Straume (2002), Lommerud et al. (2003), Glass and Saggi (2005), Strozzi (2007, 2008), and Ishida and Matsushima (2009).

Authors such as Huizinga (1993), making use of a monopoly union model, and Sørensen (1993), utilizing a more general right-to-manage model, conclude that product market integration leads to an enlargement of the market size. Consequently, the number of firms operating in the market increases, intensifying the degree of competition. This, in turn, 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 models do not take into account any interaction between the two economies before integration occurs. Closely related to this work are the contributions of Naylor (1998, 1999). In these articles, two identical firms initially produce a homogeneous product for their home markets and, under the assumption of perfect symmetry in both product and labour markets, they engage in reciprocal dumping when trade cost levels fall below a threshold value. This implies a fall in the wage demands of labor unions: intra-industry trade, putting unions in competition internationally in the labor market, erodes their monopoly power. As the degree of economic integration increases (further reduction in trade costs), unions set higher wages due to higher profits for both firms, capturing part of the firms' rent. These works study the effects of economic integration on wages and unions' outcomes, and the interaction between the two economies, exemplified by the unions' strategic behavior in labor markets.

Of interest to the analysis of this paper are the works of Lommerud et al. (2003), Glass and Saggi (2005) and Ishida and Matsushima (2009). Lommerud et al. (2003) make use of a two-country reciprocal dumping model of oligopoly with only one country unionized, focusing the analysis on how trade liberalization and wage setting affects the firms' location choice, and, therefore, the way

firms choose to serve their relevant markets. While Lommerud et al. (2003) consider the presence of one firm in each country, in a similar framework Ishida and Matsushima (2009) analyze the same issue when domestic competition occurs between firms in the same country. Taking a different approach from Lommerud et al. (2003), Glass and Saggi (2005) determine endogenously the equilibrium FDI regime without considering the effects of trade liberalization. In their international duopoly model trade costs are sufficiently low such that firms may always export their products. The crucial assumption is that both firms require one intermediate product that a local upstream monopolist supplier provides exclusively. The authors show that under these circumstances outward FDI can act as a cost-raising strategy. However, 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 a general equilibrium framework. As in Naylor and Santoni (2003), Zhao (1995) and Eckel and Egger (2009), the present paper allows for intra-industry reciprocal FDI and the presence of unions in the labor market. Notwithstanding the different approaches, underlying hypothesis and purposes of analysis, these models achieve a common result: if firms have the opportunity to invest abroad, they will cause a moderation in wage demands during the bargaining process. Consequently, the position of unions appears to be weakened.

The present paper contributes to the previous literature in the following way. It widens Naylor’s (1998; 1999) analysis by allowing firms to undertake FDI, as in Lommerud et al. (2003). However, differently from Lommerud et al. (2003), the model considers unionized workforces in both countries, in a more realistic reflection of the characteristics of the EU labor market. By assumption, the MNE’s workers are organized at company level: the model retains this hypothesis to capture the latest evidence on transnational company agreements in Europe. The implications of this framework are far-reaching. Firstly, as in Lommerud et al. (2003), it shows that trade liberalization makes the investment strategy more profitable; nonetheless, in contrast with these authors, FDI may occur even if the wage rate in the investing firm is higher than the wage resulting from the export strategy. Secondly, in the presence of FDI, exports may be present in equilibrium for a range of trade costs wider than that found in Naylor (1999). In doing so, this work tries to create a link between two issues that the previous literature treated as separate subjects, giving some plausible predictions for labor market outcomes and international business organization in a unionized environment like the EU.

The remainder of the article is organized in the following way. Section 2 outlines the analytical framework. It develops a non-cooperative three-stage game of international duopoly in the presence of unionized workforces at company level. Firms act as first movers choosing independently whether to invest in the foreign country, paying a certain level of sunk costs. If firms do not invest, they may either export to the foreign country or produce exclusively for their domestic country. Then, in the second stage, company unions select their optimal wage strategy. The usual backward induction method solves the model. Depending on sunk and trade costs, and due to the strategic interaction between firms and unions, different productive structures may arise in equilibrium. Finally, Section 3 brings the paper to its conclusion.

## **2. The Basic Model**

There are two 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 homogeneous

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

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

goods, denoted  $x$  when produced in A and  $y$  when produced in B. Firms 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. By this normalization (without loss of generality), each worker produces one unit of the product: 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).

The representative consumer in each country maximizes the following quasi-linear utility function

$$U = \bar{U}(x, y) + z = (x_{ik} + y_{jk}) - \frac{1}{2}(x_{ik}^2 + y_{jk}^2 + 2x_{ik}y_{jk}) + z$$

with  $i, j = 1, 2$   $i \neq j$ ;  $k = A, B$ , where  $\bar{U}(x, y)$  is the quadratic utility deriving from the consumption of the good produced in the imperfectly competitive sector, while  $z$  is the linear utility deriving from the consumption of the competitive good.<sup>23</sup> These consumers' preferences imply that the demand schedules are linear. Company level unions operate and organize their activities in the imperfectly competitive sector, whose workers are fully unionized.

The model is a three-stage game. In the first stage of the game, firms autonomously choose whether to invest. Each firm has two strategies<sup>24</sup> (Table 1): not to invest, maintaining all productive activities in the domestic country; and to invest abroad, setting up a new plant. If firms undertake FDI and establish a production plant in the foreign country, they incur an exogenous sunk cost  $F \geq 0$ . Otherwise, firms may serve the other country through exports, paying a constant, exogenous cost  $t \in [0, 1)$  per unit of the commodity exported.<sup>25</sup> As a consequence, several regimes might arise:

1) both firms do not invest: depending on trade costs and unions' strategic decisions, firms may serve the other market through exports, allowing for intra-industry trade (IIT)<sup>26</sup>; 2) both firms invest (reciprocal FDI, RFDI); and 3) only one firm invests (asymmetric regimes). In Table 1,  $\Pi^{NN}$  denotes the profits when both firms do not invest;  $\Pi^I$  denotes RFDI profits;  $\Pi^{NI}$  ( $\Pi^I$ ) denotes profits when one firm invests abroad while the other does not (and vice versa). In the second stage, monopoly unions (having full bargaining power, see Dowrick, 1989) set their optimal wage strategies, competing with each other in the labor market. Finally, in the third stage, firms engage in a Cournot competition,<sup>27</sup> choosing profit-maximizing quantities separately for each market, realizing output. Market segmentation, combined with the constant marginal costs assumption,

<sup>23</sup> Consumers' utility will take similar forms in the case of production in the presence of FDI.

<sup>24</sup> This paper considers only pure strategies.

<sup>25</sup> The condition  $t < 1$  represents a "viability condition". In fact, for  $t > 1$ , exports will never occur.

<sup>26</sup> In principle, there are two additional outcomes in this sub-case, namely the one-way trade regimes. As Naylor (1999) shows, if countries are symmetric, and both labor markets are unionized, one-way trade is not an equilibrium regime.

<sup>27</sup> As Brander (1981) pointed out, it might unquestionably be argued that it is unrealistic to take the quantity rather than the price as the firm strategic variable. The Cournot setting in the output market has been chosen in this paper for the sake of simplicity.

implies that the price of the good in each country depends exclusively on the total quantity available in the market.

The model is solved by the backward induction method in order to derive sub-game perfect equilibria. The following subsections inspect, for each regime of the productive structures, first the output game among firms in the product market, deriving the firms' labor demand functions in terms of wages. Then, in the second stage, given the firms' labor demands, the analysis of the unions' wage setting in the labor markets is presented. Finally, turning back to the first stage of the game, the results of the sub-games allow an evaluation of the firms' payoff functions. According to realized profits, each firm chooses which internationalization strategy should be adopted. Therefore, having collected all the relevant results, it is possible to derive the conditions under which a particular structure of production arises as equilibrium of the game.

Since the aim of this paper is to derive the productive structure arising in equilibrium when both firms undertake international business, the analysis focuses on a subset of the integration costs, that is, sunk and trade cost levels. Firstly, the scale of the sunk costs is assumed to be small enough that each firm can invest abroad independently from the strategic choice of the rival firm.<sup>28</sup> Secondly, trade costs are such that international activities are supported as sub-game perfect equilibria in pure strategies of the two-stage game "unions' wage determination - firms' quantity choices" independently from the firms' strategic choices concerning internationalization.

## 2.1 Regime 1: both firms do not invest

This subsection analyzes Regime 1, the situation in which both firms decide not to invest. These results might also be found in Straume (2002) and Naylor (1998, 1999) which are the sole references for this part of the paper.

### 2.1.1 Monopoly in Autarky

The case of monopoly is used as a benchmark. Consider country A and Firm 1. The profit function is

$$\Pi_1 = (p - w_1)x \quad (1)$$

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  $x = (1 - w_1)/2$ . The union utility function is

$$\Omega_1 = w_1x \quad (2)$$

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

$$w_M = \frac{1}{2} \quad (3)$$

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

$$x = \frac{1}{4} = y, \quad \Omega_M = \frac{1}{8}, \quad \Pi_M = \frac{1}{16},$$

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<sup>28</sup> In fact, 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. However, these profits differ according to the strategy selected by the rival firm. Therefore, if this restriction does not hold, the investment strategy is not always practicable, and the model collapses in Naylor's (1999) analysis.

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

### 2.1.2 Intra-industry Trade

#### *Stage 3: firms' output choices and labor demands*

Let us consider the case of intra-industry trade. In the last stage of the game, firms compete à la Cournot in the product markets. The profit functions are

$$\Pi_1 = p_A x_{1A} + p_B x_{1B} - w_1 x_{1A} - w_1 x_{1B} - t x_{1B} \quad (4)$$

$$\Pi_2 = p_A y_{2A} + p_B y_{2B} - w_2 y_{2A} - w_2 y_{2B} - t y_{2A} \quad (5)$$

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,  $x_{1A}$ , and Firm 2's exports,  $y_{2A}$ . Similarly,  $p_B = 1 - x_{1B} - y_{2B}$  is the price for the good in B, where  $x_{1B}$  is the quantity produced for exports by Firm 1, and  $y_{2B}$  is the quantity produced by Firm 2 for the domestic market. Notice that both firms pay a cost  $t \in [0,1)$  per unit of the goods exported representing a basket of costs including tariffs, red tape costs, transportation and logistics, etc. First-order conditions for a firm's profit maximization leads to the following Cournot reaction functions in stage 3 of the game

$$x_{1A}(y_{2A}^E) = \begin{cases} \frac{1-w_1}{2} - \frac{1}{2} y_{2A}^E & \text{for } (w_1, y_{2A}^E): y_{2A}^E \leq 1-w_1 \\ 0 & \text{otherwise} \end{cases} \quad (6)$$

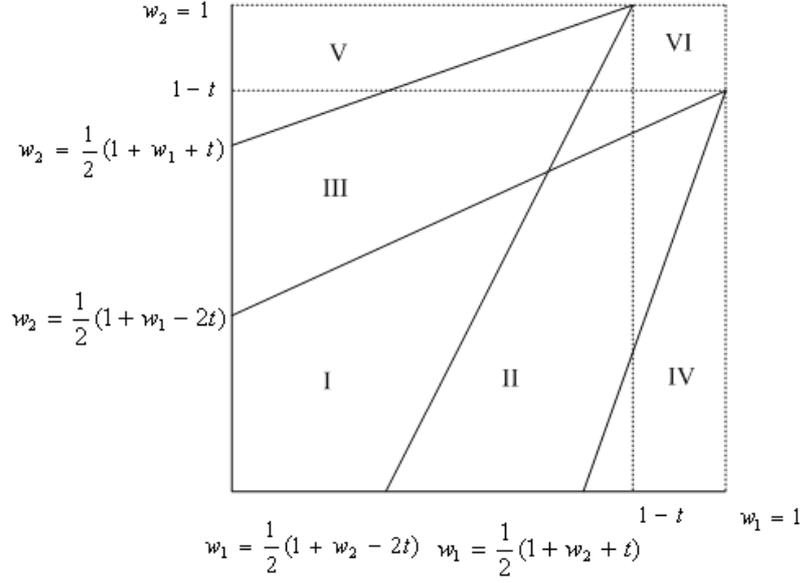
$$x_{1B}(y_{2B}^E) = \begin{cases} \frac{1-w_1-t}{2} - \frac{1}{2} y_{2B}^E & \text{for } (w_1, y_{2B}^E): y_{2B}^E \leq 1-w_1-t \\ 0 & \text{otherwise} \end{cases} \quad (7)$$

$$y_{2A}(x_{1A}^E) = \begin{cases} \frac{1-w_2-t}{2} - \frac{1}{2} x_{1A}^E & \text{for } (w_2, x_{1A}^E): x_{1A}^E \leq 1-w_2-t \\ 0 & \text{otherwise} \end{cases} \quad (8)$$

$$y_{2B}(x_{1B}^E) = \begin{cases} \frac{1-w_2}{2} - \frac{1}{2} x_{1B}^E & \text{for } (w_2, x_{1B}^E): x_{1B}^E \leq 1-w_2 \\ 0 & \text{otherwise} \end{cases} \quad (9)$$

From equation (6), it can be seen that Firm 1's production for the domestic market is certainly zero, no matter  $y_{2A}^E$ , whenever  $w_1 \geq 1$ . Each of the equations (6)-(9) also provides an upper bound for the wage level facing a firm, a wage that should not be exceeded in order for that firm's best response not to be zero, even when the rival is expected to offer zero output in the product market concerned (this upper bound is, for example,  $w_2 = 1-t$  as far as firm 2's exports are concerned). It is worth noting that equations (6) and (8), together with the realization of the expectations,  $y_{2A} = y_{2A}^E$  and  $x_{1A} = x_{1A}^E$ , and equations (7) and (9), with the equations of the expectations' realization  $y_{2B} = y_{2B}^E$

**Figure 1: Trade boundaries and possible trade regimes**



Note: adapted from Naylor (1999)

and  $x_{1B} = x_{1B}^E$ , represent two independent systems whose solutions determine the Cournot quantities in countries A and B, respectively.

**Proposition 1:** Let  $(w_1 < 1, w_2 < 1)$ .

(i) The solution of the quantity game in country A, call it  $(x_{1A}^C, y_{2A}^C)$ , is

$$(x_{1A}^C, y_{2A}^C) = \begin{cases} \left( \frac{1+t+w_2-2w_1}{3}, \frac{1-2t+w_1-2w_2}{3} \right) & \text{iff } w_1 \leq \frac{1+w_2+t}{2}, w_2 \leq \frac{1+w_1-2t}{2}, & (10a) \\ (0, \frac{1-w_2-t}{2}) & \text{iff } w_1 \geq \frac{1+w_2+t}{2}, w_2 \leq 1-t, & (10b) \\ (\frac{1-w_1}{2}, 0) & \text{iff } w_1 < 1, w_2 \geq \frac{1+w_1-2t}{2}. & (10c) \end{cases}$$

(ii) The solution of the quantity game in country B, call it  $(x_{1B}^C, y_{2B}^C)$ , is

$$(x_{1B}^C, y_{2B}^C) = \begin{cases} \left( \frac{1-2t+w_2-2w_1}{3}, \frac{1+t+w_1-2w_2}{3} \right) & \text{iff } w_1 \leq \frac{1+w_2-2t}{2}, w_2 \leq \frac{1+w_1+t}{2}, & (11a) \\ (0, \frac{1-w_2}{2}) & \text{iff } w_1 \geq \frac{1+w_2-2t}{2}, w_2 < 1 & (11b) \\ (\frac{1-w_1-t}{2}, 0) & \text{iff } w_1 \leq 1-t, w_2 \geq \frac{1+w_1+t}{2}. & (11c) \end{cases}$$

**Proof.** See the Appendix.

As Figure 1 shows, the absolute upper bounds in the first lines of equations (6)-(9) and the sets of boundary conditions derived in Proposition 1 generate six qualitatively different production regions, three of which involve trade.

In the interior of region I, all quantities are positive. Within this region, wage rates are sufficiently low that both firms export as well as producing for the domestic markets. It can be easily seen that the frontier of the region of intra-industry trade is the union of the following four sets of points in the  $(w_1, w_2)$  plane

$$w_1 = \frac{1+w_2-2t}{2}, w_1 \leq 1-2t; \quad (12)$$

$$w_2 = \frac{1+w_1-2t}{2}, w_2 \leq 1-2t; \quad (13)$$

$$w_1 = 0, w_2 \leq (1-2t)/2; \quad (14)$$

$$w_2 = 0, w_1 \leq (1-2t)/2 \quad (15)$$

$(1-2t, 1-2t)$  being the point of intersection between the graphs of the equations in (12) and (13) in the  $(w_1, w_2)$  plane. Differentiating the inequalities in (12) and (13), it is found that  $dw_1/dt < 0$  and  $dw_2/dt < 0$ , namely a decrease in trade costs enlarges region I: the graph of the equation in (12) moves down to the right, while the graph of the equation in (13) shifts up to the left. Thus, opportunities for intra-industry trade increase. Symmetric trade outcomes lie on the straight line linking the origin in  $(0,0)$ , defining the non-union outcome, to the boundaries' intersection delimiting the region where IIT occurs, given by the second equations in (12) and (13). As  $t$  increases, the value of  $1-2t$  decreases:  $w_1 = 1-2t$  and  $w_2 = 1-2t$  move toward the origin, shrinking region I. When  $1-2t < 0$ , region I disappears. Thus, for  $t \geq 1/2$  there is no trade among the two countries: exports are equal to zero. In region II (region III),  $w_1$  ( $w_2$ ) is high enough, given  $w_2$  ( $w_1$ ) and  $t$ , that Firm 1 (Firm 2) does not export: in this case only Firm 2 (Firm 1) sells in the foreign country. However,  $w_1$  ( $w_2$ ) is still sufficiently low to ensure that Firm 1 (Firm 2) produces, retaining only a share of the domestic market. 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 trade, either one-way (II, III, IV, V) or two-way (I), take place. In region VI, in contrast, no trade occurs and firms produce only for the domestic market.<sup>29</sup>

As will be shown, from equations (6) to (9) and results in Proposition 1, each union maximizes its utility function considering the region-specific labor demand schedules of the firms: the best reply function differs according to the wage level chosen by the rival union. Unions may adopt a wage policy such that, given the wage union 1 (union 2) expects to be set by union 2 (union 1), union 1 (union 2) is setting a wage so as to allow firm 1 (firm 2) to compete in both the domestic and the

<sup>29</sup> Theoretically, there are three other regions which are not depicted in Figure 1. The first region is characterized by  $w_1 > 1$  and  $w_2 < 1$ ; the second region by  $w_1 < 1$  and  $w_2 > 1$ ; the third region by  $w_1 > 1$  and  $w_2 > 1$ . Since the axes' length in Figure 1 is equal to 1 (the wage level in each country is supposed to be less than or equal to 1), these regions are outside of the surface of this box diagram. In the first two regions wage rates are so high that in country A (B) there is neither production nor consumption, but  $w_2$  ( $w_1$ ) is sufficiently low so as to make production worthwhile for the domestic market. Instead, in the third region wage rates are so high that, in both countries, there is neither production nor consumption.

foreign market,  $x_{1A}^C, x_{1B}^C > 0$  ( $y_{2A}^C, y_{2B}^C > 0$ ), i.e., in graphical terms,  $w_1$  ( $w_2$ ) is chosen so as to make the  $(w_1, w_2)$  pair lie in regions I, III or V (I, II and IV) for union 1 (union 2). Since the reasoning is similar for both unions, the following analysis will focus only on union 1's behavior. Given  $w_2$ , union 1's labor demands when choosing this wage policy can be written as

$$x_{1A} + x_{1B} = \begin{cases} \frac{1}{3}(2 - 4w_1 + 2w_2 - t) & \text{for } w_1 < \frac{1 + w_2 - 2t}{2}, w_2 \leq \frac{1 + w_1 - 2t}{2} & \text{(Region I) (16)} \\ \frac{1}{6}(5 - 7w_1 + 2w_2 - 4t) & \text{for } w_1 < \frac{1 + w_2 - 2t}{2}, \frac{1 + w_1 - 2t}{2} < w_2 \leq \frac{1 + w_1 + t}{2} & \text{(Region III) (17)} \\ \frac{1}{2}(2 - 2w_1 - t) & \text{for } w_1 \leq 1 - t, w_2 \geq \frac{1 + w_1 + t}{2} & \text{(Region V) (18)} \end{cases}$$

At the boundary between region I and III, (16) and (17) are simultaneously satisfied; thus

$$w_1 = 2w_2 + 2t - 1 \quad (19)$$

Alternatively, unions may choose a wage policy such that, given the wage union 1 (union 2) expects to be set by union 2 (union 1), union 1 (union 2) is setting a wage so as to allow Firm 1 (Firm 2) to produce only in the domestic market,  $x_{1A}^C > 0, x_{1B}^C = 0$  ( $y_{2B}^C > 0$  and  $y_{2A}^C = 0$ ), i.e., in graphical terms,  $w_1$  ( $w_2$ ) is chosen so as to make the point  $(w_1, w_2)$  lie in region II or VI (III or VI) for union 1 (union 2). Given  $w_2$ , union 1's labor demands when choosing this wage policy can be written as

$$x_{1A} = \begin{cases} \frac{1 + t + w_2 - 2w_1}{3} & \text{for } \frac{1 + w_2 - 2t}{2} < w_1 < \frac{1 + w_2 + t}{2}, w_2 \leq \frac{1 + w_1 - 2t}{2} & \text{(Region II) (20)} \\ \frac{1 - w_1}{2} & \text{for } \frac{1 + w_2 - 2t}{2} < w_1 < \frac{1 + w_2 + t}{2}, \frac{1 + w_1 - 2t}{2} < w_2 \leq \frac{1 + w_1 + t}{2} & \text{(Region VI) (21)} \end{cases}$$

At the boundary between region II and VI, (20) and (21) are simultaneously satisfied; therefore

$$w_1 = 2w_2 + 2t - 1. \quad (22)$$

Each of these labor demand equations for union 1 (union 2) shifts in the  $(x_1, w_1)$  ( $(x_2, w_2)$ ) plane with both  $w_2$  ( $w_1$ ) and  $t$ . To derive union 1's (union 2's) best-reply function with respect to the wage set by the rival union, the analysis has to consider how labor demands shift along with changes in  $w_2$  ( $w_1$ ), for given  $t$ .

Given the purposes of this paper (the search for equilibria where both firms are involved in international activities), the relevant candidates for sub-game equilibria have to be found in region I. Some preliminary considerations allow restriction of the field of analysis for the definition of the relevant unions' best-reply functions and the value of trade costs supporting IIT as equilibrium in pure strategy. For  $(w_1, w_2)$  pairs along the boundary between region II and IV and in region IV, firm 1 neither exports nor produces for the domestic market. A similar reasoning applies for  $(w_1, w_2)$  pairs along the boundary between region III and V and in region V: firm 2 produces zero output. For  $(w_1, w_2)$  pairs internal to region VI and along the boundary between regions II and VI and regions III and VI, no trade occurs: firms produce only for the domestic market. This implies that the unions' relevant payoff functions are associated with Regions I, II, and III.

*Stage 2: unions' wage setting*

Having derived the labor demands for each region it is possible now to define the unions' payoff function. Given symmetry, the analysis considers only the case of union 1. Union 1's relevant payoff function is:

$$\Omega_1 = \begin{cases} w_1 \left[ \frac{1}{3}(2 - 4w_1 + 2w_2 - t) \right] & \text{(Region I)} \quad (23) \\ w_1 \left[ \frac{1}{3}(1 + w_2 - 2w_1 + t) \right] & \text{(Region II)} \quad (24) \\ w_1 \left[ \frac{1}{6}(5 - 7w_1 + 2w_2 - 4t) \right] & \text{(Region III)} \quad (25) \end{cases}$$

This function is continuous over the range  $w_1 \in (0,1)$ . It can easily be checked that: 1) for a given  $t$  union 1's payoff function is increasing in  $w_2$ ; and 2) for a given  $w_2$ , a reduction in  $t$  increases union 1's payoff function in region I and III where firm 1 exports, while it decreases the union utility in region II where firm 1 produces only for the domestic market. Moreover,  $\partial\Omega_1/\partial w_1\partial w_2 > 0$  in region I, II and III. This means that wages are strategic complements: an increase in the wage rate in firm 2 leads to an increase in the marginal utility (in terms of its own strategy) of union 1. Depending on the values of  $w_2$  and  $t$ , this utility function has one maximum or more relative maxima. Therefore, union 1's payoff function relative to changes in the independent variables is studied to derive the best-reply function.

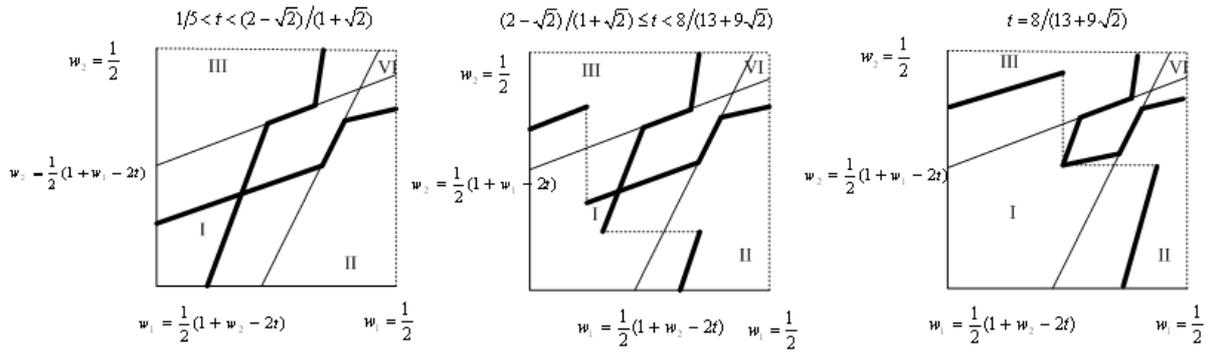
**Proposition 2:** *Union 1's reaction function, call it  $RF_1$ , is:*

$$RF_1(w_2) = \begin{cases} \text{for } t < (2 - \sqrt{2})/(1 + \sqrt{2}) \approx .242: \\ w_1 = (2 + 2w_2 - t)/8 & \text{iff } w_2 \in [0, (10 - 17t)/14) \\ w_1 = 2w_2 + 2t - 1 & \text{iff } w_2 \in [(10 - 17t)/14, (19 - 32t)/26) \\ w_1 = (5 + 2w_2 - 4t)/14 & \text{iff } w_2 \in [(19 - 32t)/26, (19 + 10t)/26]; \\ \text{for } (2 - \sqrt{2})/(1 + \sqrt{2}) < t \leq 8/(13 + 9\sqrt{2}) \approx .31: \\ w_1 = (1 + w_2 + t)/4 & \text{iff } w_2 \in [0, [(1 + \sqrt{2})/(2 - \sqrt{2})]t - 1), \\ w_1 = (2 + 2w_2 - t)/8 & \text{iff } w_2 \in [[(1 + \sqrt{2})/(2 - \sqrt{2})]t - 1, (10 - 17t)/14), \\ w_1 = 2w_2 + 2t - 1 & \text{iff } w_2 \in [(10 - 17t)/14, (19 - 32t)/26), \\ w_1 = (5 + 2w_2 - 4t)/14 & \text{iff } w_2 \in [(19 - 32t)/26, (19 + 10t)/26] \end{cases}$$

where  $t \leq 8/(13 + 9\sqrt{2})$  is the critical value above which IIT is not supported in a pure strategy equilibrium. Identical expressions hold for union 2, simply transposing  $w_2$  with  $w_1$ .

**Proof.** See the Appendix and Naylor (1998, 1999).

**Figure 2: Unions' reaction functions and sub-game equilibrium**



Note: adapted from Naylor (1998, 1999)

Figure 2 depicts graphically the two unions' reaction functions for some ranges of  $t$ . In the left box, trade costs are such that the best-reply functions are continuous. The center box shows the case of trade cost levels such that the reaction functions are discontinuous, and the switching wage is less than the wage's value at which the best-reply functions of the two unions intersect. The right box shows the unions' reaction function at  $t = 8/(13+9\sqrt{2}) \approx .31$ , the critical value of trade costs supporting IIT in a pure strategy equilibrium.

*Sub-game perfect equilibria of the two-stage game "unions' wage determination - firms' quantity choices"*

For trade costs below or equal to the threshold value of  $t \approx .31$ , the Bertrand-Nash wage in equilibrium is

$$w_{IIT} = \frac{1}{3} - \frac{1}{6}t. \quad (26)$$

In the case of intra-industry trade, unions compete with each other over employment, causing a fall in wage levels compared to the autarky regime. Hence trade, in this model, deteriorates union power.

Nevertheless,  $dw_{IIT} / dt < 0$ : an increase in economic integration (a reduction in trade costs) will induce trade unions to raise wages. The intuition is the following. For values lower than the threshold, IIT occurs between the two countries. A decrease in trade costs will induce harsher competition amongst the participants in the international oligopoly: firms' outputs rise because exports increase. Consequently, labor demand increases, and, therefore, unions will choose to set higher wages, capturing a higher share of oligopoly rents, while firms may experience a loss in profits. Substituting (26) into the quantity expressions (10a) and (11a), the following values are obtained:

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

which are the Cournot quantities in equilibrium in the presence of intra-industry trade. Further substitutions lead to the following union utility and firm profits

$$\Omega_{IIT} = \frac{1}{27}(2-t)^2, \quad \Pi_{IIT} = \frac{8}{81} - \frac{8}{81}t + \frac{85}{162}t^2.$$

## 2.2 Regime 2: both firms invest. Reciprocal FDI

### Stage 3: firms' quantity choices and labor demands

Let us now consider the RFDI regime. The Firms' profit functions are the following

$$\Pi_1 = p_A x_{1A} + p_B y_{1B} - w_1 x_{1A} - w_1 y_{1B} - F \quad (27)$$

$$\Pi_2 = p_A x_{2A} + p_B y_{2B} - w_2 x_{2A} - w_2 y_{2B} - F \quad (28)$$

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,  $x_{1A}$ , and the quantity produced by Firm 2's branch located in the same country,  $x_{2A}$ . Similarly,  $p_B = 1 - y_{1B} - y_{2B}$  is the price for the good in B.

Companies, in theory, may still export to the foreign country instead of serving the foreign market by producing locally. However, having borne the burden of a sunk cost equal to  $F$ , firms do not export. The rationale is that firms incur additional costs of  $t$  for the quantities exported, and this is less profitable than the option of serving the foreign market with local production alone. It follows that the specification of the firms' profit functions in the presence of RFDI is exactly as in (27)-(28). Notice that, in the present model, multinational firms pay the same wage in both countries: this hypothesis is consistent with the idea, frequently found in the literature, that a multinational pays a wage rate *different* from that of domestic firms, see e.g. Leahy and Montagna (2000).

From first-order conditions for profit maximization, the following Cournot reaction functions are derived

$$x_{1A}(x_{2A}^E) = \begin{cases} \frac{1-w_1}{2} - \frac{1}{2} x_{2A}^E & \text{for } (w_1, x_{2A}^E) : x_{2A}^E \leq 1-w_1 \\ 0 & \text{otherwise} \end{cases} \quad (29)$$

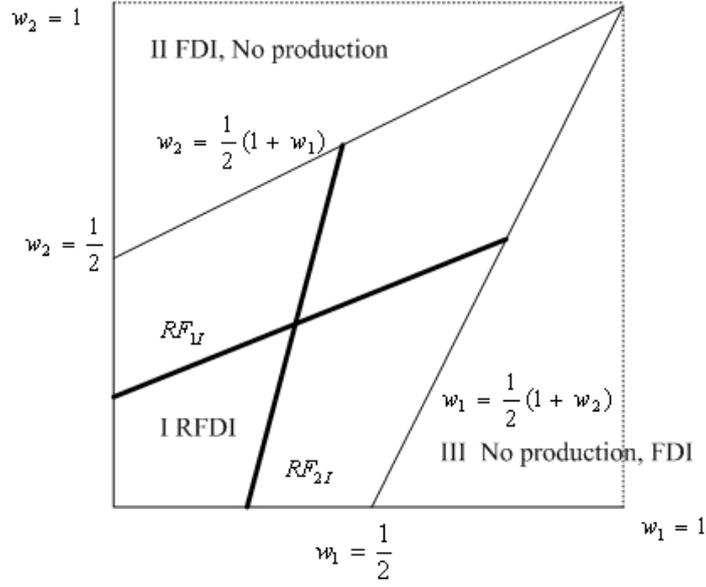
$$y_{1B}(y_{2B}^E) = \begin{cases} \frac{1-w_1}{2} - \frac{1}{2} y_{2B}^E & \text{for } (w_1, y_{2B}^E) : y_{2B}^E \leq 1-w_1 \\ 0 & \text{otherwise} \end{cases} \quad (30)$$

$$x_{2A}(x_{1A}^E) = \begin{cases} \frac{1-w_2}{2} - \frac{1}{2} x_{1A}^E & \text{for } (w_2, x_{1A}^E) : x_{1A}^E \leq 1-w_2 \\ 0 & \text{otherwise} \end{cases} \quad (31)$$

$$y_{2B}(y_{1B}^E) = \begin{cases} \frac{1-w_2}{2} - \frac{1}{2} y_{1B}^E & \text{for } (w_2, y_{1B}^E) : y_{1B}^E \leq 1-w_2 \\ 0 & \text{otherwise} \end{cases} \quad (32)$$

Similar to the previous case, from equation (29), it can be seen that Firm's 1 production for the domestic market is certainly zero, regardless of  $x_{2A}^E$ , whenever  $w_1 \geq 1$ . Each of the equations (29)-(32) also provides an upper bound for the wage facing a firm, a wage not to be exceeded in order for that firm's best response not to be zero, even when the rival is expected to offer zero output in the product market concerned. This upper bound is, for example,  $w_2 = 1$  as far as firm 2's local production in country A is concerned. These upper bounds for the wages identified are shown in Figure 3. Equations (29) and (31), together with the equations of the realization of expectations,

**Figure 3: Investment Boundaries and Unions' Reaction Functions**



$x_{2A} = x_{2A}^E$  and  $x_{1A} = x_{1A}^E$ , and equations (30) and (32), with  $y_{2B} = y_{2B}^E$  and  $y_{1B} = y_{1B}^E$ , represent the two independent systems whose solutions determine the Cournot quantities in countries A and B, respectively.

**Proposition 3:** Let  $(w_1 < 1, w_2 < 1)$ .

(i) The solution of the quantity game in country A, call it  $(x_{1A}^C, x_{2A}^C)$ , is such that

$$(x_{1A}^C, x_{2A}^C) = \begin{cases} \left( \frac{1+w_2-2w_1}{3}, \frac{1+w_1-2w_2}{3} \right) & \text{iff } w_1 \leq \frac{1+w_2}{2}, w_2 \leq \frac{1+w_1}{2}, & (33a) \\ \left( 0, \frac{1-w_2}{2} \right) & \text{iff } w_1 \geq \frac{1+w_2}{2}, w_2 < 1 & (33b) \\ \left( \frac{1-w_1}{2}, 0 \right) & \text{iff } w_2 \geq \frac{1+w_1}{2}, w_1 < 1. & (33c) \end{cases}$$

(ii) The solution of the quantity game in country B, call it  $(y_{1B}^C, y_{2B}^C)$ , is such that

$$(y_{1B}^C, y_{2B}^C) = \begin{cases} \left( \frac{1+w_2-2w_1}{3}, \frac{1+w_1-2w_2}{3} \right) & \text{iff } w_1 \leq \frac{1+w_2}{2}, w_2 \leq \frac{1+w_1}{2}, & (34a) \\ \left( 0, \frac{1-w_2}{2} \right) & \text{iff } w_1 \geq \frac{1+w_2}{2}, w_2 < 1 & (34b) \\ \left( \frac{1-w_1}{2}, 0 \right) & \text{iff } w_2 \geq \frac{1+w_1}{2}, w_1 < 1. & (34c) \end{cases}$$

**Proof.** See the Appendix.

If unions fix too high wage levels (regions II and III in Figure 3), the firms do not find it profitable to exploit the foreign plant, although they have already incurred the sunk cost. High wages set by

unions also price out each firm from the domestic market; each firm finds it inconvenient to produce there. The reason is that, given  $w_1$  ( $w_2$ ), for  $w_2$  ( $w_1$ ) such that the point  $(w_1, w_2)$  lies on the boundary between Regions I and II (III) or is internal to Region II (III), the wage rate is not lower than the price under domestic monopoly (the autarky case).

*Stage 2: unions' wage setting*

From the above discussion, it follows that, in stage 2 of the game, each company-level union chooses a wage allowing firms to pursue both domestic production and exploitation of the plants abroad. Making use of the optimal quantities the utility function for union 1 is

$$\Omega_1 = w_1(x_{1A} + y_{1B}) \quad (35)$$

and the utility function for union 2 takes a similar form. Substitution of (33a) and (34a) into (35), and solving the maximization problem, leads to the following expression:

$$RF_1(w_2) = w_1 = \frac{1}{4} + \frac{1}{4}w_2$$

which is the reaction function for union 1. A similar result (interchanging  $w_1$  with  $w_2$ ) pertains for union 2.

*Sub-game perfect equilibria of the two-stage game "unions' wage determination - firms' output choices"*

Solving the linear system composed by the two unions' reaction functions, the Bertrand-Nash equilibrium wage level is

$$w_{RFDI} = \frac{1}{3}. \quad (36)$$

It follows that production levels are

$$x_{1A} = y_{1B} = y_{2B} = x_{2A} = \frac{2}{9}$$

Comparing wages (see equations (36) and (26)) and production outcomes (and thus employment levels: see equations (6)-(7) and (29)-(30)), it is immediately clear that, in the case of international production, both achieve higher values, and, therefore, unions in equilibrium have higher utility levels in the RFDI regime than in IIT. The firms' production levels for the domestic market decrease, while those for the foreign market increase. The rationale for the latter result is that, in the case of investment, the marginal cost of serving the market abroad by local production is lower than in the case of exports. Nevertheless, the expansion in the foreign market more than offsets the loss of market shares in the domestic market: total output (and, therefore, employment), rises. Labor demand increases as well and, therefore, each company-level union may claim for higher wages than in IIT, while firms may experience a fall in profit levels. Additionally, wage rates increase because the firms' rents in RFDI are larger than those in IIT (due to trade cost savings), and unions are able to capture a share of these enlarged rents. Thus, for unions organized at company level, the investment strategy of the firms is advantageous.

After subsequent substitutions, the following expressions for the union utility and firm profits are obtained

$$\Omega_{RFDI} = \frac{4}{27}, \quad \Pi_{RFDI} = \frac{8}{81} - F.$$

### 2.3 Regime 3: only one firm invests. Asymmetric regimes

#### *Stage 3: firms' quantity choices and labor demands*

The evaluation of the firms' profits in asymmetric regimes (one firm invests while the other does not) requires the establishment of a set of game equilibria. In these asymmetric regimes, different configurations in both the product and the labor markets are possible. Considering, for example, the case that firm 1 does not invest while firm 2 undertakes a FDI; in the general case, the firms' profit functions are

$$\Pi_1 = p_A x_{1A} + p_B x_{1B} - w_1 x_{1A} - w_1 x_{1B} - t x_{1B} \quad (37)$$

$$\Pi_2 = p_A x_{2A} + p_B y_{2B} - w_2 x_{2A} - w_2 y_{2B} - F \quad (38)$$

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 produced by Firm 2's subsidiary in the same country, while  $p_B = 1 - x_{1B} - y_{2B}$ , the price of the good in B, depends on country B's imports from firm 1 and the quantity produced by firm 2 for its domestic market. Notice that, in the case under examination, firm 2 may export towards country A. Nevertheless, having undertaken the sunk cost of  $F$ , firm 2 does not export since it incurs additional costs of  $t$  for the quantities exported. Therefore, the choice of simultaneous export and local production is less profitable than the choice of local production only.

First-order conditions for the maximization of firms' profits lead to these expressions for the Cournot reaction functions

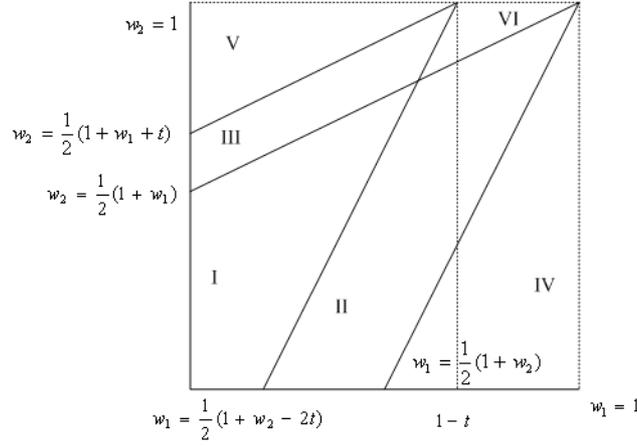
$$x_{1A}(x_{2A}^E) = \begin{cases} \frac{1-w_1}{2} - \frac{1}{2} x_{2A}^E & \text{for } (w_1, x_{2A}^E) : x_{2A}^E \leq 1-w_1 \\ 0 & \text{otherwise} \end{cases} \quad (39)$$

$$x_{1B}(y_{2B}^E) = \begin{cases} \frac{1-w_1-t}{2} - \frac{1}{2} y_{2B}^E & \text{for } (w_1, y_{2B}^E) : y_{2B}^E \leq 1-w_1-t \\ 0 & \text{otherwise} \end{cases} \quad (40)$$

$$x_{2A}(x_{1A}^E) = \begin{cases} \frac{1-w_2}{2} - \frac{1}{2} x_{1A}^E & \text{for } (w_2, x_{1A}^E) : x_{1A}^E \leq 1-w_2 \\ 0 & \text{otherwise} \end{cases} \quad (41)$$

$$y_{2B}(x_{1B}^E) = \begin{cases} \frac{1-w_2}{2} - \frac{1}{2} x_{1B}^E & \text{for } (w_2, y_{1B}^E) : x_{1B}^E \leq 1-w_2 \\ 0 & \text{otherwise} \end{cases} \quad (42)$$

**Figure 4: Trade and Investment Boundaries and Possible Configurations In Asymmetric Regimes**



From equation (39), it is seen that Firm 1's production for the domestic market will certainly be zero, no matter  $x_{2A}^E$ , whenever  $w_1 \geq 1$ , and similarly firm 1's exports will certainly be zero, no matter  $y_{2B}^E$ , if  $w_1 \geq 1-t$ . By arguing likewise, firm 2's production for the domestic market (exports) will certainly be zero, no matter  $x_{1B}^E$  ( $x_{1A}^E$ ) whenever  $w_2 \geq 1$ . The upper bounds for the wages so identified are shown in Figure 4. In this case, equations (39) and (41), with the relative equations for the expectations' realization,  $x_{2A} = x_{2A}^E$  and  $x_{1A} = x_{1A}^E$ , and equations (40) and (42) with  $y_{2B} = y_{2B}^E$  and  $x_{1B} = x_{1B}^E$ , represent the two independent systems whose solutions establish the Cournot outputs in countries A and B, respectively.

**Proposition 4:** Let  $(w_1 < 1, w_2 < 1)$ .

(i) The solution of the quantity game in country A, call it  $(x_{1A}^C, x_{2A}^C)$ , is such that

$$(x_{1A}^C, x_{2A}^C) = \begin{cases} \left( \frac{1+w_2-2w_1}{3}, \frac{1+w_1-2w_2}{3} \right) & \text{iff } w_1 \leq \frac{1+w_2}{2}, w_2 \leq \frac{1+w_1}{2}, & (43a) \\ \left( 0, \frac{1-w_2}{2} \right) & \text{iff } w_1 \geq \frac{1+w_2}{2}, w_2 < 1 & (43b) \\ \left( \frac{1-w_1}{2}, 0 \right) & \text{iff } w_2 \geq \frac{1+w_1}{2}, w_1 < 1. & (43c) \end{cases}$$

(ii) The solution of the quantity game in country B, call it  $(x_{1B}^C, y_{2B}^C)$ , is such that

$$(x_{1B}^C, y_{2B}^C) = \begin{cases} \left( \frac{1-2t+w_2-2w_1}{3}, \frac{1+t+w_1-2w_2}{3} \right) & \text{iff } w_1 \leq \frac{1+w_2-2t}{2}, w_2 \leq \frac{1+w_1+t}{2}, & (44a) \\ \left( 0, \frac{1-w_2}{2} \right) & \text{iff } w_1 \geq \frac{1+w_2-2t}{2}, w_2 < 1 & (44b) \\ \left( \frac{1-w_1-t}{2}, 0 \right) & \text{iff } w_2 \geq \frac{1+w_1+t}{2}, w_1 \leq 1-t. & (44c) \end{cases}$$

**Proof.** See the Appendix.

Figure 4 depicts all the boundary conditions and possible asymmetric configurations. These boundary conditions generate six qualitatively different regions in the  $(w_1, w_2)$  plane, three involving trade, and three local production due to the FDI. In the interior of region I, all quantities are positive. This region relates to values of wages sufficiently low such that both firms may undertake international business, either in the form of exports or utilization of the foreign plant for local production. The frontier of the area for reciprocal intra-industry international business is the union of the following four sets of points in the  $(w_1, w_2)$  plane

$$w_1 = \frac{1+w_2-2t}{2}, w_1 \leq 1 - \frac{4}{3}t \quad (45)$$

$$w_2 = \frac{1+w_1}{2}, w_2 \leq 1 - \frac{2}{3}t \quad (46)$$

$$w_1 = 0, w_2 \leq 1/2; \quad (47)$$

$$w_2 = 0, w_1 \leq (1-2t)/2 \quad (48)$$

$(1-4/3t, 1-2/3t)$  being the intersection (the upper vertex of region I in Figure 4) between the graphs representing the equations in (45) and (46). Differentiation of the inequalities in (45) and (46) leads to  $dw_1/dt < 0$  and  $dw_2/dt < 0$ : the graph of the equation in (45) shifts down to the right, while the graph of the equation in (46) moves up to the left. That is, a decrease in trade costs expands region I, increasing the opportunities for intra-industry international activities. Comparing the inequalities in (45)-(46) with those in (12)-(13), it is worth noting that, with the presence of an investing firm, the range of  $t$  such that intra-industry international activities take place in asymmetric regimes is wider than that in the case of IIT. To be more precise, for a given level of trade costs  $t$ , a given  $(w_1, w_2)$  pair may not be congruent with positive exports in both countries in the case of IIT, while it may be consistent with a situation of Firm 1's positive exports and the foreign plant's exploitation of Firm 2 in the asymmetric regime under examination.

In region II,  $w_1$  is high enough, given  $t$ , that firm 1 cannot export: in this case only firm 2 undertakes international business because of FDI, while  $w_1$  is still sufficiently low to ensure that firm 1 produces positive quantities for the domestic market. In region III on the other hand,  $w_2$  is such that, given  $t$ , firm 2 cannot exploit the production plant located abroad. However, albeit prohibitive to the exploitation of the foreign plant,  $w_2$  is still sufficiently low to allow 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 configurations where forms of international activities occur. In region VI, in contrast, no international business occurs and firms produce only for the domestic markets.<sup>30</sup>

As will be shown in the next subsection, from equations (39) to (42) and results in Proposition 4, each union maximizes its utility function taking into account specific firms' labor demand schedules: the best-reply functions of each union differ according to the wage rate chosen by the

<sup>30</sup> As in Figure 1, theoretically there are three other regions which are not depicted in Figure 8 (the axes' length equals 1, and is therefore outside of the surface of the box diagram). The first region is characterized by  $w_1 > 1$  and  $w_2 < 1$ ; the second region by  $w_1 < 1$  and  $w_2 > 1$ ; the third region by  $w_1 > 1$  and  $w_2 > 1$ . In the first two regions, wage rates are so high that in country A (B) there is neither production nor consumption, but  $w_2$  ( $w_1$ ) is sufficiently low so as to make production for the domestic market worthwhile. On the other hand, in the third region wage rates are so high that, in both countries, there is neither production nor consumption.

rival. Given the purposes of the paper (equilibria involving international activities for both firms), the relevant candidate for sub-game equilibria has to be found in region I. However, some preliminary considerations allow restriction of the field of analysis for the definition of the relevant best-reply functions. Firstly, for  $(w_1, w_2)$  pairs along the boundary between region II and IV and in region IV, firm 1 neither exports nor produces for the domestic market. A similar reasoning applies for  $(w_1, w_2)$  pairs along the boundary between regions III and V and in region V: firm 2 is priced out of the market and it does not produce. Instead, for  $(w_1, w_2)$  internal to region VI and along the boundaries between regions II and VI and regions III and VI, no international business occurs: each firm produces only for the domestic market. Secondly, the following result is derived.

**Proposition 5:** *Given the assumption that Firm 2 invests, in asymmetric regimes, at any wage pair  $(w_1, w_2)$  internal to Region III or on the boundary between Regions I and III, union 2 fails to make a best response.*

**Proof.** See the Appendix.

According to Proposition 5, the best reply function of the union of the investing firm is sufficiently low so as to allow the exploitation of the foreign plant: union 2 does not play wage levels in region III. In the case under examination, the rationale is that, given  $w_1$ , for  $w_2$  such that the point  $(w_1, w_2)$  is on the boundary between Regions I and III or internal to Region III, the labor demand function for union 2 is relatively elastic. Namely, the percentage change in employment is greater than the percentage change in wage, so that in absolute value  $\varepsilon = (dl_{2III}/dw_2)(w_2/l_{2III}) > 1$ , where  $l_{2III} = y_{2B}^C = (1/3)(1+t+w_1-2w_2)$ .<sup>31</sup>

From this discussion, the field of analysis concerning the determination of sub-game equilibria in asymmetric regimes can be restricted to regions I and II. Under the assumptions adopted in this subsection (firm 1 does not invest, firm 2 invests), union 1 faces the following labor demand functions

$$x_{1A} + x_{1B} = \frac{1}{3}(2 - 4w_1 + 2w_2 - 2t) \quad \text{for} \quad w_2 \leq \frac{1+w_1}{2}, w_1 \leq \frac{1+w_2-2t}{2} \quad (\text{Region I}) \quad (49)$$

$$x_{1A} = \frac{1}{3}(1 + w_2 - 2w_1) \quad \text{for} \quad \frac{1+w_2-2t}{2} < w_1 \leq \frac{1+w_2}{2}, w_2 \leq \frac{1+w_1}{2} \quad (\text{Region II}) \quad (50)$$

while union 2's labor demand functions are

$$y_{2B} + x_{2A} = \begin{cases} \frac{1}{3}(2 - 4w_2 + 2w_1 + t) & \text{for} \quad w_2 \leq \frac{1+w_1}{2}, w_1 \leq \frac{1+w_2-2t}{2} & (\text{Region I}) & (51a) \\ \frac{1}{6}(5 - 7w_2 + 2w_1) & \text{for} \quad \frac{1+w_2-2t}{2} < w_1 \leq \frac{1+w_2}{2}, w_2 \leq \frac{1+w_1}{2} & (\text{Region II}) & (51b) \end{cases}$$

<sup>31</sup> This result can be checked as follows. The elasticity of the labor demand in Region III, in absolute value, is  $\varepsilon_{l_{2III}} = (2w_2/(1+t+w_1-2w_2))$ . The inequality  $\varepsilon_{l_{2III}} > 1$  holds if and only if  $4w_2 > 1+t+w_1$ . Taking into account that  $w_1 < 1-t$  (otherwise the point  $(w_1, w_2)$  is outside Region III), this condition may be rewritten as  $4w_2 > 1+t+1-t-\delta = 2-\delta$ , where  $\delta \equiv 1-t-w_1 > 0$ . However,  $4w_2 > 2-\delta$  always holds true since  $4w_2 \geq 2$ : the last result follows from the fact that  $2w_2 \geq 1+w_1$  (otherwise the point  $(w_1, w_2)$  is certainly outside Region III).

With these elements, the following analysis derives the unions' best-reply functions and the value of the trade costs allowing intra-industry international activities to be supported in equilibrium in pure strategies.

*Stage 2: unions' wage-setting*

Having derived the labor demands for each significant region it is possible now to define the unions' payoff functions.

Union 1's relevant payoff function in asymmetric regimes is

$$\Omega_1 = \begin{cases} w_1 \left[ \frac{1}{3}(2 - 4w_1 + 2w_2 - 2t) \right] & \text{(Region I) (52)} \\ w_1 \left[ \frac{1}{3}(1 + w_2 - 2w_1) \right] & \text{(Region II) (53)} \end{cases}$$

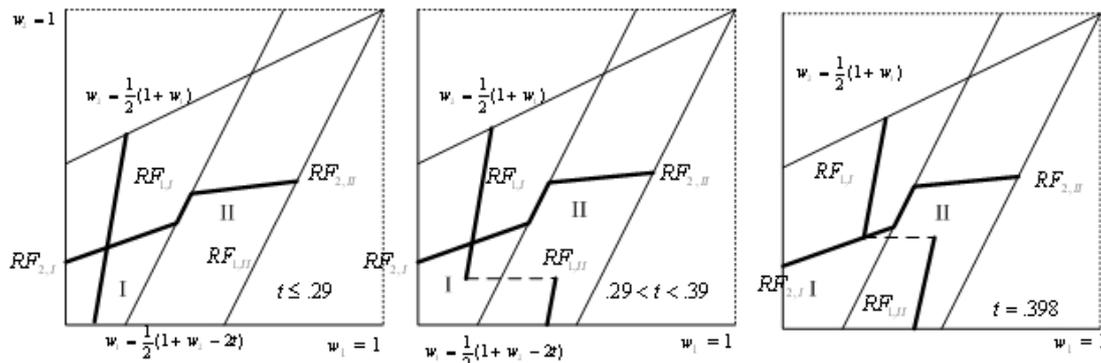
This function is continuous over the range of union 1's wage rates, namely  $w_1 \in (0,1)$ . Union 1's utility is increasing in  $w_2$ , and for a given  $w_2$ , it increases in region I (firm 1 exports) when  $t$  decreases, whilst remaining unaffected by trade costs in region II (production only for the domestic market). In both regions,  $\partial\Omega_1/\partial w_1\partial w_2 > 0$ : wages are strategic complements.

Instead, union 2's relevant payoff function is

$$\Omega_2 = \begin{cases} w_2 \left[ \frac{1}{3}(2 - 4w_2 + 2w_1 + t) \right] & \text{(Region I) (54)} \\ w_2 \left[ \frac{1}{6}(5 - 7w_2 + 2w_1) \right] & \text{(Region II) (55)} \end{cases}$$

This function is also continuous over the range of union 2's wage rates, that is,  $w_2 \in (0,1)$ . Union 2's payoff function is increasing in  $w_1$ . For a given  $w_1$ , a reduction in  $t$  decreases union 2's payoff function in region I, where firm 1 exports, while, in region II, union 2's utility function is not affected by trade costs. In addition, in both regions,  $\partial\Omega_2/\partial w_2\partial w_1 > 0$ : that is, wages are strategic complements. Depending on  $w_2$  ( $w_1$ ) and  $t$ , union 1 (2)'s payoff function presents one maximum or more relative maxima. Therefore, the unions' payoff functions are analyzed in relation to the respective independent variables' changes in order to derive the relative best-reply functions.

**Figure 5: Trade and Investment Boundaries and Unions' Reaction Functions in Asymmetric Regimes**



**Proposition 6:** Unions' reaction functions, call them respectively  $RF_1$  and  $RF_2$ , are:

$$RF_1(w_2) = \begin{cases} \text{for } t < 2/(2 + \sqrt{2}) \approx .29: \\ w_1 = \frac{1}{4}(1 + w_2 - t) & \text{iff } w_2 \in [0, (5-t)/7), \\ \text{for } 2/(2 + \sqrt{2}) \leq t \leq 20/(29 + 15\sqrt{2}) \approx .39: \\ w_1 = \frac{1}{4}(1 + w_2) & \text{iff } w_2 \in [0, (2 + \sqrt{2})t - 1), \\ w_1 = \frac{1}{4}(1 + w_2 - t) & \text{iff } w_2 \in [(2 + \sqrt{2})t - 1, (5-t)/7). \end{cases}$$

$$RF_2(w_1) = \begin{cases} \text{for } \forall t \in [0, 20/(29 + 15\sqrt{2})]: \\ w_2 = \frac{1}{8}(2 + 2w_1 + t) & \text{iff } w_1 \in [0, (10 - 15t)/14), \\ w_2 = 2w_1 + 2t - 1 & \text{iff } w_1 \in [(10 - 15t)/14, (19 - 28t)/26), \\ w_2 = \frac{1}{14}(5 + 2w_1) & \text{iff } w_1 \geq (19 - 28t)/26. \end{cases}$$

where  $t \leq 20/(29 + 15\sqrt{2}) \approx .398$  is the critical value above which intra-industry international activities are not supported in a pure strategy equilibrium.

**Proof.** See the Appendix.

Figure 5 depicts the two unions' reaction functions for some definite values of  $t$ . The left box depicts the case of trade costs such that the two unions' best-reply functions are continuous and intersect in region I. The center box shows the case of trade costs such that the reaction functions are discontinuous, and the switching wage is lower than the wage at which the two unions' best-reply functions intersect. The right box shows the unions' reaction functions at  $t = 20/(29 + 15\sqrt{2})$ , the critical value of trade costs supporting intra-industry international activities in a pure strategy equilibrium.

*Sub-game perfect equilibria of the two-stage game "unions' wage determination - firms' output decisions"*

For trade cost levels less than, or equal to, the threshold of  $t \approx .39$ , the Bertrand-Nash wages in equilibrium are

$$w_{1,Asy} = \frac{1}{3} - \frac{7}{30}t \quad (56)$$

$$w_{2,Asy} = \frac{1}{3} + \frac{1}{15}t. \quad (57)$$

Substitutions of equilibrium wages (56) and (57) into quantity expressions yield

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

It is immediately evident that  $t$  plays a different role in wage levels, depending on the international economic activity the firm undertakes. In fact, increasing economic integration (a reduction in barriers to trade) stimulates exports for firm 1. Consequently, labor demand for firm 1 increases, and this, in turn, implies that union 1, which operates in the exporting firm, chooses to set higher wages: wages in the exporting firm increase. On the other hand, a higher degree of economic integration translates both to a decrease in the total production of Firm 2, the investing firm, and to a wage reduction for its workers. Nonetheless, wages and total output in the multinational firm are always higher than those in the exporting firm, unless  $t = 0$ . The union in the multinational captures higher shares of the firm's rents generated by the savings in trade costs. However, trade cost savings imply an expansion in the multinational's output, and, therefore, an increase in its employment levels. The rival firm's decision to undertake FDI shifts the union's reaction function in the exporting firm downward. Despite the strategic effect due to wage complementarity, the labor demand effect outweighs these gains. The rationale is that the exporting firm faces stronger competition in the domestic market when the competing firm produces locally. It follows that, in asymmetric regimes, wages in the exporting firm are lower with respect to the IIT case. Subsequent substitutions of equilibrium wages and quantities lead to the values for union utility level and firms' profit functions in the case of asymmetric regimes

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

$$\Omega_{2,Asy}^{IN} = \frac{4}{675}(5+t)^2, \Pi_{2,Asy}^{IN} = \frac{8}{81} + \frac{16}{405}t + \frac{241}{4050}t^2 - F.$$

#### 2.4 First stage: Firms' Selection Strategy and Game Equilibria

It is now possible to go back to the first stage of the game to investigate the firms' strategies. Depending both on trade and investment costs, and the unions' wage setting, different productive structures might arise as equilibria of the game. In the sub-game defined by the firms' strategy profile  $(N;N)$ , IIT is supported as the Nash equilibrium in pure strategies in the two-stage sub-game "unions' wage determination - firms' quantity choices" if trade cost levels are below  $t \leq .31$ . Firms' payoffs in the RFDI regime depend on wage levels set by unions and the amount of sunk costs. Conversely, in the two asymmetric sub-games, depending on  $t$ ,  $F$  and the unions' wage strategies, international activities for both firms are supported as the Nash equilibrium in pure strategies in the two-stage sub-game "unions' wage determination - firms' quantity choices" if  $t \leq .398$ . The subsequent analysis imposes the following restriction on the values of the parameters  $t$  and  $F$  to obtain well-defined solutions in pure strategies.

**Restriction 1.**  $t \in [0, .311]$ ,  $F < .034$ .

Restriction 1 defines the range of trade and sunk costs where sub-game perfect equilibria allowing internationalization of firms' activities exist. The restriction on trade costs limits the analysis to sub-game perfect equilibria in the two-stage sub-game "unions' wage determination - firms' quantity choices" such that the internationalization of firms' activities is always possible. The parameter's restriction on trade costs is given by  $t \leq .31$  because, at this level, any union wage combination in the two-stage sub-game "unions' wage determination - firms' quantity choices" is consistent with

**Table 2: First stage, Nash Equilibria**

<p>1) for <math>0 \leq t \leq 8/(13+9\sqrt{2}) \approx .31</math> and for <math>0 \leq F \leq 1/8100[88/(13+9\sqrt{2}) - 20]^2 \approx .034</math>:</p> <p>a) for <math>F = 0</math>:</p> <p>in the range <math>0 \leq t \leq 140/471 \approx .297</math>, RFDI Nash equilibrium;  in the range <math>140/471 &lt; t \leq 8/(13+9\sqrt{2})</math>, multiple RFDI and IIT equilibrium.</p> <p>b) in the range <math>0 &lt; F \leq 392/38151 \approx .0102</math>:</p> <p>in <math>0 \leq t \leq 35/137 - 5/274 \sqrt{196 - 11097F}</math>, IIT Nash equilibrium;  in <math>35/137 - 5/274 \sqrt{196 - 11097F} &lt; t \leq 70/471 - 5/942(\sqrt{784 - 76302F})</math>, multiple RFDI and IIT equilibrium;  in <math>70/471 - 5/942(\sqrt{784 - 76302F}) &lt; t \leq 70/471 + 5/942(\sqrt{784 - 76302F})</math>, RFDI equilibrium;  in <math>70/471 + 5/942(\sqrt{784 - 76302F}) &lt; t \leq .31</math>, multiple RFDI and IIT Nash equilibrium;</p> <p>c) in the range <math>392/38151 &lt; F \leq 1184/81675 \approx .0145</math>:</p> <p>in <math>0 \leq t \leq 35/137 - 5/274 \sqrt{196 - 11097F}</math>, IIT Nash equilibrium;  in <math>35/137 - 5/274 \sqrt{196 - 11097F} &lt; t \leq .31</math>, multiple RFDI and IIT Nash equilibrium;</p> <p>d) in the range <math>1184/81675 &lt; F \leq 196/11097 \approx .0176</math>:</p> <p>in <math>0 \leq t \leq 35/137 - 5/274 \sqrt{196 - 11097F}</math>, IIT Nash equilibrium of the game;  in <math>35/137 - 5/274 \sqrt{196 - 11097F} &lt; t \leq 35/137 + 5/274 \sqrt{196 - 11097F}</math>, multiple RFDI and IIT Nash equilibrium;  in <math>35/137 + 5/274 \sqrt{196 - 11097F} &lt; t \leq .31</math>, multiple asymmetric Nash equilibrium;</p> <p>e) for <math>196/11097 &lt; F \leq 1/8100[88/(13+9\sqrt{2}) - 20]^2 \approx .034</math>, IIT unique Nash equilibrium in the range <math>0 \leq t \leq .31</math>.</p>
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every configuration of the firms' strategies involving international activities (IIT, RFDI and asymmetric regimes).

The meaning of the restriction on sunk costs is as follows. The profits generated in the foreign market by the investing firm have to be greater than the size of the sunk costs to undertake the investment abroad. The amounts of these profits differ according to the strategy that the rival firm selects. The threshold value for the size of sunk costs derives from  $F \in [0, \min(\Pi_{ij,RFDI}^H; \Pi_{ij,Asy}^{IE})]$  with  $i=1,2$ ;  $j=B,A$ , where  $\Pi_{ij,RFDI}^H = 4/81$  and  $\Pi_{ij,Asy}^{IE} = (11t-20)^2/8100$ . It can easily be checked that, over the range  $t \leq .31$ ,  $\Pi_{ij,RFDI}^H \geq \Pi_{ij,Asy}^{IN}$ , with the equality holding only for  $t = 0$ . Hence, the relevant range of  $F$  is  $F \in [0, (\Pi_{ij,Asy}^{IN} = (11t-20)^2/8100)|_{t=.31}] \approx .034$ : in fact, for  $t \leq .31$ , profits associated with asymmetric structures of international activities are the lowest for the investing firm. Therefore, this restriction defines the set where the investment strategy can be played by each firm at every value of  $t \leq .31$  independently from the rival firm's choice as regards its internationalization strategy.<sup>32</sup>

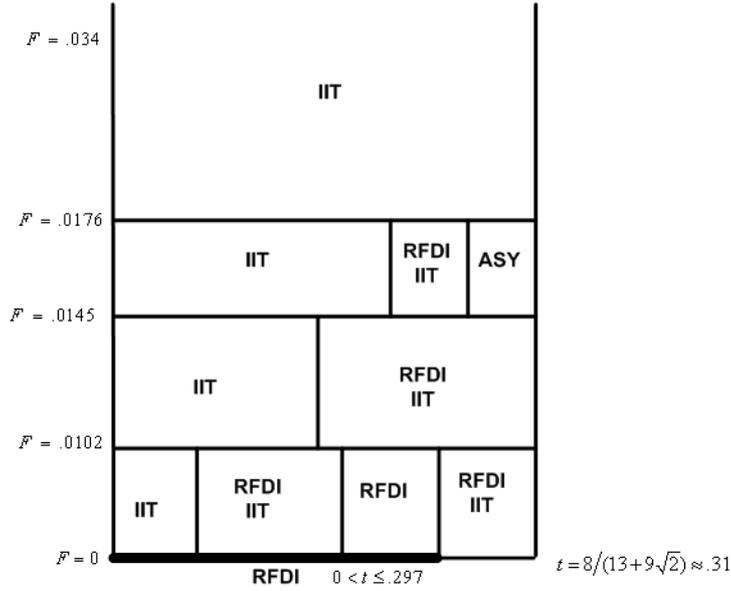
Making use of the results of stages 2 and 3 and Restriction 1, the firms' payoff structure in stage 1 of the game is

$$(\Pi_{1,RFDI}^H; \Pi_{2,RFDI}^H), (\Pi_{1,Asy}^{IN}; \Pi_{2,Asy}^{NI}), (\Pi_{1,Asy}^{NI}; \Pi_{2,Asy}^{IN}), (\Pi_{1,IIT}^{NN}; \Pi_{2,IIT}^{NN}).$$

Table 2 reports the equilibria of the game. When  $F = 0$  (a direct investment without costs), in the range  $0 < t \leq 140/471 \approx .297$ , RFDI is the Nash equilibrium, while for  $t > 140/471$  both RFDI and IIT arise. As the magnitude of the sunk costs varies, the profit function associated with FDI goes down. This implies that there are areas where profits associated with the export strategy are higher than those related to the investment strategy. Thus, there are combinations of the parameters  $t$  and  $F$  such that RFDI and IIT arise as simultaneous, multiple Nash equilibria of the game.

<sup>32</sup> If the restriction on sunk costs does not hold, the investment strategy is not always practicable. Therefore, the results of the analysis are those obtained in Naylor (1998).

**Figure 6: Production Structures in Equilibrium**



The broad picture relative to the productive structures in equilibrium is quite complex, due to the interdependence of  $t$  and  $F$ . Figure 6 reports graphically the results in Table 2 in the  $(F, t)$ -space. Changes in  $F$  may shrink or enlarge the area where an equilibrium productive structure arises. Additionally, these parameters, in turn, affect directly and indirectly the union's wage strategy selection. Nonetheless, some general observations can be addressed.

Firstly, if sunk costs are low enough ( $0 < F \leq .017$ ), the RFDI regime arises not only when trade costs are high (the so-called *tariff jumping argument*), but also when barriers to trade are low, and IIT is a viable option. In other words, RFDI arises purely for strategic reasons. The explanation is as follows. A reduction in trade costs makes the investment option more attractive. In fact, differentiation reveals that  $\partial(\Pi_{ij,Asy}^{IN})/\partial t < 0 \forall t \in [0, .31]$ : as  $t$  decreases, foreign profits for the investing firm in the asymmetric regime increase. That is, the investing firm may disburse a large amount for the sunk costs to enter the foreign market. In other words, the set for which to invest is a feasible strategy enlarges. Secondly, despite the symmetric structures of the two countries, the interdependencies between trade and sunk costs and the unions' strategic behavior create the conditions for multiple, asymmetric productive structure regimes arising in equilibrium. Finally, if sunk costs are high enough ( $.017 < F < .34$ ), IIT is the only equilibrium of the game: the combination of relatively large sunk costs and wage levels higher than in the case of exports does not overcome the trade cost savings for firms when they invest. These results can be summarized in the following proposition.

**Proposition 7:** *Under Restriction 1:*

1) for  $F = 0$ , in the range  $0 < t \leq .297$ , RFDI is the Nash equilibrium, while for  $t > .297$  a multiple RFDI and IIT equilibrium arises; 2) for  $0 < F \leq .017$ , symmetric (IIT or RFDI), multiple symmetric, and multiple asymmetric regime equilibria occur; 3) for  $.017 < F < .34$ , IIT is the unique equilibrium of the game.

### 3. Conclusion

This paper deals with the consequences of the process of international market integration, exemplified by the reduction in trade costs and the possibility to undertake direct investment in a foreign country, on firms and unions' strategic behavior. This work develops a general framework to analyze how these two aspects of economic integration affect firms' decisions concerning

international business, and the strategic behavior of company-wide unions in the labor market. The model allows firms to choose their internationalization strategy. It complements the basic two-way intra-industry trade analytical framework of Naylor (1998, 1999) and the FDI-autarky model of Naylor and Santoni (2003). In a three-stage game, firms act as first movers and choose independently whether to invest in a foreign country; monopoly labor unions select their wage strategy in the second stage; in the third stage output is realized. The model focuses on trade and sunk cost levels such that firms can initiate international activities. Trade costs affect the union's wage strategy formation, and this, in turn, affects the strategic behavior of firms. Considering the wage strategies of rival unions, the complete set of production structure regimes arising as sub-game perfect Nash equilibria for different combinations of trade and sunk costs is derived. The main results are as follows.

Whenever a firm invests abroad to start international business, company unions cannot choose a prohibitive wage rate condemning their workers to be priced out of the labor market. Nevertheless, labor unions gain a larger share of the firms' rents than in the IIT regime because of savings in trade costs: company-wide unions may welcome FDI.

Union wages exclusively influence the firms' payoffs in the RFDI regime. The firms' strategy profile  $(N; N)$  defines that IIT is supported as the Nash equilibrium in pure strategies if and only if the trade cost level is below  $t \leq .31$ . This result is also obtained in Naylor (1998). The two sub-games identified by the firms' strategy profiles  $(I; N)$  and  $(N; I)$ , if  $t \leq .398$ , define that the company-level union operating in the exporting firm sets a wage level such that the firm would export in the other country. The union in the investing firm sets a wage such that the company can exploit the production facilities in both countries.

Because of the interdependence of  $t$ ,  $F$  and unions' strategic behavior, equilibria involving different configurations of international activities arise. Nonetheless, some noteworthy observations can be addressed. Firstly, the RFDI regime also arises as equilibrium for low values of trade costs: to invest is a viable strategic option for a firm not only for the tariff jumping argument, but also when IIT is feasible. The reason lies in the fact that increasing economic integration makes the investment option increasingly suitable. Secondly, in spite of the symmetric structures of the model, the interdependency between trade and sunk costs and the unions' strategic behavior generates conditions such that multiple, asymmetric production structures arise as equilibria of the game. Finally, if sunk costs are sufficiently large, IIT is the unique equilibrium of the game: if firms want to invest, the size of the sunk costs and the wage levels higher than in the case of exports do not offset the trade cost savings.

However, caution is advised regarding the general conclusion of this article. The analysis uses a basic framework. The model presents a certain lack of robustness because of specific functional forms for utility, production and cost functions. These represent all the drawbacks of the model. As Naylor (1999) suggests, a more general right-to-manage model of wage bargaining is a suitable way to develop this work. It would be interesting to test, empirically, if the prospect of company-wide negotiations conducted by unique workers' representatives may affect firms' strategic decisions related to international activities. This is left for future research.

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## Appendix

### Proof of Proposition 1.

Consider the quantity game in country A, described by the system of equations (6) and (8). Each firm chooses its profit-maximizing output given its expectations about the rival firm's choice, and each firm's expectations about the rival's choice is correct. Inserting in the first line of equations (6) and (8) the condition that for each firm the expected quantity of the rival is realized (that is,  $y_{2A} = y_{2A}^E$  for firm 1, and  $x_{1A} = x_{1A}^E$  for firm 2, respectively), yields

$$x_{1A}(y_{2A}) = \frac{1-w_1}{2} - \frac{1}{2}y_{2A}; y_{2A}(x_{1A}) = \frac{1-w_2-t}{2} - \frac{1}{2}x_{1A}.$$

Solving for the two best-response functions, the Cournot equilibrium output levels are

$$x_{1A}^C = \frac{1+t+w_2-2w_1}{3}; y_{2A}^C = \frac{1-2t+w_1-2w_2}{3}.$$

The quantity produced by firm 1 for the domestic market is positive when the wage level  $w_1$ , given  $w_2$  and  $t$ , is such that

$$x_{1A}^C = \frac{1+t+w_2-2w_1}{3} > 0 \Rightarrow w_1 < \frac{1+w_2+t}{2},$$

while the quantity produced by firm 2 for the foreign market is positive when the wage level  $w_2$ , given  $w_1$  and  $t$ , is such that

$$y_{2A}^C = \frac{1-2t+w_1-2w_2}{3} > 0 \Rightarrow w_2 < \frac{1+w_1-2t}{2}.$$

Since  $w_1 < 1$ , if  $w_2 < \frac{1+w_1-2t}{2}$ , then the basic condition for exports of firm 2 in equation (8),  $w_2 < 1-t$ , is also satisfied and, therefore, redundant. In fact, the two inequalities together yield  $\frac{1+w_1-2t}{2} < 1-t \Rightarrow w_1 < 1$ . The quantity produced by firm 1 for its domestic market equals zero when the wage level  $w_1$ , given  $w_2$  and  $t$ , is such that

$$x_{1A}^C = \frac{1+t+w_2-2w_1}{3} = 0 \Rightarrow w_1 \geq \frac{1+w_2+t}{2}.$$

Substituting  $x_{1A}^C = 0$  into the first line in equation (8), it is obtained that  $y_{2A}^C = \frac{1-w_2-t}{2}$ . Since

$w_1 < 1$ , if  $w_1 \geq \frac{1+w_2+t}{2}$ , it follows that the condition  $w_2 < 1-t$  is satisfied, and thus redundant. In

fact, combining the two inequalities renders  $1 > \frac{1+w_2+t}{2} \Rightarrow w_2 < 1-t$ .

Finally, the quantity produced by firm 2 for sales in the foreign market is zero when the wage level  $w_2$ , given  $w_1$  and  $t$ , is such that

$$y_{2A}^C = \frac{1-2t+w_1-2w_2}{3} = 0 \Rightarrow w_2 > \frac{1+w_1-2t}{2}.$$

Further substitution of  $y_{2A}^C = 0$  into the first line in equation (6), leads to  $x_{1A}^C = \frac{1-w_1}{2}$ . A similar reasoning holds in deriving  $(x_{1B}^C, y_{2B}^C)$ , the solutions of the quantity game in country B.  $\square$

### Proof of Proposition 2.

a.0) Let us start by considering the case of  $w_2 \in [0, (1+t)/2]$  and  $t \leq 1/8 = .125$ , where  $w_2 = (1+t)/2$  is the positive, vertical intercept of the line representing the boundary between region III and V in Figure 1. It should be noted that for  $t \leq 1/8$ ,  $(1+t)/2 < 1-2t$ . This implies that, for  $w_2 \in [0, (1+t)/2]$ , every  $(w_1, w_2)$  pair does not belong to region V and VI. For  $w_2 \in [0, (1+t)/2]$  and  $t \leq 1/8$ , the reaction function cannot be in region II. In fact, the right derivative of union 1's payoff function, evaluated at  $w_1$  such that the  $(w_1, w_2)$  pair is on the boundary between region I and II, is equal to

$$\partial \Omega_{1II} / \partial w_1 \Big|_{w_1=(1/2)(1+w_2-2t)} = -(1+w_2-5t) < 0$$

for  $t \in [0, 1/8]$ . Since the derivative is non-positive at the boundary between Region I and Region II, it will be non-positive for any  $w_1$  such that  $(w_1, w_2)$  lies in region II, given the concavity of  $\Omega_1$  with respect to  $w_1$  in region II.

a.1) Let us consider now the behavior of the function  $\Omega_1$  due to changes in  $w_1$  for  $(w_1, w_2)$  pairs belonging to region I, for  $t \leq 1/8$ . Along the boundary between region I and II, it can be verified that  $\partial \Omega_1 / \partial w_1 < 0$  for  $w_2 \leq (1-2t)/2$  (that is, for the points below or equal to the vertical intercept of the line representing the boundary between regions I and III),  $w_2 \in ((1-2t)/2, (1+t)/2)$ , and  $w_2 \in ((1+t)/2, 1-2t)$ . Given the concavity of  $\Omega_1$  with respect to  $w_1$ ,  $\Omega_1$  has a relative maximum in region I if and only if the two following conditions hold: 1) for  $(w_1 = 0, w_2 \leq (1-2t)/2)$   $\partial \Omega_1 / \partial w_1 > 0$ . It can easily be checked that this always holds true; 2) for  $w_2 \in ((1-2t)/2, 1-2t]$ , the right derivative  $\partial \Omega_1 / \partial w_1 > 0$  for  $w_1$  such that the  $(w_1, w_2)$  pair is along the boundary between region I and region III. This holds for

$$\partial \Omega_{1I} / \partial w_1 \Big|_{w_1=2w_2-1+2t} = (10-14w_2-17t) \geq 0 \Rightarrow w_2 \leq (10-17t)/14.$$

Given that  $t < 1$ , it follows  $(1-2t)/2 < (10-17t)/14$ . Since for  $w_2 \in (0, (1-2t)/2)$  and  $t \leq 1/8$  every  $(w_1, w_2)$  pair is always outside regions III, V and VI, an interior relative maximum exists for  $\Omega_1$  in region I. Thus, it follows that the reaction function is  $RF_1(w_2) = w_1 = (2+2w_2-t)/8$  because, for these values of  $w_2$ ,  $\Omega_{1II}(w_1, w_2) < \Omega_{1I}(w_1 = (2+2w_2-t)/8, w_2)$  (from a.0).

For  $w_2 \in ((1-2t)/2, (1+t)/2)$ , the behavior of the function  $\Omega_1$  in region III is also analyzed. It can be shown that  $\partial\Omega_1/\partial w_1 > 0, \forall (w_1 = 0, w_2 \in ((1-2t)/2, (1+t)/2))$ . Thus, given the concavity of  $\Omega_1$  with respect to  $w_1$ , for  $w_2 \in ((1-2t)/2, (1+t)/2)$  this function has an interior maximum in region III if and only if the left derivative  $\partial\Omega_1/\partial w_1$  along the boundary between regions I and III is negative. It follows that

$$\partial\Omega_{1III}/\partial w_1 \Big|_{w_1=2w_2-1+2t} = (19-26w_2-32t) \leq 0 \Rightarrow w_2 \geq (19-32t)/26.$$

Since  $t \leq 1/8$ , it follows that  $(1-2t)/2 < (10-17t)/14 < (19-32t)/26$ . Consequently, for  $w_2 \in ((1-2t)/2, (10-17t)/14)$ , first-order conditions of equation (23) lead to  $RF_1(w_2) = w_1 = (2+2w_2-t)/8$ :  $\Omega_1$  still has a relative maximum at the interior of region I; for  $w_2 \in ((10-17t)/14, (19-32t)/26)$ ,  $\Omega_1$  has a relative maximum on the boundary between region I and region III and, therefore, the reaction function is given by the equation of the boundary between regions I and III, namely  $RF_1(w_2) = 2w_2 + 2t - 1$ ; for  $w_2 \in ((19-32t)/26, (1+t)/2)$ , first-order conditions of equation (25) lead to  $RF_1(w_2) = (5+2w_2-4t)/14$ .

As regards  $w_2 \in [(1+t)/2, 1-2t]$  and  $t \leq 1/8$ , an interior maximum in region III exists so long as the left derivative  $\partial\Omega_1/\partial w_1$  along the boundary between regions III and V is negative, that is, at the value of

$$\partial\Omega_{1III}/\partial w_1 \Big|_{w_1=2w_2-1-t} = (19-26w_2+10t) \leq 0 \Rightarrow w_2 \leq (19+10t)/26.$$

For  $t \leq 1/8$ ,  $1-2t < (19+10t)/26$ . Thus  $w_2 \in [(1+t)/2, 1-2t]$ ,  $\Omega_1$  has a relative interior maximum in Region III and, therefore, the reaction function is  $RF_1(w_2) = (5+2w_2-4t)/14$ . Indeed, it can easily be checked that this last expression is also union 1's best-reply for  $w_2 \in (1-2t, (19+10t)/26)$ . In addition, for  $w_2 > (19+10t)/26$ , the analysis involves the boundary between regions III and region V and region V, areas outside the field of interest.

The analysis is not substantially altered for  $t \in (1/8, 2/15)$  and  $t \in (2/15, 1/5)$ , taking into account only these differences: for  $t \in (1/8, 2/15)$ , the following relations hold  $(10-17t)/14 < (1+t)/2 \leq (19-32t)/26$ , while for  $t \in (2/15, 1/5)$ , the inequalities become  $(10-17t)/14 < (19-32t)/26 \leq (1+t)/2$ . Nevertheless, as regards the shape of the reaction functions, the results remain unaffected.

a.2) Let us now consider the case of  $w_2 \in [0, 1-2t]$  and  $t > 1/5 = .2$ . For  $t > 1/5$ ,  $(1+t)/2 > 1-2t$ : the value of the intercept representing the boundary between regions III and V lies above the value of the upper vertex of the area delimiting the possibility of intra-industry trade. Moreover,  $(1+t)/2 \leq 1-t$  if  $t \leq 1/3$ . This implies that, for  $w_2 \in [0, (1+t)/2]$ , every  $(w_1, w_2)$  pair does not belong to region V, but some  $(w_1, w_2)$  pairs may be part of region VI. For  $w_2 \in [0, 1-2t]$  and values of trade costs marginally above  $1/5$ , a relative maximum exists in region II if the right derivative of  $\Omega_1$  evaluated at  $w_1$  such that  $(w_1, w_2)$  lies along the boundary between regions I and II is positive, while the left derivative is negative. The right derivative of union 1's payoff function equals

$$\partial\Omega_{III}/\partial w_1 \Big|_{w_1=(1/2)(1+w_2-2t)} = -(1+w_2-5t) \geq 0 \Rightarrow w_2 \leq 5t-1.$$

On the other hand, the left derivative is equal to

$$\partial\Omega_{IV}/\partial w_1 \Big|_{w_1=(1/2)(1+w_2-2t)} = -2-2w_2+7t < 0 \quad \forall w_2 \in (0, 1-2t).$$

These findings, together with the concavity of  $\Omega_1$  with respect to  $w_1$  in region II, ensure the existence of a relative maximum in region II. Thus, for  $w_2 \in (0, 5t-1)$ , first-order conditions of equation (24) yield that, in region II, a relative maximum is at  $w_1 = (1+w_2+t)/4$ . However, it can be checked that, for  $w_2 \in (0, 5t-1)$ ,  $\Omega_{III}(w_1 = (1+w_2+t)/4, w_2) < \Omega_{IV}(w_1 = (2+2w_2-t)/8, w_2)$ . This, in turn, implies that, for  $w_2 \in (0, (10-17t)/14)$ , the reaction function is  $RF_1(w_2) = (2+2w_2-t)/8$ ; for  $w_2 \in ((10-17t)/14, (19-32t)/26)$ , the reaction function is  $RF_1(w_2) = 2w_2+2t-1$  (notice that  $(19-32t)/26 < 1-2t$  for  $1/5 < t \leq 7/20$ ), while for  $w_2 \in ((19-32t)/26, 1-2t)$  the reaction function is  $RF_1(w_2) = (5+2w_2-4t)/14$ .

The analysis follows, taking into account  $w_2 \in (1-2t, (1+t)/2]$  and trade costs marginally above  $1/5$ . As previously underlined, within this range of  $w_2$  some  $(w_1, w_2)$  pairs may belong to region VI. In region VI, given the labor demand function in equation (21), the union payoff function is  $\Omega_{IV} = w_1[(1/2)(1-w_1)]$ . A relative maximum in region VI exists if and only if these conditions hold: 1) for  $w_2 \in (1-2t, (1+t)/2]$ , the left derivative  $\partial\Omega_1/\partial w_1$  along the boundary between regions III and VI is negative, while the right derivative is positive; and 2) the left derivative  $\partial\Omega_1/\partial w_1$  evaluated for  $w_1$  that belongs to the boundary between regions II and VI is negative. The left derivative along the boundary between regions III and VI equals

$$\partial\Omega_{III}/\partial w_1 \Big|_{w_1=(1/2)(1+w_2-2t)} = -2-2w_2+7t < 0 \quad \forall w_2 \in (1-2t, (1+t)/2)$$

for  $t \in (1/5, 1/2)$ . The right derivative for  $w_1$  taking values along the boundary between regions III and VI is equal to

$$\partial\Omega_{IV}/\partial w_1 \Big|_{w_1=(1/2)(1+w_2-2t)} = -(1/2)w_2+t.$$

Given that  $t > 1/5$ , for  $w_2 \in (1-2t, (1+t)/2)$  there are sufficiently high levels of  $w_2$  such that this condition is satisfied. In addition, the value of the left derivative for values of  $w_1$  that belongs to the boundary between regions II and VI equals

$$\partial\Omega_{IV}/\partial w_1 \Big|_{w_1=2w_2-1+2t} = 3-4w_2-4t < 0 \Rightarrow w_2 > (3-4t)/4.$$

Notice that  $1-2t < (1+t)/2 \leq (3-4t)/4$  only if  $t \geq 1/4$ . Thus, for  $w_2 \in (1-2t, (1+t)/2)$ , as long as the trade cost levels do not reach the value of  $t = 1/4$  the payoff function  $\Omega_1$  has no interior relative maximum in region VI. Consequently, for  $w_2 \in (1-2t, (1+t)/2)$  and trade cost marginally above the value of  $1/5$ , the reaction function is  $RF_1(w_2) = (5+2w_2-4t)/14$ . Finally, also for

$w_2 \in ((1+t)/2, (19+10t)/26)$  (notice that, since  $t < 1$ ,  $(1+t)/2 < (19+10t)/26$ ), the reaction function is  $RF_1(w_2) = (5 + 2w_2 - 4t)/14$ .

a.3) The discussion in a.2) has shown that for  $t > 1/5$ , an interior relative maximum exists in region II. As  $t$  increases, there comes a point where, for  $w_2 \in [0, 1-2t]$ , the relative maximum of the payoff function  $\Omega_1$  in region II is equal to (is higher than) the relative maximum of the payoff function in region I, namely

$$\Omega_{III}(w_1 = (1 + w_2 + t)/4, w_2) = (1/24)(1 + w_2 + t)^2 \geq \Omega_{II}(w_1 = (2 + 2w_2 - t)/8, w_2) = (1/48)(2 + 2w_2 - t)^2$$

This occurs if and only if  $w_2 \leq [(1 + \sqrt{2})/(2 - \sqrt{2})]t - 1$ , representing the switching wage level. This, in turn, implies that the union switches from a wage policy allowing for exports to a wage policy allowing only domestic production if and only if  $t \geq (2 - \sqrt{2})/(1 + \sqrt{2}) \approx .242$ : for trade cost levels higher than this value, there are levels of  $w_2$  sufficiently low that the relative maximum of the function  $\Omega_1$  in region II is equal to (higher than) the relative maximum of  $\Omega_1$  in region I. Differentiation of the switching wage shows that  $dw_2/dt > 0$ : as  $t$  decreases, the range of  $w_2$  such that union 1's best response is a wage allowing firm 1 to export shrinks. Consequently, if trade cost levels are marginally above  $(2 - \sqrt{2})/(1 + \sqrt{2}) \approx .242$ , the reaction function is  $RF_1(w_2) = (1 + w_2 + t)/4$  for  $w_2 \in (0, [(1 + \sqrt{2})/(2 - \sqrt{2})]t - 1)$ ;  $RF_1(w_2) = (2 + 2w_2 - t)/8$  for  $w_2 \in [[(1 + \sqrt{2})/(2 - \sqrt{2})]t - 1, (10 - 17t)/14)$ . For  $w_2 \in [(10 - 17t)/14, (19 + 10t)/26)$ , the shape of the reaction function is as depicted in a.2), namely for  $w_2 \in [(10 - 17t)/14, (19 - 32t)/26)$ , the reaction function is  $RF_1(w_2) = 2w_2 + 2t - 1$ , and for  $w_2 \in ((19 - 32t)/26, (19 + 10t)/26)$  the reaction function is  $RF_1(w_2) = (5 + 2w_2 - 4t)/14$ .

As  $t$  increases, when  $t \geq 1/4$ , the analysis in a.2) has shown that for  $w_2 \in (1 - 2t, (1 + t)/2]$  an interior maximum also exists in region VI, outside the field of interest. Nevertheless, from maximization of (26), first-order conditions lead to

$$\partial \Omega_{VI} / \partial w_1 = (1/2) - w_1 = 0 \Rightarrow w_1 = 1/2,$$

and, for values of trade costs marginally above  $1/4$ , it occurs that

$$\Omega_{III}(w_1 = (5 + 2w_2 - 4t)/14, w_2) = (1/168)(5 + 2w_2 - 4t)^2 > \Omega_{VI}(w_1 = 1/2) = 1/8.$$

Thus, for  $w_2 \in (1 - 2t, (1 + t)/2]$ , the reaction function is still  $RF_1(w_2) = (5 + 2w_2 - 4t)/14$ . The analysis relative to  $w_2 \in (0, 1 - 2t]$  and  $w_2 \in ((1 + t)/2, (19 + 10t)/26)$  remains unchanged. Therefore, the shape of the reaction function of union 1 is as described above.

a.4) It can be verified that, for  $w_2 \in (0, (19 + 10t)/26)$  and  $t \in (1/4, 2/7)$ , the shape of union 1's reaction function is unaffected. For trade costs marginally above  $2/7$ , union 1's payoff function  $\Omega_1$  has a relative maximum interior to region II if and only if: 1) for  $w_2 \in (0, 1 - 2t)$ , the analysis conducted in a.2) applies, and this holds true; and 2) for  $w_2 \geq 1 - 2t$ , the right derivative of  $\Omega_1$  with

respect to  $w_1$  is positive for union 1's wage rates such that the  $(w_1, w_2)$  pair is along the boundary between regions II and VI. Analytical inspection reveals that this occurs when

$$\partial\Omega_{III}/\partial w_1 \Big|_{w_1=2w_2-1+2t} = 5 - 7w_2 - 7t \geq 0 \Rightarrow w_2 \leq (5 - 7t)/7.$$

However, for  $t > 2/7$ , the left derivative of  $\Omega_1$  with respect to  $w_1$  for union 1's wage rates such that the  $(w_1, w_2)$  pair is along the boundary between regions I and II is negative if

$$\partial\Omega_{II}/\partial w_1 \Big|_{w_1=(1/2)(1+w_2-2t)} = -2 - 2w_2 + 7t < 0 \Rightarrow w_2 > (7t - 2)/2.$$

Therefore, if trade barriers are marginally above  $2/7$ , the function  $\Omega_1$  has an interior relative maximum in region I for  $w_2 \in ((7t - 2)/2, (10 - 17t)/14)$ ; for  $w_2 \in ((10 - 17t)/14, (19 - 32t)/26)$ , a relative maximum is on the boundary between region I and region III; for  $w_2 \in ((19 - 32t)/26, (19 + 10t)/26)$ , an interior relative maximum exists in region III; an interior relative maximum is in region II for  $w_2 \in (0, 1 - 2t)$ ; a relative maximum is along the boundary between region II and region VI for  $w_2 \in ((5 - 7t)/7, (3 - 4t)/4)$  (note that  $(5 - 7t)/7 < (3 - 4t)/4 \forall t \in (0, 1)$ ); and, for  $w_2 > (3 - 4t)/4$ , a relative interior maximum exists in region VI. Straightforward comparisons show that the following inequalities hold: for wage rates in the range  $w_2 \in (0, (7t - 2)/2)$ , union 1's payoff function is such that  $\Omega_{III}(w_1 = (1 + w_2 + t)/4, w_2) > \Omega_{II}(w_1, w_2)$ ; for  $w_2 \in ((7t - 2)/2, [(1 + \sqrt{2})/(2 - \sqrt{2})]t - 1)$ , union 1's payoff function is such that  $\Omega_{III}(w_1 = (1 + w_2 + t)/4, w_2) > \Omega_{II}(w_1 = (2 + 2w_2 - t)/8, w_2)$ ; for wages  $w_2 \in [[(1 + \sqrt{2})/(2 - \sqrt{2})]t - 1, (10 - 17t)/14)$ , union 1's payoff function is such that  $\Omega_{III}(w_1 = (1 + w_2 + t)/4, w_2) \leq \Omega_{II}(w_1 = (2 + 2w_2 - t)/8, w_2)$ ; for  $w_2 \in ((10 - 17t)/14, (19 - 32t)/26)$ ,  $\Omega_{III}(w_1, w_2) < \Omega_{II}(w_1 = 2w_2 - 1 - 2t, w_2)$ ; for wages in the range  $w_2 \in ((19 - 32t)/26, (5 - 7t)/7)$ ,  $\Omega_{III}(w_1 = (1 + w_2 + t)/4, w_2) < \Omega_{III}(w_1 = (5 + 2w_2 - 4t)/14, w_2)$ ; for  $w_2 \in ((5 - 7t)/7, (3 - 4t)/4)$ ,  $\Omega_{III}(w_1 = 2w_2 - 1 - 2t, w_2) < \Omega_{III}(w_1 = (5 + 2w_2 - 4t)/14, w_2)$ ; and for wages in the range  $w_2 \in ((3 - 4t)/4, (19 + 10t)/26)$ ,  $\Omega_{III}(w_1 = (5 + 2w_2 - 4t)/14, w_2) > \Omega_{VI}(w_1 = 1/2)$ .

Thus, union 1's reaction function is as in a.3), that is, for  $w_2 \in (0, [(1 + \sqrt{2})/(2 - \sqrt{2})]t - 1)$  the expression is given by  $RF_1(w_2) = (1 + w_2 + t)/4$ ; for  $w_2 \in [[(1 + \sqrt{2})/(2 - \sqrt{2})]t - 1, (10 - 17t)/14)$ , the best-reply is  $RF_1(w_2) = (2 + 2w_2 - t)/8$ ; for  $w_2 \in [(10 - 17t)/14, (19 - 32t)/26)$ , the best-reply is given by  $RF_1(w_2) = 2w_2 - 1 - 2t$ ; for  $w_2 \in [(19 - 32t)/26, (19 + 10t)/26)$ , the reaction function is  $RF_1(w_2) = (5 + 2w_2 - 4t)/14$ .

a.5) As  $t$  increases above  $2/7$ , there comes a point where the intersection of the two unions' reaction functions in region I,  $RF_1(w_2) = (2 + 2w_2 - t)/8$  and  $RF_2(w_1) = (2 + 2w_1 - t)/8$ , given by

$$w_1 = w_2 = w_{III} = 1/3 - (1/6)t.$$

matches the switching wage. These values are satisfied concurrently when

$$1/3 - (1/6)t \geq [(1 + \sqrt{2})/(2 - \sqrt{2})]t - 1.$$

This implies that the critical value of  $t$  above which IIT is not supported in pure strategy equilibrium (Naylor 1998, 1999) equals  $t \leq 8/(13+9\sqrt{2}) \approx .31$ . For  $t \in (2/7, 8/(13+9\sqrt{2}))$ , all the inequalities in a.4) are valid.  $\square$

### Proof of Proposition 3.

Consider the quantity game in country A, described by the system of equations (29) and (31). Each firm selects its profit-maximizing quantity given its expectations about the rival firm's choice, and each firm's expectations concerning the rival choice is correct. Adding to equations (29) and (31) the condition that the rival's expected quantity is realized for each firm (namely  $x_{2A} = x_{2A}^E$  for firm 1 and  $x_{1A} = x_{1A}^E$  for firm 2), it is obtained

$$x_{1A}(x_{2A}) = \frac{1-w_1}{2} - \frac{1}{2}x_{2A}; x_{2A}(x_{1A}) = \frac{1-w_2}{2} - \frac{1}{2}x_{1A}.$$

Solving the system, the following results are derived

$$x_{1A}^C = \frac{1+w_2-2w_1}{3}; x_{2A}^C = \frac{1+w_1-2w_2}{3}$$

Firm 1's output level for the domestic market is positive when the wage level  $w_1$ , given  $w_2$ , is such that

$$x_{1A}^C = \frac{1+w_2-2w_1}{3} > 0 \Rightarrow w_1 < \frac{1+w_2}{2}$$

while Firm 2's quantity produced for the foreign market is positive when the wage level  $w_2$ , given  $w_1$  and  $t$ , is

$$x_{2A}^C = \frac{1+w_1-2w_2}{3} > 0 \Rightarrow w_2 < \frac{1+w_1}{2}.$$

The quantity produced by firm 1 for the domestic market is zero when the wage level  $w_1$ , given  $w_2$ , is such that

$$x_{1A}^C = \frac{1+w_2-2w_1}{3} = 0 \Rightarrow w_1 \geq \frac{1+w_2}{2}.$$

Substitution of  $x_{1A}^C = 0$  into the first line in equation (29) leads to  $x_{2A}^C = \frac{1-w_2}{2}$ . To conclude the proof, the output produced by firm 2 for the foreign market is equal to zero when the wage level  $w_2$ , given  $w_1$  and  $t$ , is such that

$$x_{2A}^C = \frac{1+w_1-2w_2}{3} = 0 \Rightarrow w_2 > \frac{1+w_1}{2}.$$

Substituting  $x_{2A}^C = 0$  into the first line in equation (31) gives  $x_{1A}^C = \frac{1-w_1}{2}$ . Analogous reasoning applies for  $(x_{1B}^C, x_{2B}^C)$ , the solutions of the quantity game in country B.  $\square$

#### Proof of Proposition 4.

Given the asymmetry in the productive choice of the two firms, the quantity games are analyzed separately for each country. First, let us consider the game in country A, where firm 2 undertakes FDI. This is described by the system of equations (39) and (41). With the condition that for each firm the rival's expected output is realized, (that is,  $x_{2A} = x_{2A}^E$  for firm 1 and  $x_{1A} = x_{1A}^E$  for firm 2), it follows

$$x_{1A}(x_{2A}) = \frac{1-w_1}{2} - \frac{1}{2}x_{2A}; x_{2A}(x_{1A}) = \frac{1-w_2}{2} - \frac{1}{2}x_{1A}.$$

Thus, the solution of the game in A is as in Proposition 2. Consider the quantity game in country B, described by the system of equations (40) and (42). Adding the condition that for each firm the rival's expected output is realized (namely  $y_{2B} = y_{2B}^E$  for firm 1 and  $x_{1B} = x_{1B}^E$  for firm 2), it is obtained

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

The output produced by firm 1 for the foreign market is positive when the wage level  $w_1$ , given  $w_2$  and  $t$ , is such that

$$x_{1B}^C = \frac{1-2t+w_2-2w_1}{3} > 0 \Rightarrow w_1 < \frac{1+w_2-2t}{2}$$

while the quantity produced by firm 2 for the domestic market is positive when the wage level  $w_2$ , given  $w_1$  and  $t$ , is

$$y_{2B}^C = \frac{1+t+w_1-2w_2}{3} > 0 \Rightarrow w_2 < \frac{1+w_1+t}{2}.$$

Since  $w_2 < 1$ , if  $w_1 < \frac{1+w_2-2t}{2}$  then Firm 1's condition for exports in equation (40),  $w_1 < 1-t$ , is satisfied, and therefore redundant. In fact, the last two inequalities together lead to  $\frac{1+w_2-2t}{2} < 1-t \Rightarrow w_2 < 1$ .

In addition, firm 1's output for the foreign market equals zero when the wage level  $w_1$ , given  $w_2$  and  $t$ , is such that

$$x_{1B}^C = \frac{1-2t+w_2-2w_1}{3} = 0 \Rightarrow w_1 \geq \frac{1+w_2-2t}{2}.$$

Substituting  $x_{1B}^C = 0$  into equation (42), the solution is  $y_{2B}^C = \frac{1-w_2}{2}$ . Finally, Firm 2's output for the domestic market is zero when the wage rate  $w_2$ , given  $w_1$  and  $t$ , is such that

$$y_{2B}^C = \frac{1+t+w_1-2w_2}{3} = 0 \Rightarrow w_2 > \frac{1+w_1+t}{2}.$$

Further substitution of  $y_{2B}^C = 0$  into equation (40) yields  $x_{1B}^C = \frac{1-w_1-t}{2}$ . Since  $w_2 < 1$ , if  $w_2 > \frac{1+w_1+t}{2}$  it follows that the condition  $w_1 < 1-t$  in equation (40) is satisfied, and thus redundant. In fact, combining the inequalities, it follows that  $1 > \frac{1+w_1+t}{2} \Rightarrow w_1 < 1-t$ .  $\square$

### Proof of Proposition 5.

To prove Proposition 5, union 2's payoff function is analyzed in relation to changes of the independent variables  $w_1$  and  $t$  in Region III. Union 2's payoff in that region is:

$$\Omega_2 = w_2 \left[ \frac{1}{3} (1+t+w_1-2w_2) \right]$$

This function is continuous over the range  $w_2 \in (0,1)$ . Union 2's payoff function in region III is: 1) increasing in  $w_1$ ; 2) for a given  $w_1$ , a reduction in  $t$  decreases union 2's payoff; 3)  $\partial\Omega_2/\partial w_2 \partial w_1 > 0$ , namely wages are strategic complements; 4)  $\partial^2\Omega_2/\partial w_2^2 < 0$ , the payoff function is concave with respect to  $w_2$ .

Suppose now that union 2 chooses to set a wage rate in region III. In this region, firm 2 does not exploit the foreign plant while firm 1 exports. For  $w_1 \in [0, 1-(4/3)t]$ , the left derivative of union 2's payoff function, evaluated at  $w_2$  such that the  $(w_1, w_2)$  pair is on the boundary between regions I and III, is equal to

$$\partial\Omega_{2III}/\partial w_2 \Big|_{w_2=(1/2)(1+w_1)} = -1+t-w_1 < 0 \quad \forall t \in (0,1) .$$

Since the derivative is non-positive at the boundary between Region I and Region III, it will be non-positive for any  $w_2$  such that  $(w_1, w_2)$  lies in region III, given the concavity of  $\Omega_2$  with respect to  $w_2$  in region III. The payoff function is decreasing across Region III and, therefore, union 2's reaction function cannot be in that region.  $\square$

### Proof of Proposition 6.

a.0) Firstly, let us consider union 1's payoff function. Notice that, for  $t < 3/4$ ,  $1/2 < 1-(2/3)t$ : the value of the positive, vertical, intercept of the line  $w_2 = (1/2)(1+w_1)$  (the boundary between regions I and III in Figure 4), lies below the value of  $w_2$  at the point of intersection between the boundaries  $w_2 = (1/2)(1+w_1)$  and  $w_1 = (1/2)(1+w_2-2t)$  (the upper vertex of region I in Figure 4). That is,

region I exists in the first quadrant of the Cartesian plan if and only if  $t < 3/4$ . This implies also that, for  $w_2 \in [0, 1/2]$ , every  $(w_1, w_2)$  pair belongs neither to region III nor to region VI.

a.1) The analysis begins by taking into account  $w_2 \in [0, 1/2]$  and  $t \leq 1/4 = .25$ . For  $w_2 \in [0, 1/2]$  and  $t \leq 1/4 = .25$ , the reaction function cannot be in region II so long as the right derivative of the union 1 payoff function, evaluated at  $w_1$  such that  $(w_1, w_2)$  lies along the boundary between regions I and II, is negative. This occurs for

$$\partial\Omega_{II}/\partial w_1 \Big|_{w_1=(1/2)(1+w_2-2t)} = -1 - w_2 + 4t < 0 \Rightarrow w_2 > 4t - 1.$$

Thus, for  $t \leq 1/4$ , since the derivative is non-positive at the boundary between Region I and Region II, it will be non-positive for any  $w_1$  such that  $(w_1, w_2)$  lies in region II; given the concavity of  $\Omega_1$  with respect to  $w_1$  in region II, no interior maximum exists in region II. Instead, along the boundary between regions I and II, it can be checked that the left derivative  $\partial\Omega_1/\partial w_1 < 0$ . Given the concavity of  $\Omega_1$  with respect to  $w_1$ , a relative maximum in region I exists if and only if this condition holds: for  $(w_1 = 0, w_2 \leq 1/2)$  (namely for the points below or equal to the value of the vertical intercept of the line representing the boundary between regions I and III),  $\partial\Omega_1/\partial w_1 > 0$ , and this can easily be confirmed to be always the case, however small  $w_2$  may be.

a.2) Let us continue by considering  $w_2 \in (1/2, 1 - (2/3)t]$  and  $t \leq 1/4 = .25$ . For  $w_2 \in (1/2, 1 - (2/3)t]$ , some  $(w_1, w_2)$  pairs reside in the interior of Region III and along the boundary between region I and region III, while some other  $(w_1, w_2)$  pairs are in the interior of region I. An interior maximum in region I exists if and only if, for  $w_1$  such that the  $(w_1, w_2)$  pair is on the boundary between region I and region III, the right derivative  $\partial\Omega_1/\partial w_1 > 0$ . This holds for

$$\partial\Omega_{II}/\partial w_1 \Big|_{w_1=2w_2-1} = (5 - 7w_2 - t) \geq 0 \Rightarrow w_2 \leq (5 - t)/7.$$

Further analytical inspection reveals that  $(5 - t)/7 < 1 - (2/3)t$  as long as  $t < 6/11 \approx .54$ . Summarizing, since for  $w_2 \in [0, 1/2]$  and  $t \leq 1/4 = .25$  every  $(w_1, w_2)$  pair is always outside regions III, V and VI, it follows that the reaction function is  $RF_1(w_2) = w_1 = (1 + w_2 - t)/4$  because, for these values of  $w_2$ ,  $\Omega_{II}(w_1, w_2) < \Omega_{II}(w_1 = (1 + w_2 - t)/4, w_2)$  (from part a.1). On the other hand, for  $w_2 \in (1/2, 1 - (2/3)t)$  and  $t \leq 1/4$ , the reaction function is  $RF_1(w_2) = w_1 = (1 + w_2 - t)/4$  for wage rates  $w_2 \in (1/2, (5 - t)/7)$ . For  $w_2 > (5 - t)/7$ , union 1 plays a wage level such that the resulting  $(w_1, w_2)$  pair will be interior to region III. Given that trade costs are  $1/4 < 6/11$ , according to Proposition 5 this wage combination cannot be an equilibrium of the unions' wage setting sub-game because union 2 fails in making a best-response in region III.

a.3) For  $w_2 \in [0, 1/2]$ , as  $t$  increases marginally above  $1/4$ , there are levels of  $w_2$  such that union 1's utility function,  $\Omega_1$ , has an interior relative maximum in region II. In fact, for trade costs marginally above  $t = 1/4$ , the right derivative of the union 1 payoff function, evaluated at  $w_1$  such that  $(w_1, w_2)$  lies along the boundary between regions I and II, is positive (or equal to zero) if

$$\partial\Omega_{II}/\partial w_1 \Big|_{w_1=(1/2)(1+w_2-2t)} = -1 - w_2 + 4t \geq 0 \Rightarrow w_2 \leq 4t - 1.$$

Thus, for  $w_2 \in [0, 4t - 1]$ , the first-order conditions of equation (53) yield that, in region II, a relative maximum is reached at  $w_1 = (1 + w_2)/4$ . Nevertheless, it can be checked that, for trade barriers marginally above  $1/4$  and  $w_2 \in [0, 4t - 1]$ ,  $\Omega_{II}(w_1 = (1 + w_2)/4, w_2) < \Omega_{II}(w_1 = (1 + w_2 - t)/4, w_2)$ . Moreover, for  $w_2 \in (1/2, 1 - (2/3)t]$  and trade costs marginally above  $1/4$ , the analysis conducted in a.2) for this range of  $w_2$  remains unaffected. This, in turn, implies that, for  $w_2 \in [0, (5 - t)/7)$ , the reaction function is in region I and is equal to  $RF_1(w_2) = w_1 = (1 + w_2 - t)/4$ .

a.4) The discussion in a.3) has shown that for trade barriers marginally above  $1/4$ , there are levels of  $w_2$  such that  $\Omega_1$  has an interior relative maximum in region II. As trade cost levels increase, there comes a point such that, for  $w_2 \in [0, 1 - (2/3)t]$ , the relative maximum in region II equals (is higher than) the relative maximum of the payoff function in region I. That is,

$$\Omega_{II}(w_1 = (1 + w_2)/4, w_2) = (1/24)(1 + w_2)^2 \geq \Omega_{II}(w_1 = (1 + w_2 - t)/4, w_2) = (1/12)(1 + w_2 - t)^2.$$

This occurs if and only if  $w_2 \leq (2 + \sqrt{2})t - 1$ , representing the switching wage level in the asymmetric regime. This, in turn, implies that, for  $t \geq 1/(2 + \sqrt{2}) \approx .29$ , there are levels of  $w_2$  sufficiently low that the relative maximum of  $\Omega_1$  in region II is equal to (higher than) the relative maximum of  $\Omega_1$  in region I. Differentiation of the switching wage shows that  $dw_2/dt > 0$ : as trade cost decreases, the range of  $w_2$  such that union 1's best reply is a wage allowing firm 1 to export gets smaller. Summarizing, for  $w_2 \in [0, 1 - (2/3)t]$  and trade cost levels marginally above  $1/(2 + \sqrt{2}) \approx .29$ , the analysis shows that union 1's reaction function is  $RF_1(w_2) = (1 + w_2)/4$  for  $w_2 \in (0, (2 + \sqrt{2})t - 1]$ , while for  $w_2 \in ((2 + \sqrt{2})t - 1, (5 - t)/7)$  the reaction function is  $RF_1(w_2) = w_1 = (1 + w_2 - t)/4$ .

a.5) For  $w_2 \in [0, 1 - (2/3)t]$ , as  $t$  rises and reaches  $t > 1/3$ , the left derivative  $\partial\Omega_{II}/\partial w_1$  for union 1's wages such that the  $(w_1, w_2)$  pair is along the boundary between regions I and II is negative if

$$\partial\Omega_{II}/\partial w_1 \Big|_{w_1=(1/2)(1+w_2-2t)} = -1 - w_2 + 3t < 0 \Rightarrow w_2 > 3t - 1.$$

Given that  $t > 1/3$ , there are sufficiently high levels of  $w_2$  that the previous condition is satisfied. This condition says simply that, in the range  $w_2 \in (0, 3t - 1)$ , the function  $\Omega_1$  is increasing in region I. The analysis carried out in a.3)-a.4) has shown that there is a range of values of  $w_2$  such that the utility function  $\Omega_1$  has a relative interior maximum in region II. Thus, for  $w_2 \in [0, 1 - (2/3)t]$ , if trade barriers are marginally above  $1/3$ , an interior relative maximum exists in region I for  $w_2 \in (3t - 1, (5 - t)/7)$ , and an interior maximum is in region II for  $w_2 \in (0, 4t - 1)$ . Moreover, since  $0 < t$ , the switching wage  $(2 + \sqrt{2})t - 1 > 3t - 1$ . Therefore, for  $w_2 \in (0, 3t - 1)$ , the function  $\Omega_1$  has a relative maximum in region II, and direct payoff comparison shows that, for  $w_2 \in (3t - 1, (2 + \sqrt{2})t - 1]$ ,  $\Omega_{II}(w_1 = (1 + w_2)/4, w_2) \geq \Omega_{II}(w_1 = (1 + w_2 - t)/4, w_2)$ ; for wages

$w_2 \in ((2 + \sqrt{2})t - 1, (5 - t)/7)$ ,  $\Omega_{III}(w_1 = (1 + w_2)/4, w_2) < \Omega_{II}(w_1 = (1 + w_2 - t)/4, w_2)$ . Thus, union 1's reaction function is  $RF_1(w_2) = (1 + w_2)/4$  for  $w_2 \in (0, (2 + \sqrt{2})t - 1]$ , and  $RF_1(w_2) = w_1 = (1 + w_2 - t)/4$  for  $w_2 \in ((2 + \sqrt{2})t - 1, (5 - t)/7)$ .

a.6) For  $w_2 \in [0, 1 - (2/3)t]$ , as  $t$  increases, there comes a point when the values of  $w_2 = 3t - 1$  and  $w_2 = (5 - t)/7$  equal  $w_2 = 1 - (2/3)t$ . This occurs at  $t = 6/11 \approx .54$ . For  $t$  above this level,  $\Omega_1$  is increasing across region I and, thus, this function has a relative maximum only in region II. Therefore, the reaction function is  $RF_1(w_2) = (1 + w_2)/4$  for  $w_2 \in (0, 5/7]$  (the value of  $5/7$  is the value of the intersection of the reaction function with the boundary between regions II and VI).

b.0) Let us now consider union 2's payoff function. The analysis starts by taking into account the case of  $w_1 \in [0, (1 - 2t)/2]$ , where  $w_1 = (1 - 2t)/2$  is the intercept of the line representing the boundary between regions I and II in Figure 4, given by  $w_1 = (1/2)(1 + w_2 - 2t)$ . Notice that, for  $t \in (0, 1)$ ,  $(1 - 2t)/2 < 1 - (4/3)t$ . This implies that, for  $w_1 \in [0, (1 - 2t)/2]$ , every  $(w_1, w_2)$  pair does not belong to regions II and VI. Notice also that for  $t < 3/8$ ,  $1/2 < 1 - (4/3)t$ , where  $w_1 = 1/2$  is the intercept of the line representing the boundary between regions II and IV in Figure 4, given by  $w_1 = (1/2)(1 + w_2)$ .

b.1) Proposition 5 has shown that the right derivative of union 2's payoff function, evaluated at  $w_2$  such that  $(w_1, w_2)$  lies along the boundary between regions I and III, is negative  $\forall t \in (0, 1)$ . Thus, since the derivative is non-positive at the boundary between region I and region III, it will be non-positive for any  $w_2$  such that  $(w_1, w_2)$  lies in region III; given the concavity of  $\Omega_2$  with respect to  $w_2$  in region III, no interior maximum exists in region III.

b.2) Let us consider, for  $w_1 \in [0, 1 - (4/3)t]$  and  $t < 3/8$ , the behavior of the function  $\Omega_2$  due to changes in  $w_2$  for  $(w_1, w_2)$  pairs belonging to region I. Given the concavity of  $\Omega_2$  with respect to  $w_2$ ,  $\Omega_2$  has a relative maximum in region I, if and only if the two following conditions hold: 1) for  $(w_2 = 0, w_1 \leq (1 - 2t)/2)$  (that is, for points to the left of or equal to the intercept on the horizontal axis of the boundary between regions I and II),  $\partial\Omega_2/\partial w_2 > 0$ : this can be checked to always hold true; 2) for  $w_1 \in ((1 - 2t)/2, 1 - (4/3)t)$ , the right derivative of  $\Omega_2$  with respect to  $w_2$  is positive for  $w_2$  such that the  $(w_1, w_2)$  pair is along the boundary between region I and region II. This holds for

$$\partial\Omega_{2I}/\partial w_2 \Big|_{w_1=(1/2)(1+w_2-2t)} = (10 - 14w_1 - 15t) \geq 0 \Rightarrow w_1 \leq (10 - 15t)/14.$$

Since  $t < 1$ , it follows that  $(10 - 15t)/14t < 1 - (4/3)t$ . Thus, for  $w_1 \in [0, (1 - 2t)/2]$ , an interior relative maximum exists for  $\Omega_2$  in region I. For  $w_1 \in ((1 - 2t)/2, (10 - 15t)/14)$ , there is still a relative maximum of this function at the interior of region I. Given that for  $w_1 > (10 - 15t)/14$  the right derivative  $\partial\Omega_2/\partial w_2 < 0$  for  $w_2$  such that the  $(w_1, w_2)$  pair is along the boundary between region I and region II,  $\Omega_2$  has a relative maximum on the boundary between regions I and II. For  $w_1 \in ((10 - 15t)/14, 1/2)$ , given the concavity of  $\Omega_2$  with respect to  $w_2$ , this function has an interior

maximum in region II if and only if the left derivative  $\partial\Omega_2/\partial w_2$  along the boundary between regions I and II is negative; this occurs when

$$\partial\Omega_{2II}/\partial w_2 \Big|_{w_2=2w_1-1+2t} = (19 - 26w_1 - 28t) \leq 0 \Rightarrow w_1 \geq (19 - 28t)/26.$$

Since  $t < 1$ , it follows that  $(10 - 15t)/14 < (19 - 28t)/26 < 1 - (4/3)t$ . Consequently, union 2's reaction function is as follows: for  $w_1 \in (0, (10 - 15t)/14)$ , first-order conditions of equation (54) lead to  $RF_2(w_1) = w_2 = (2 + 2w_1 + t)/8$ ; for wages in the range  $w_1 \in ((10 - 15t)/14, (19 - 28t)/26)$ , the best-reply function is  $RF_2(w_1) = w_2 = (2w_1 - 1 + 2t)$ ; for  $w_1 \in ((19 - 28t)/26, 1 - (4/3)t)$ , first-order conditions of equation (55) lead to  $RF_2(w_1) = w_2 = (5 + 2w_1)/14$ .

b.3) For  $t > 3/8$ ,  $1 - (4/3)t < 1/2$ , the intercept of the line representing the boundary between regions II and IV in Figure 4, given by  $w_1 = (1/2)(1 + w_2)$ , is greater than the value of  $w_1$  representing the upper vertex of region I in Figure 4. Nevertheless, the shape of the reaction function is as in b.2), adding only that for  $w_1 \in (1 - (4/3)t, 1/2)$  the reaction function is still  $RF_2(w_1) = w_2 = (5 + 2w_1)/14$  (indeed, it can be verified that this is union 2's best-reply for  $w_1 \in (1 - (4/3)t, 16/27)$ , where the latter value represents the value of the point of intersection of the segment of union 2's reaction function in region II with the boundary between regions II and IV).

c.0) The two unions' reaction functions in region I,  $RF_1(w_2) = w_1 = (1 + w_2 - t)/4$  for union 1 and  $RF_2(w_1) = w_2 = (2 + 2w_1 + t)/8$  for union 2, intersect at

$$w_{1,Asy} = 1/3 - (7/30)t, \quad w_{2,Asy} = 1/3 + (1/15)t.$$

These values represent the Bertrand-Nash wages in equilibrium allowing for both firms to undertake international business in the asymmetric regime where firm 2 invests. Intra-industry international activities are supported as pure strategy equilibrium until trade costs are such that the level of  $w_2$  representing the switching wage for union 1 is satisfied concurrently with the Bertrand-Nash equilibrium wage for union 2, that is,

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

It follows that the critical value of  $t$  above which intra-industry international activities in asymmetric regimes are not supported as pure strategy equilibrium is equal to

$$t \leq 20/(29 + 15\sqrt{2}) \approx .398. \quad \square$$

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