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The author

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International Production and Wage Coordination in an Integrated Economy

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Abstract: Key aspects in economic integrated areas like the EU are both the internationalization of productive activities, which usually occurs in unionized countries, and the ongoing process of labor market integration. 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. It shows that, contrary to conventional wisdom, under certain conditions wage coordination could lead from a social point of view to a Pareto superior outcome respect to separate wage settings.

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1 Introduction

Closer economic integration within regional and international spheres has been the course of action characterizing the last decades of contemporary history. International trade and foreign direct investment (FDI) have been among the fastest expanding economic activities around the world due to increasing removal of trade restrictions and deregulation of international capital markets. Nowadays, FDI leads the process of internationalization of productive activities, whose principal actors are Multinational Enterprises (MNEs). While undertaking direct investments in different countries of economic integrated areas like the EU or the NAFTA,[1] MNEs own plants in several locations, organizing their business on an international basis.

As suggested by Horn and Wolinsky (1988a), MNEs may exploit this organizational structure strategically to avoid the creation of an encompassing union. In this context, a major concern for organized labor is that MNEs are able to obtain concessions in terms of wage demands from unions. Public opinion asks unions of taking care of national interest, preserving existing jobs and economic activities, and trying to promote further domestic employment. Consequently, an increasing number of unions has shown interest in coordinating their activities across boundaries to recover bargaining positions. Mainly in the EU, the ongoing process of economic integration seems to encourage trans-national cooperation. The exchange of information on wage levels, working conditions, and employment policies in different countries, as well as some shared rules in collective bargaining, have been recently introduced in Europe. These initiatives mostly occur at the intersectoral level − e.g., since 1998 the European Trade Union Confederation (ETUC) yearly provides the "guideline for collective bargaining at the European level".[2] While union coordination in trading sectors is relatively rare, the figures concerning trans-national agreements in industries characterized by the presence of large MNEs steadily increased in last years: from 92 in 2005 to 243 in 2007, two thirds of which related to European MNEs' activities within the EU itself (ETUC, 2008).

Despite its relevance, the analysis of incentives and scopes for union cooperation in a context of economic integration started only in recent times. Precisely, this work focuses on this subject.

Surprisingly, cross-border wage coordination policies (the main form of union cooperation) has received attention in a limited number of theoretical works. For instance, Huizinga (1993), Naylor (1999), Straume (2002), and Strozzi (2007, 2008) consider this issue 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; the effects of wage harmonization are briefly sketched. Instead, in a two-country duopoly model with homogeneous products and segmented markets Naylor (1999) shows that unions may find advantageous to establish an international agreement for some trade cost levels, colluding over a wage rate which induces an autarky regime as equilibrium. The works of Straume (2002) and Strozzi (2007, 2008) deeply analyze the scope for unions to adopt collusive behavior. They start from Naylor's (1999) framework, and examine which conditions support collusion as equilibrium of an infinitely repeated game. In particular, Strozzi (2007, 2008) shows that the sustainability of trans-national 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 be sustained; product differentiation strengthen this effect. Instead, in the presence of sufficiently high trade costs, a decrease of their level do not influence the sustainability of union collusion, which turns out to be easier the less similar are goods.

The labor market effects of transnational union coordination are also considered in Zhao (1998), and Borghijs and Du Caju (1999). These authors focus on international productive activities. Zhao (1998) builds up a two-county model with union-management efficient bargaining and integrated

[1] For example, of all the flows of FDI into the EU, the EU itself originated its bulk: as for the period 2003-2006, the average of inward intra-EU FDI flows was 76% (see European Commission, 2008).

[2] See European Commission (2009) for a review on cross-border coordination activities concerning collective bargaining,.

product markets to investigate the impact of foreign direct investments on wage and employment outcomes. The author's conclusion is that if union cooperation takes place, unions' bargaining power increases since their outside option in negotiations will improve. Borghijs and Du Caju (1999) analyze the prospects for union cooperation in a context of international production considering an integrated product market. The model has a basic set up: a single firm with two plants in different countries characterized by decreasing returns to scale technology in the only factor of production, labor. The authors show that, for coordination costs large enough, monopoly unions are better off competing in the labor market; so, unions moderate their wage demands. For transaction costs lower than a threshold value, wage coordination turns out to be an attractive option, leading to higher wages. A further decline in coordination costs reduces the collusive wage, but this remains higher than the wage under separate setting.

"Frictions" in the economic integration process affect union collusion: trade costs in the intra-industry trade literature; coordination costs in the labor markets. While Straume (2002) and Strozzi (2007, 2008) address the analysis to the effects of product market integration on union collusion in a standard reciprocal dumping model, this work complements the earlier theoretical contributions exploring the topic in the presence of MNEs operating in an integrated product market. As in Borghijs and Du Caju (1999), the focus is on the impact of labor market integration. In doing so, the present work further extends their analysis to the sustainability of union collusive behavior and the implications of coordinated wage demands for social welfare. A key result is that, contrary to conventional wisdom that union collusion is always detrimental, wage coordination may improve overall welfare. Despite the results cannot be directly compared with the received literature (due to differences in the reference frameworks), this paper may help to shed lights on the recent developments of unions' collusive practices.

The rest of the paper is organized as follows. Section 2 presents the formal model of international production in unionized countries, analyzing both the outcomes of a separate and a collusive wage setting. Section 3 investigates the sustainability of trans-national coordinated wage demands. Section 4 examines the welfare implications under the two different wage settings. Section 5 closes the paper.

2 A model of international production in unionized countries

This section develops a partial equilibrium model of international oligopoly whit unionized countries. It extends Borghijs and Du Caju (1999), adding one firm and introducing a degree of product differentiation.

In economically integrated bloc, there are two countries, A and B. In each country, two firms, denoted 1 and 2, locate a plant. Firms act as Cournot competitors in the single integrated product market. There are some exogenous fix costs large enough such that neither the incumbent firms start-up a new production facility nor a potential entrant will enter into the industry: the market structure is blockaded. Each firm produces differentiated goods, denoted x when produced in A, and y in B. Labor is the only factor of production, with decreasing returns to scale. By assumption, the labor supply is sufficiently large to avoid corner solutions. A union operates in each country, and the industry's workforce is unionized. 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 then the goods are eventually exported without extra costs.

The model is a two-stage game, solved by backward induction. In the first stage, rent-maximizing monopoly unions set wages. The analysis compares two different wage settings: 1) a separate wage

setting, where unions fix wages at national level;[3] 2) a transnational collusive agreement on wages by labor unions. In the second stage, firms compete in the product market in a Cournot fashion. Firms' production functions are $x_i = \sqrt{n_{iA}}$ and $y_i = \sqrt{n_{iB}}$. The inverse demand function for each product is

$$p_i = a - q_i - cq_j \quad i, j = 1,2 \quad i \neq j, \tag{1}$$

where $q_i = x_i + y_i$ is total production of the firm i, and $c \in (-1,1)$ is the degree of product differentiation. If $c < (>)0$, goods are complements (substitutes). Following Singh and Vives (1984), this demand structure derives from the maximization problem of a representative consumer which utility function takes the quasi-linear form

$$U = a\sum_i q_i - \frac{1}{2}(\sum_i q_i^2 + 2cq_iq_j) \qquad i, j = 1,2 \quad i \neq j. \tag{2}$$

Firms' profits are:

$$\Pi_i = p_i(x_i + y_i) - w_A x_i^2 - w_B y_i^2 \quad i = 1,2 \tag{3}$$

where w_A is the wage rate paid in A and w_B is the wage rate paid in B, respectively. Union utilities in countries A and B are

$$\Omega_A = (w_A - \varpi)n_A \ , \ \Omega_B = (w_B - \varpi)n_B, \tag{4}$$

respectively, where $n_A = n_{1A} + n_{2A}$ is total employment in country A, and $n_B = n_{1B} + n_{2B}$ is total employment in country B. $\varpi > 0$ is common in both countries, and could be interpreted as a minimum wage fixed by national governments in observance to an EU directive, and hence exogenously given for unions.

2.1 Stage 2: Cournot competition between firms

In the second stage of the game, the firms compete à la Cournot in the product market. The profit maximization problem is

$$\max_{x_i, y_i} \Pi_i = \max_{x_i, y_i} [(a - (x_i + y_i) - c(x_j + y_j)](x_i + y_i) - w_A x_i^2 - w_B y_i^2 \qquad i, j = 1,2 \quad i \neq j \tag{5}$$

from which first-order conditions yield the following reaction functions

$$x_i = \frac{(a - cq_j)w_B}{2(w_A + w_B + w_A w_B)}, \ y_i = \frac{(a - cq_j)w_A}{2(w_A + w_B + w_A w_B)} \quad i, j = 1,2 \quad i \neq j.$$

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

$$x_i^*(w_A, w_B) = \frac{aw_B}{2w_A w_B + (2 + c)(w_A + w_B)} \ , \ y_i^*(w_A, w_B) = \frac{aw_A}{2w_A w_B + (2 + c)(w_A + w_B)}.$$

[3] Given the assumptions of this model, national and industry level wage settings are identical. Nonetheless, as remarked in the introduction, the greatest part of the trans-national union agreements occurs at industry the level.

As expected, $x_i/y_i = w_B/w_A$: the marginal cost of production for firm i across the two countries are equal. Given total production, this represents the necessary condition so that total production cost is minimized (and hence profit maximized). Allocation of production directly implies the following labor demands in each plant

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

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.

2.2 Stage 1, Case 1: Separate wage setting by national unions

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

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

This maximization problem leads to

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

representing the 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 $i = 1,2$.

2.2 Stage 1, Case 2: Collusive wage setting between national unions

Let us consider the case of collusive behavior by unions. In this model, collusion stands for unions to achieve an agreement over a common wage that maximizes their joint utility, namely the sum of their utilities (*efficient union collusion*). However, unions incur an exogenous transactional cost $\tau \geq 0$ to coordinate their activities and for the sharing of information. These costs may counterbalance collusive gains (Borghijs and Du Caju, 1999). A reduction in transaction costs for unions is the measure for describing an increase in the labor market integration. Unions now maximize 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 to evaluate the employment levels at each plant, given by $n_{iA}^C = n_{iB}^C = [a/4(\gamma + \tau)]^2$, for $i = 1,2$.

2.3 Unions and wage coordination

This section analyzes unions' position respect to wage coordination. Making use of 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 $n^S - n^C > 0 \ \forall c \in (-1,1)$, where $n^S = n_A^S + n_B^S$ and $n^C = n_A^C + n_B^C$.
Differently from monopoly unions model with linear cost and demand functions where the collusive wage is higher (lower), and employment levels are lower (higher), than the separate setting if products are substitutes (complements),[4] the collusive agreement always determines a higher wage and lower employment. This is so because, with a convex cost function, the conventional substitutability (complementarity) among products does not necessarily imply the strategic complementarity (substitutability) between them. Since monopoly unions set wages for all the workers in the industry, they internalize both the effects of product differentiation on wages and employment levels, and the positive externalities created by an increase in wage rates when unions operate independently (Davidson, 1988; Horn and Wolinsky, 1988b). In 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 labor market, workers in A compete against workers in B. A similar result holds for union B. Instead, in 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; competition among workers in the labor market disappears.
Depending on the wage setting, the relative unions' payoffs are different. Transnational coordination is profitable 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 setting. Payoffs' comparison leads to the following proposition.

Proposition 1: *The separate wage setting is Pareto-dominated by the collusive outcome if* $\tau \leq \tau^* = \gamma(\varpi + \gamma - 2\varphi)/4\varphi$.

Therefore, whenever coordination costs are below the threshold, unions face a Prisoner's Dilemma: national unions have incentives to coordinate wage demands only if transaction costs, affected both by the minimum wage level and the degree of product differentiation, are not excessively high. Further analytical inspection yields to the following result.

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

For low values of the minimum wage, the costs' threshold for union cooperation tends to be high, approaching infinity as long as $\varpi \to 0$. Intuitively, wage coordination seems to be more likely

[4] Under the same assumptions on demand and cost function, these results also hold in a more general "right-to-manage" model, as Horn and Wolinsky (1988b) show.

when ϖ is small, because high coordination costs are necessary to prevent union collusion. Instead, product differentiation reduces the magnitude of the threshold value for collusion profitability: as long as products are more differentiated, the range where the collusive outcome Pareto-dominates the independent setting is smaller. The insight is that union collusion is easier and more advantageous when product are substitutes rather than complements. The next proposition supports this intuition.

Proposition 2: *If $\tau \leq \tau^*$, a decrease in transaction costs makes the incentives for collusion higher, 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 leads to $\partial^2(\Omega^C - \Omega^S)/\partial\tau\partial c = a^2/2(\gamma + \tau)^3 > 0$. For transaction costs sufficiently low, unions always find profitable wage coordination, whatever is the degree of product differentiation. Even if a reduction in transaction costs leads to a lower wage rate, gains in employment more than offset this loss. However, unions tend to perform better as long as the more products are similar.□

Thus, incentives for trans-national coordination exist, but the findings show that a classical Prisoner's Dilemma exemplifies unions' position respect to collusion. The next section investigates when collusion arises, and conditions for its sustainability as equilibrium of the unions' game.

3 The sustainability of trans-national union cooperation

Collusion could be implemented in an infinitely repeated two-stage game. With four players, the set of possible strategy combinations is large. For the paper's purposes, a simplifying assumption needs: firms have not the possibility to collude and always act as Cournot competitors. In a repeated framework, this is a strong assumption because also firms have incentives to collude. This work retains it to isolate the effects of unions' coordinated wage demands. However, this hypothesis could be also seen as if there is an effective Antitrust Authority watching over the product market.
Starting from a situation where unions demand a coordinated wage, each of them will capture an instantaneous utility gain by unilaterally deviating from the collusive agreement. Deviation implies a reduction in wage levels inducing the firms to relocate part of their productive activities in the country which union makes concessions. By assumption, when one union breaks the collusive agreement, in the subsequent period both unions come back to a national autonomous wage setting. Such a situation reflects that unions adopt a trigger strategy. Collusion can be sustained only if some realistic threats back it, 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. It is also assumed that the discount factor is identical for both unions. Collusion is sustainable in a repeated framework if

$$\delta \geq (\Omega^D - \Omega^C)/(\Omega^D - \Omega^S),$$

where Ω^C is the utility level obtained with collusion, Ω^D is the utility level deriving from the one-period defection[5] and Ω^S the utility derived from punishment. The right-hand side of the expression above is the discount factor threshold for sustainability of union collusion. This condition implies that unions will implicitly collude as long as they do not discount too much

[5] If, for example, the cheating union is Union in country A, the maximization problem characterized as follows $w_A = \arg\max_{w_A} (w_A - \varpi - \tau) n_A(w_A, w_B^C)$. Further substitution of the optimal wage level under deviation into union utility expressions yields the utility from deviation, Ω_A^D.

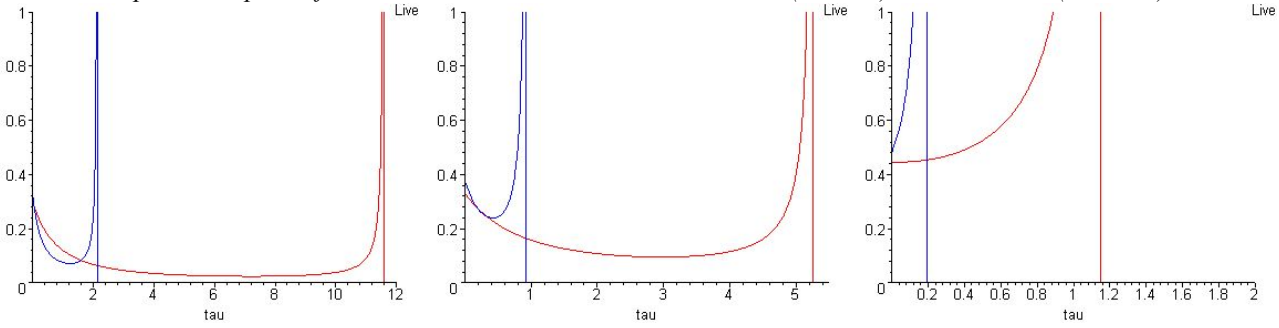
future, and the immediate gains from unilateral deviation are low. Insertion of the relevant payoffs into the discount factor expression yields to

$$\delta \geq \delta(\varpi, \tau, c)\,. \tag{9}$$

Given the complexity of the expression for the discount factor threshold, the discussion on the role played by transaction costs in the sustainability of collusion uses analytical tools and numerical simulations. Corollary 1 shows that an increase in the value of ϖ lowers the threshold for the coordination costs and product differentiation further reduces the critical level of τ which makes collusion profitable. Figure 1 depicts the discount factor threshold as a function of the transaction costs for given levels of minimum wages and product differentiation. Differentiation of (9) respect to transaction costs yields $\partial\delta/\partial\tau = (c+2)^2(\gamma+\varphi)^2\,\mathrm{N}/\Delta^2$, where $\mathrm{N} = \mathrm{N}(\varpi, \tau, c)$ and $\Delta = \Delta(\varpi, \tau, c)$. The sign of this derivative depends on the sign of the numerator. Numerical simulations show that $\partial\delta/\partial\tau \geq 0$ if $\varpi \geq \varpi^* \approx .517$ when c is close to 1 (substitutes), while $\varpi \geq \varpi^* \approx .174$ when c is close to -1 (complements). For $\varpi < \varpi^*$, the discount factor threshold presents a U shaped relation: as long as coordination costs increase, it initially decreases and then remains at a low value of τ within a certain range (wider in the case of substitutes). When coordination costs approach the upper limit τ^*, the threshold of δ drastically increases, and transnational coordination becomes prohibitively sustainable.

This could be explained by the fact that, for given levels of product differentiation, combinations of low levels of ϖ and τ make the losses of unilateral deviation from the collusive agreement relatively high for unions. Moreover, even if the *value* of τ^* is lower in the presence of complement goods, for small values of ϖ the *level* of the discount factor threshold may be lower respect to substitute goods, as Figure 1 shows (left side). In other words, there are parameters' combinations such that the wage differential's impact from deviation on unions' welfare when goods are complements is smaller than respect to substitute goods. However, as long ϖ increases, gains from unilateral deviation in terms of wages in the presence of substitute goods are sufficiently small, and the long-run punishment is quite harsh, to make deviation not profitable. Instead, for $\varpi \geq \varpi^*$, a reduction in coordination costs for unions unambiguously reduces the discount factor threshold, making collusion more sustainable. Nonetheless, it should be noted that for $\varpi \geq \varpi^*$, an increase in ϖ implies an increase in the *level* of the discount factor threshold: if the minimum wage level is relatively high, the utility loss faced by unions following unilateral deviation in coordinated wage demands turns out to be sensibly low. However, even if at low values of transaction costs $\partial\delta/\partial\tau \leq 0$ for $\varpi < \varpi^*$, the discount factor threshold is lower respect to $\varpi \geq \varpi^*$.[6]

Figure 1: *Relationship between the discount factor threshold and coordination costs.*
Graphs are depicted for $\varpi = .01, \varpi = .04\ \varpi = .5$, *and* $c = .99$ *(red line), and* $c = -.99$ *(blue line).*



[6] The threshold for the discount factor evaluated at $\delta(\tau = 0, \varpi^*) \approx .4469\ \forall c \in (-1,1)$.

Finally, 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 $\varpi \to \infty$.

The above results complement those obtained in the intra-industry trade literature. Strozzi (2007, 2008), extending the analysis of Straume (2002), finds that whit 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. If trade costs are relatively low, further trade liberalization makes to deviate an increasingly attractive option for unions, and deviation is comparatively more beneficial from the unions' point of view the more differentiated goods are. Instead, when intra-industry trade occurs, but trade barriers are relatively high, a reduction in trade costs does not affect the sustainability of tacit collusion, which is easier the less similar are 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 implicit collusion.

The fact that unions' transnational agreements related to MNEs activities in the EU are growing in recent years may lead to think that coordination costs for union activities are falling. This suggests that labor markets' integration is increasing. The findings here may shed light on the fact that wage coordination emerges as a gradually viable option for unions operating in MNEs.

4 Union coordination and welfare

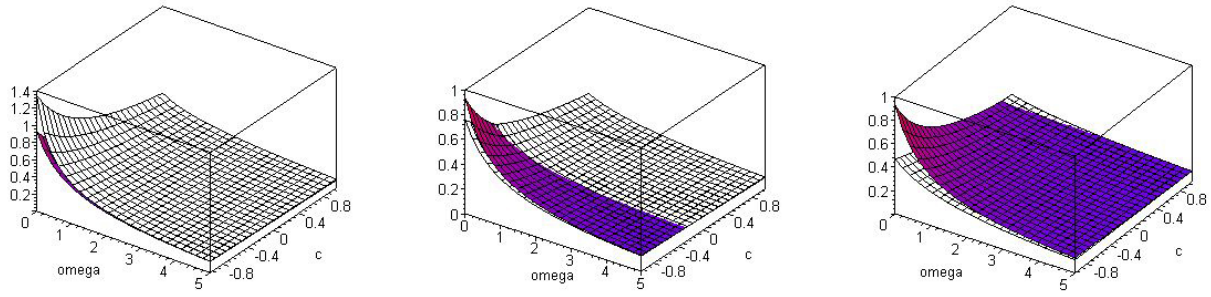
As previously seen, if union collusion could be implemented, a transnational agreement improves workers' conditions because their welfare share is higher in case of wage coordination respect to a separate setting. Now, a question arises: is union collusion always an undesirable outcome from the social view point? To answer this question is noteworthy for its redistributive implications. The sum of consumers' surplus, profits and union utilities defines global welfare; formally

$$GW = U - \sum_i p_i q_i + \sum_i \Pi_i + \Omega_A + \Omega_B \qquad i, j = 1,2 \quad i \neq j. \tag{10}$$

The minimum wage level could be used as an instrument by the "EU Commission" at central level to prevent wage coordination. An increase in ϖ lowers the threshold for unions to coordinate their activities, making collusion less likely. Nevertheless, two observations need. First, such intervention has the cost of lowering the welfare level: in fact, $\partial GW^S/\partial\varpi < 0$ in the relevant (ϖ, c)-space (see Appendix). This is so because an increase in ϖ has a pass-through effect on higher prices and consequently in a consumer surplus' fall, which is not compensated by other welfare components. Second, if union collusion arises as equilibrium, for a given level of transaction costs in the economy a change in ϖ to avoid it not necessarily implies that $GW^S > GW^C$. Suppose that the minimum wage in the economy is equal to ϖ and the coordination cost for unions equals the threshold, $\bar{\tau} = \tau^*(\varpi, c)$. An "EU Commission" intervention that increases the minimum wage to $\varpi' = \varpi + \varepsilon$ implies that $\bar{\tau} > \tau^*(\varpi', c)$, preventing collusion. However, depending on the magnitude of ε, it could be that for some combinations of (ϖ', c), $GW^C(\bar{\tau}, \varpi) < GW^S(\varpi')$, while for other parameters' configuration $GW^C(\bar{\tau}, \varpi) > GW^S(\varpi')$, as Figure 2 shows. These findings allow to establish the following proposition.

Proposition 3: *In the presence of productive activities spread across countries, for a given level of transaction costs in the labor market, an increase in the minimum wage level may lead to a Pareto-superior outcome from a social point of view the transnational wage coordination with respect to separate national wage settings.*

Figure 2: *Global Welfare in the* (ϖ, c) *-space: Black and white refers to* $GW^S(\varpi')$, *color to* $GW^C(\bar{\tau}, \varpi)$. Plots refer to $\varpi' = \varpi + .1$ (left), $\varpi' = \varpi + .5$ (center) and $\varpi' = \varpi + 1.1$ (right).



Separate settings at low values of ϖ ensure the highest social welfare levels, but this is exactly the case where a collusive agreement by unions is likely to arise as equilibrium. To obtain Pareto improvements in such a situation, the only way seems to be a political solution: unions may renounce to coordinate wage demands in favor of national government interventions adopting country specific redistributive policies.

5 Conclusions

This work analyzes unions' cross borders wage coordination in a 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' position toward wage coordination. In the presence of coordination costs (a measure of the labor 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 element affecting 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 individual wage setting, and the collusive outcome is less likely to arise. 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 favor of subsequent national governments' redistributive policy.

These findings stand on peculiar hypothesis 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, if union collusion occurs as equilibrium, a deeper analysis needs to determine the public policy instruments to be implemented at national level in redistributing welfare.

Appendix

■ Global equilibrium expressions of the relevant variables in the two different wage settings follow.

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

$$n^S = [a/(\varphi + \gamma)]^2$$
$$\Omega^S = \varphi\,[a/(\varphi + \gamma)]^2$$
$$\Pi^S = (\varpi + \varphi + 2)\,[a/(\varphi + \gamma)]^2$$
$$CS^S = (c + 1)\,[a/(\varphi + \gamma)]^2$$
$$GW^S = (2\varphi + \gamma + 1)\,[a/(\varphi + \gamma)]^2$$

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

$$n^C = [a/2(\gamma + \tau)]^2$$
$$\Omega^C = (\gamma + \tau)\,[a/2(\gamma + \tau)]^2$$
$$\Pi^C = [\varpi + \gamma + 2(1 + \tau)]/2\,[a/2(\gamma + \tau)]^2$$
$$CS^C = (c + 1)\,[a/2(\gamma + \tau)]^2$$
$$GW^C = [3(\gamma + \tau) + 1]\,[a/2(\gamma + \tau)]^2$$

■ Proof of Corollary 1 follows.

Proof. The expression for the derivative of the threshold for transaction costs τ^* with respect to the minimum wage is given by

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

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

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

The sign of these derivatives depends on the sign of the numerators of the relative expressions. Given the analytical complexity, their behavior is plotted in Figure 3) on the right), where it is shown that num $\partial\tau^*/\partial\varpi < 0$ (left), and num $\partial\tau^*/\partial c > 0$ in the relevant range of analysis $\varpi \in (0, \infty) \wedge c \in (-1,1)$.□

Figure 3: *Numerator functions of the partial derivatives* $\partial\tau^*/\partial\varpi$ *(left) and* $\partial\tau^*/\partial c$ *(right) in the* (ϖ, c) *-space*

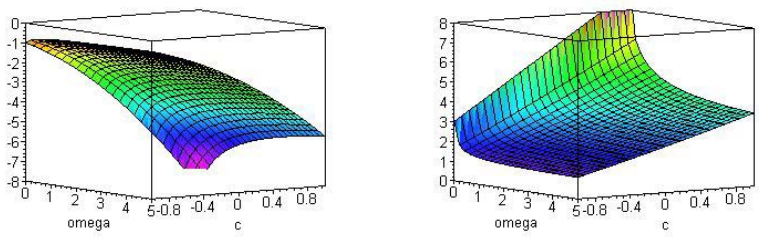
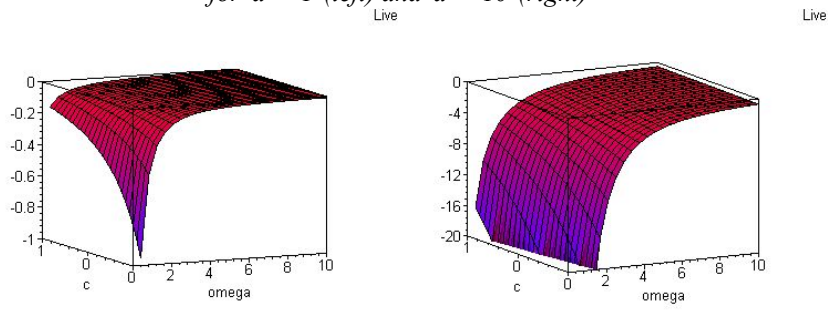


Figure 4: *Numerator function of the partial derivative* $\partial GW^S/\partial\varpi$ *in the* (ϖ, c) *-space for* $a = 1$ *(left) and* $a = 10$ *(right)*



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

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

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

The sign of this derivative depends on the sign of the numerator. Since the analytical expression is not easy to be interpreted, the behavior of the numerator function is plotted in Figure 4 which shows that it is negative, approaching in the relevant range of analysis the value of 0 from below for $\varpi \to \infty\ \forall c \in (-1,1)$.□

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