Domestic and Cross-border Mergers in Unionized Oligopoly*

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February 2012

Abstract

We re-examine the model of Lommerud et al. (2006) which shows that cross-border mergers should be expected in the presence of powerful unions. In contrast, we obtain a domestic mergers outcome whenever firms are sufficiently heterogeneous (both in terms of productive efficiency and product differentiation). Cost asymmetries tend to dampen labor unions' wage demands and allow the merged firms to partially reallocate production from the high cost to the low cost plant. When cost asymmetries become smaller and products more substitutable, then cross-border mergers are the unique equilibrium. However, cross-border mergers may be either between symmetric or asymmetric firms. Finally, we show that a domestic merger outcome is less desirable from a social welfare perspective when compared with cross-border mergers.

JEL-Classification: D43, J51, L13.

Keywords: Unionization, International Oligopoly, Endogenous Mergers.

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*We gratefully acknowledge financial support by the German Science Foundation (DFG) for the research project "Unionised Oligopolies."

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1 Introduction

Mergers and acquisitions between firms in a downstream industry may affect labor markets and wages, the direction of the effect is however not quite clear (see, e.g., Gokhale et al., 1995; McGuckin et al., 2001). With increasing integration of international product markets, especially the impact of cross-border mergers and the option of outsourcing production to low-wage countries has received considerable attention in the literature (e.g., Zhao, 1995, 1998; Bughin and Vannini, 1994 for the impact of FDI on unionized labor).

Cross-border mergers have become the predominant form of FDI.[1] A salient feature of international mergers and acquisitions is the *threat effect* associated with cross-border transactions vis-à-vis (national or local) input suppliers (Freeman, 1995). Intuitively, by creating an "outside option" abroad, a firm can threaten to move production abroad which creates downward pressure on input prices.[2]

Accordingly, the presence of labor unions adds a strategic motive to cross-border mergers, as firms can increase their bargaining power vis-à-vis monopoly unions by optimally scaling up production abroad. Despite an increasing trend towards more cross-border mergers, however, the vast majority of mergers and acquisitions still occurs at national levels.[3] In addition, mergers typically involve asymmetric firms. Gugler et al. (2003) report that target firms are on average only about 16 percent of the size of their acquirers.

Our paper builds on a growing literature which is analyzing mergers in a vertical structure where upstream firms (or, unions in the case of labor) have market power vis-à-vis downstream oligopolists (Horn and Wolinsky, 1988; Dobson and Waterson, 1997; Zhao, 2001; Symeonidis, 2010). Making the vertical structure explicit that literature has uncovered new incentives for downstream mergers resulting from improved purchasing conditions on input markets.

We depart from those works by analyzing an international setting and we apply the approach of endogenous merger formation as put forward by Horn and Persson

[1]For example, in 1999 cross-border mergers and acquisitions already accounted for approximately 80 percent of global foreign direct investments (UNCTAD, 2000).

[2]Choi (2001) provides empirical evidence for the presence of the threat effect of cross-border M&A and its downward pressure on the union wage premium in U.S. manufacturing industries. See also Fabbri et al. (2003) for another empirical study which shows that labor demand of UK and US firms for low skilled workers between 1958 and 1991 (UK data are available until 1986) has become more elastic while multinational activity of firms and foreign direct investments have increased.

[3]Gugler et al. (2003) utilize a dataset on 44,600 mergers and acquisitions between 1981 and 1998. Cross-border mergers accounted only for 22 % of all deals. By now, the share of cross-border mergers has increased to approximately 33% of total M&A.

(2001a, 2001b).[4] Our analysis is closely related to Lommerud et al. (2006) which we extend by considering asymmetric firms.[5] Lommerud et al. (2006) analyze a two-country model with four symmetric firms (two in each country) each producing an imperfect substitute. In each country a monopoly union sets wages at the firm level. Within such a symmetric setting, Lommerud et al. obtain their main result that the endogenous merger equilibrium only exhibits cross-country mergers. Under the resulting market structure wages reach their minimum as both merged firms can most effectively threaten to scale up production abroad if a union raises its wage.

Considering asymmetric firms in each country we can qualify that finding as follows:[6] *i)* When firms' products are differentiated, then a domestic merger equilibrium follows whenever cost asymmetries between national firms are large enough. *ii)* When products become more substitutable, then the cross-country merger equilibrium emerges; however, both a symmetric cross-country merger and an asymmetric cross-country merger outcome are possible.

Our results show that Lommerud et al.'s result remains largely valid if products are close substitutes. In those instances a cross–country merger induces intense competition between the unions to the benefit of the international firm. If, however, products are relatively differentiated then this effect of "internal" union competition becomes less effective. Considering cost asymmetries gives then rise to our main result that a domestic merger equilibrium emerges. From the perspective of the low-cost firm, a national merger with the high cost firm becomes attractive as this constrains the wage demand of the domestic union.[7] It is, therefore, the "uniformity" effect of a domestic merger that prevents the labor union from extracting rents from a low-cost plant in order to maintain

[4]Horn and Persson (2001b) analyze how international merger incentives depend on input market price setting and, in particular, on trade costs. They show how trade costs affect cross-country merger incentives and the type of mergers (unionized or non-unionized firms).

[5]Related are also Lommerud et al. (2005) and Straume (2003). Straume (2003) considers international mergers in a three-firm, three-country model where labor is unionized only in some firms. Lommerud et al. (2005) examine how different union structures affect downstream merger incentives in a three-firm Cournot oligopoly.

[6]Specifically, we assume that total costs are the sum of labor and non-labor costs. With regard to non-labor costs we suppose a high-cost and a low-cost firm in each country. Firms do not differ with regard to labor productivity.

[7]We assume that a union cannot discriminate workers in a single firm which appears to be standard current practice. In Germany, for instance, the *tariff unity* principle ("Tarifeinheit") stipulates that only *one* collective bargaining agreement can govern workers' labor conditions in a single firm. This principle implies that a firm must "unify" labor contracts after a merger. A recent example is the merger between *RWTÜV* and *TÜVNORD* in 2011. Both firms had different collective agreements before the merger. After the merger, the merged entity settled for a new collective wage agreement with the labor union (see Verdi, 2011) which now defines a uniform wages profile for all workers of the company.

employment at a high-cost plant. The merged entity can partially shift production domestically from a less towards a more efficient plant, rendering a domestic merger even more profitable.

As a result, we find that either domestic or cross-border mergers may result in equilibrium, depending on the cost difference between firms and the degree of product substitutability. Interestingly, a merger between asymmetric firms remains an equilibrium of the merger formation process even when firms become highly asymmetric; a result which stands in contrast to previous works on mergers between asymmetric firms (Barros, 1998; Neubecker and Stadler, 2003).

The remainder of the paper is organized as follows: Section 2 presents the basic model and the merger formation process. We analyze firms' merger incentives in Section 3. In Section 4 we determine the equilibrium ownership structure of the industry. Welfare implications of our model are discussed in Section 5. Finally, Section 6 concludes.

2 The Model

We consider an oligopolistic industry with initially four independent firm owners. Each owner operates a single plant to produce a differentiated product. There are two countries A and B: owners 1 and 2 are located in country A, while owners 3 and 4 reside in country B. The firms compete in quantities in the internationally integrated product market (i.e., we consider Cournot competition).

The price for brand i is given by the linear inverse demand function $p_i = 1 - q_i - \beta \sum_k q_k$ for $i = 1, 2, 3, 4$ and $i \neq k$, where q_i denotes the quantity supplied by owner i, and $\beta \in (0, 1)$ measures the degree of product differentiation. As β approaches 1, brands become perfect substitutes, while for β close to 0 products can be considered to be independent.

In order to produce their output, firms use labor and non-labor inputs in fixed proportions. One unit of output of brand i requires one unit of labor, i.e., $q_i = l_i$, at wage w_i and a given amount of non-labor inputs at price c_i.

Firms differ according in their non-labor production costs. We assume that firms 1 and 3 are the low-cost firms with $c_1 = c_3 = 0$, while firms 2 and 4 are the high-cost producers with $c_j =: c \geq 0$ for $j = 2, 4$.[8] For $c = 0$, all firms are ex ante identical and we are back in the model analyzed by Lommerud et al. (2006). We can express firm i's cost function as

$$C_i(q_i) = (w_i + D_i c) q_i, \tag{1}$$

[8] To ensure that each plant produces a non-negative output in every industry structure to be anaylzed, we assume that $0 \leq c \leq \bar{c}$. We derive this upper bound on c, $\bar{c}$, in the appendix.

where $D_i \in \{0,1\}$ such that $D_i = 1$ for the high-cost firms $i = 2,4$ and $D = 0$ for the low-cost firms $i = 1,3$.

The profit of a producer supplying brand i is thus given by

$$\pi_i = (p_i - w_i - D_i c) q_i, \text{ for } i = 1,2,3,4. \tag{2}$$

Workers are organized in centralized trade unions in their countries.[9] We adopt the right-to-manage approach which stipulates that labor unions set wages for the firms residing in their respective countries, whereas the responsibility to determine employment remains with the firms. Unions make take-it or leave-it wage offers to firms, which resembles a situation in which the labor unions possess all bargaining power. We assume that each union sets plant-specific wages for the firms located in its country when there is no merger in order to maximize its wage bill. Labor unions' utilities (or, wage bills) are given by

$$U_A = (w_1 - \bar{w})l_1 + (w_2 - \bar{w})l_2 \text{ and} \tag{3}$$

$$U_B = (w_3 - \bar{w})l_3 + (w_4 - \bar{w})l_4, \tag{4}$$

for where w_i denotes the wage level paid at owner i and l_i is the derived labor demand of firm i. By $\bar{w}$ we denote the outside option (wage) of workers[10] and assume them to be identical in both countries. For simplicity, we normalize the outside wage to zero.

When a national merger occurs, the responsible labor union is required to set a uniform wage to the merged firm. For example, consider a national merger between owners 1 and 2 in country A (the case of a merger in country B is obviously perfectly analogue). In this case the utility of the labor union in country A is given by

$$U_A = (w_{12} - \bar{w})(l_1 + l_2).$$

We analyze a three-stage game:

1. In the first stage, owners of plants cooperatively determine the equilibrium ownership structure of the industry and form firms according to the cooperative merger formation process proposed by Horn and Persson (2001).

2. After having observed the outcome of the firm formation process, labor unions simultaneously and non-cooperatively set wages.

[9] A crucial assumption is that workers are unable to organize in unions across borders. This assumption is sensible in the light of empirical evidence. Although there have be tendencies towards more cooperation between labor unions on a European level, in general, labor market regimes are bound locally at the national level (Traxler and Mermet, 2003).

[10] This can either be a wage level which can be achieved outside the considered industry or unemployment benefits.

3. Finally, firms compete in quantities in the final product market.

We solve our model by backward induction, beginning in the last stage of the game where firms compete in quantities. The Solution concept applied is the core.

2.1 The Merger Formation Process

In the following, we will shortly describe the merger formation process.[11] We apply the method developed by Horn and Persson (2001) by modelling the merger formation process as a cooperative game of coalition formation. We let an ownership structure M^r be a partition of the set $N = \{1, 2, 3, 4\}$ of firms into voluntary coalitions. We consider only two-firm mergers for the following reasons: first, we are interested in highlighting the incentives for national versus international mergers and the role asymmetries between firms play in this formation process. If firms have the opportunity to monopolize the market, one would suppose that the result were an all-encompassing merger in equilibrium, regardless of firm asymmetries. Second, a three- or four-firm merger may be blocked by competition authorities since it is more likely to be anticompetitive. Therefore, we stick to the analysis of two-firm mergers, which renders 8 possible different industry structures which can result of the merger formation process:

1. No merger: $M^0 = \{1, 2, 3, 4\}$
2. One national merger: $M^{D1} = \{12, 3, 4\}, M'_{N1} = \{1, 2, 34\}$
3. Two national mergers: $M^{D2} = \{12, 34\}$
4. One efficient symmetric international merger: $M^{C1se} = \{13, 2, 4\}$
5. One inefficient symmetric international merger: $M^{C1si} = \{1, 3, 24\}$
6. Two symmetric international mergers: $M^{C2s} = \{13, 24\}$
7. One asymmetric international merger: $M^{C1a} = \{14, 2, 3\}$, $M^{C1a'} = \{1, 4, 23\}$
8. Two asymmetric international mergers: $M^{C2a} = \{14, 23\}$

As firms are not identical, international mergers can happen in different constellations. First, firms with the same non-labor production costs can merge, which we denote by *symmetric* international mergers in structures 4) to 6). When there is only one international symmetric merger, it can either be the two efficient (M^{C1se}) or the two

[11] For a detailed description of the approach, see Horn and Persson (2001).

inefficient (M^{C1si}) firms that merge. The ownership structure with two mergers between the symmetric (low cost and high cost) firms is represented by structure M^{C2s}. Thus, in structure M^{C2s} there is one very efficient firm producing brands 1 and 3 at low cost, and one very inefficient firm producing brands 2 and 4 at high cost.

Second, there can be an international merger between two firms with different costs, which is denoted by *asymmetric* international mergers in structures 7) and 8). If there is only one asymmetric international merger, the outcome is obviously identical for structures M^{C1a} and $M^{C1a'}$. Ownership structure M^{C2a} indicates that there have been two international mergers between one low cost and one high cost plant each. As a result each merged firm produces one brand at low cost and the other brand at high cost.

To determine the outcome of the cooperative merger formation process, the main concept is the determination of dominance relations between the structures. If an ownership structure is dominated by another structure, it cannot be the equilibrium outcome of the cooperative merger formation game. The approach involves a comparison of each structure M^r against all other structures M^{-r} separately. M^r dominates a structure M^l if the combined profits of the decisive group of owners in structure M^r exceeds those in structure M^l.

Decisive owners can influence which coalition of plants is built. Thus, a group of owners which belongs to identical coalitions in ownership structures M^r and M^l is not decisive as we exclude the possibility of transfer payments between coalitions. Within a coalition, owners are free to distribute the joint profit among each other. Thus, an ownership structure M^r dominates another structure M_l if all decisive owners prefer M^r to M^l. Naturally, a decisive group of owners will only prefer M^r over M^l if the combined profit of this group is larger in M^r than in M^l.

According to the bilateral dominance relationship, it is possible to rank different ownership structures. We are interested in the equilibrium industry structure (EIS) of the industry, i.e. a structure that is undominated. As we observe heterogeneous firms, it is possible that an ownership structure is only undominated for certain parameter constellations. Consequently, there may be more than one EIS depending on the relation of c and β. We apply the core as our solution concept. All undominated structures which are in the core are defined as equilibrium industry structures (EIS). To solve our model, we use the method of backward induction.

3 Merger Incentives

We solve our model for all possible ownership structures in the appendix. Our main focus of interest are the driving forces behind domestic and cross-border mergers between asymmetric firms in the presence of labor unions. The main incentive for firms to merge internationally in Lommerud et al. (2006) stems from the opportunity to reduce union power and thus realize lower wage rates. In particular, the option to shift production to a foreign plant puts downward pressure on wages set by national labor unions.

In our model, two additional effects resulting from firm asymmetry may give firms an incentive to form domestic mergers: One the one hand, a uniform wage rate may provide an incentive for firms to merge nationally in order to obtain a wage rate which is lower on average than two discriminatory wage rates. On the other hand, due to firm asymmetry, firms have an incentive to reallocate production domestically towards the more efficient producer.

3.1 Merger Profitability

To establish which type of industry structure will prevail in equilibrium it is worth looking at unilateral merger incentives of firms.

Proposition 1. *Mergers are always profitable for the insiders in cross-border one-merger structures (M^{C1se}, M^{C1si}, M^{C1a}) compared to the no merger benchmark M^0. One domestic merger (M^{D1}) is profitable to the insiders compared to the no-merger unless products are close substitutes and firms are very symmetric. Two-firm mergers (M^{D2}, M^{C2s}, M^{C2a}) are always profitable to the insiders in comparison to no merger structure.*

Proof. *See Appendix.*

Cross-border mergers are always profitable for the merger insiders, even if only one merger occurs. This result is not surprising in the light of the threat effect result found by Lommerud et al. (2006). As cross-border mergers put downward pressure on wages due to the threat of outsourcing abroad, wage reductions are sufficiently high to render a merger profitable to the insiders.

The profitability of one domestic merger is not so unambiguous as for the cross-border mergers, however a comparison of the insiders' profit levels to the no merger profits reveals that also one domestic merger may be profitable to the insiders for a wide range of parameter values. Only if products are very close substitutes and firms are very symmetric, one domestic merger is unprofitable. This relation is sensible in the light of the uniform wage-setting regime. When merger participants differ more strongly according to non-labor costs, the effect of a uniform post-merger wage is greater: the union will balance an increase in the uniform wage against the loss of employment in the less efficient firm. For the merged entity, which can partially scale up production in the efficient plant, this means that merger profitability rises as asymmetry increases. At the same time, a stronger degree of product differentiation limits the outsiders' possibilities to free-ride on the merger.

Naturally, two-merger structures are always profitable to the insiders (all firms) compared to a no merger benchmark. Comparing two-merger to one-merger structures, we can establish the following result:

Lemma 1. *When firms are allowed to determine the industry structure according to the method proposed by Horn and Persson (2001) the only candidates for EIS are given by industry structures which include the minimum possible number of firms in the market.*

Proof. *See Appendix.*

A comparison of profit levels reveals that industry structures involving two mergers (M^{D2}, M^{C2a}, M^{C2s}) unambiguously provide higher total industry profits than industry structures in which more than two firms prevail in the market. Obviously, the higher the concentration in the market, the higher are firms' profits. Thus, when analyzing possible candidates for equilibrium industry structures, only structures with two firms (since a merger to monopoly is excluded from analysis by assumption) should be considered.

Therefore, we restrict our attention in the following to three possible industry structures: M^{D2}, M^{C2a} and M^{C2s}, i.e. we focus on the incentives for either two domestic or two cross-border mergers, where we distinguish between coalitions of symmetric plants (two efficient and two inefficient plants merge) and coalitions between asymmetric plants (one efficient producer merges with one inefficient producer each).

3.2 Wage and Employment Effects of Domestic and Cross-Border Mergers

We begin with an analysis of the effects of different kinds of mergers on wage rates. As we restrict our attention to two-merger industry structures, wage rates in countries A and B will be symmetric, although there will be differences in the wage rates paid by efficient and inefficient plants if labor unions set plant-specific wages (in structures M^{C2s} and M^{C2a}). For expositional purposes, therefore, denote by subscript I wages paid by inefficient plants (plants 2 and 4) and by subscript E those paid by efficient plants (1 and 3). As there is only one uniform wage for M^{D2}, there is no superscript.

When we compare the wage rates set by the labor unions in countries A and B for structures M^{D2}, M^{C2s} and M^{C2a}, we find that the plant-specific wages in ownership structures involving international mergers can be ranked unambiguously, while such a ranking is not distinctly possible when including the uniform wage set for national merger participants. The relation between the wage rates in the different industry structures then depends on the relation between product differentiation (β) and cost asymmetry

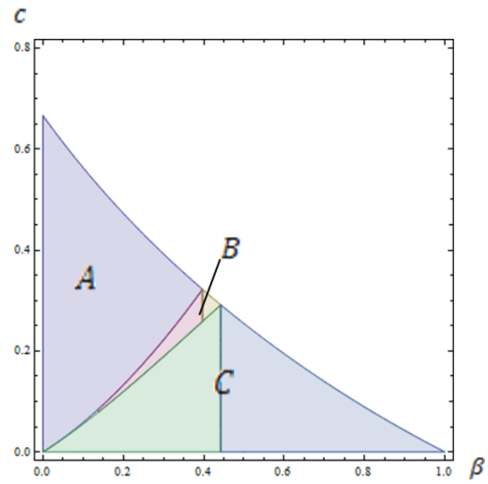

Figure 1: Wage effects of two domestic mergers

between firms (c).

Proposition 2. *(a) The ranking of wage rates set by labor unions in ownership structures M^{C2s} and M^{C2a} is unambiguously given by $w_E^{C2a} > w_E^{C2s} > w_I^{C2s} > w_I^{C2a}$ $\forall$ $\beta \in (0,1)$ and $c \in (0, \bar{c})$.*

(b) Comparing the uniform wage rate set by the labor unions in structure M^{D2}, the ranking depends on the degree of product differentiation and the cost asymmetry between firms.

Proof. *The proof involves a mere comparison of the wage rates reported in the Appendix.*

Efficient plants pay unambiguously higher plant-specific wage rates than inefficient plants. Obviously, labor unions are able to extract a higher surplus from efficient plants. However, wage rates after a merger depend on which type of plants have formed a coalition. The intuition behind this result stems from the effect mergers between asymmetric plants have on equilibrium labor demand decisions of firms. When two identical plants merge (M^{C2s}) the merged firm has no incentive to reshuffle production from one plant to the other for reasons of non-labor cost savings. In contrast, when two asymmetric plants form a merged firm, owners have an incentive to reshuffle production towards the low-cost producer in order to save on non labor costs.

With higher employment at the low cost plants in structure M^{C2a}, labor unions have an incentive to increase wage rates at those plants while limiting wage demands at high cost plants in order to maintain employment. In contrast, in structure M^{C2s} labor unions' limit their wage demands at low cost plants in order to prevent an outsourcing of production to an identical plant abroad.

For Part (b) of Proposition 2, the wage pattern of ownership structures is less clear cut with respect to the domestic merger structure. Figure 1 illustrates the different rankings of wage rates. The three areas are defined as follows:

$$\begin{aligned}A &: w_E^{C2a} > w_E^{C2s} > w^{D2} > w_I^{C2s} > w_I^{C2a};\\ B &: w_E^{C2a} > w^{D2} > w_E^{C2s} > w_I^{C2s} > w_I^{C2a};\\ C &: w^{D2} > w_E^{C2a} > w_E^{C2s} > w_I^{C2s} > w_I^{C2a}.\end{aligned}$$

In general, we can observe that the position of the uniform wage rate w^{D2} compared to the firm specific wages in structures M^{C2s} and M^{C2a} decreases in the ranking when firms become more asymmetric. For low to intermediate degree of product substitutability, the uniform wage rate w^{D2} is inbetween the plant-specific wage rates of efficient and inefficient plants . Thus, compared to cross-border merger structures, efficient plants would pay a lower wage rate if they chose domestic mergers for these combinations of the parameters β and c.

More specifically, note that

$$\frac{\partial w^{D2}}{\partial c} = -\frac{1}{4+2\beta} < 0$$

for $\beta \in (0,1)$. When the non-labor cost of production of the inefficient plants marginally increases, the wage rate paid by the merged firm falls. As uniformity of wages restricts the labor union in exploiting the production efficiency of the low cost producer, it limits its wage demand when firms become more asymmetric in order to maintain employment at the high cost plant. In contrast, in international merger structures, low cost plants' wages rise if non-labor costs of high cost plants increase.

$$\frac{\partial w_E^{C2a}}{\partial c} = \frac{\beta}{4-\beta} > 0,$$

and

$$\frac{\partial w_E^{C2s}}{\partial c} = \frac{2(1-\beta)\beta}{(4-\beta)(4-3\beta)} > 0.$$

How does this relationship influence possible merger incentives? Owners will find it profitable to merge plants if a coordination of production leads to a sufficient decrease in wage demands by labor unions. In Lommerud et al. (2006), firms therefore merge internationally to create a competitive situation between national labor unions. With an egaltiarian wage regime, firms may want to merge domestically because this may constrain a union in its wage demand.

For owners, a domestic merger thus becomes attractive when asymmetries between firms increase. A domestic merger opens the possibility to reallocate production partially from a high cost to a low cost plant within the same country in order to save upon non-labor costs of production. Furthermore, the uniformity rule of national wage bargaining regimes restricts labor unions' wage demands.

What determines the optimal union choices of wage rates in different industry structures? Following Lommerud et al. (2005, 2006), mergers may diversely affect labor demand of firms as well as the slope of the labor demand curves. From the first order conditions of the unions' optimization problems in *Stage II,* we can derive the slopes of the firms' labor demands for the pre-merger and two-merger industry structures $\left|\frac{\partial \hat{l}_i}{\partial w_i}\right|, \left|\frac{\partial \hat{l}_i}{\partial w_{ij}}\right|$:

$$\frac{\partial l_E^0}{\partial w_E^0} = \frac{\partial l_I^E}{\partial w_I^0} = \frac{2+2\beta^2}{(\beta-2)(2+3\beta)}$$

$$\frac{\partial l_E^{D2}}{\partial \bar{w}^{D2}} = \frac{\partial l_I^{D2}}{\partial \bar{w}^{D2}} = \frac{2-2\beta^2}{4(\beta-1)(1+2\beta)}$$

$$\frac{\partial l_E^{C2s}}{\partial w_E^{C2s}} = \frac{\partial l_I^{C2s}}{\partial w_I^{C2s}} = \frac{\partial l_E^{C2a}}{\partial w_E^{C2a}} = \frac{\partial l_I^{C2a}}{\partial w_I^{C2a}} = \frac{2+2\beta+\beta^2}{4(\beta-1)(1+2\beta)}$$

Ceteris paribus, we would suppose if $\left|\frac{\partial \hat{l}_i}{\partial w_i}\right|, \left|\frac{\partial \hat{l}_i}{\partial w_{ij}}\right|$ increases (decreases), labor demand becomes more (less) elastic. A comparison of pre- and post merger labor demand reveals that

$$\left|\frac{\partial l_l^{D2}}{\partial w^{D2}}\right| - \left|\frac{\partial l_l^0}{\partial w_l^0}\right| = \frac{\beta(1+\beta)(4+3\beta)}{2(-4-12\beta-5\beta^2+6\beta^3)} < 0,$$

and

$$\left|\frac{\partial l_l^{C2s}}{\partial w_l^{C2s}}\right| - \left|\frac{\partial l_l^0}{\partial w_l^0}\right| = \frac{3\beta^2(2+2\beta+\beta^2)}{4(4-8\beta-7\beta^2-11\beta^3+6\beta^4)} > 0.$$

Thus, we observe that labor demand becomes less wage responsive for domestic mergers, while it becomes more price responsive for cross-border mergers. This observation is line with the results by Lommerud et al. (2006), however, a countervailing effect may arise in our model increasing firms' incentives to merge domestically: the constraining effect of a uniform wage on a labor union's ability to extract surplus from efficient firms.

To understand which types of mergers will be chosen in equilibrium, it is also instructive to look at employment effects of different merger types. The following Lemma summarizes the impact of different merger types on total employment.

Lemma 2. *(a) Total employment is always lower in the domestic merger structure than in the international merger structures:* $Q^{C2s} = Q^{C2a} > Q^{D2}$. *(b) Comparing employment in the two-merger structures to no merger, we find that*

(i) $Q^0 > Q^{C2s} = Q^{C2a} > Q^{D2}$ *if* $\beta \in (0, 0.5)$*, and*

(ii) $Q^{C2s} = Q^{C2a} > Q^0 > Q^{D2}$ *if* $\beta \in (0.5, 1)$.

Proof. *The proof involves a mere comparison of total employment in the four relevant industry structures.*

Three interesting observations can be made from Lemma 3. First of all, we find that total employment is always lowest in the domestic merger structure compared to cross-border merger structures and the no merger benchmark.[12] Inspection of the plant-specific employment rates (see Appendix) reveals that this mainly hinges upon the low employment of inefficient plants in the domestic merger structure. Note that domestic mergers create a market structure of two bilateral monopolies, where one union sets wages for one (merged) firm each.

Second, total employment in the two cross-border merger structures is identical, although different types of mergers are formed in the two structures. The reason for this result becomes obvious from the ranking of wage rates above. In the two cross-border merger structures, labor unions set wages as to balance total costs for the firms in the two structures. Note that, however, this does not mean that the distribution of output across plants is identical for the merger structures. This is not the case, as firms shift production towards more efficient plants in structure M^{C2a} while this not possible for structure M^{C2s}, where plants with identical technologies merge.

Third, for a lower degrees of product differentiation, total employment is higher with cross-border mergers than in the no merger case. If products are closer substitutes (β close to 1) the opportunity for firms to shift production, for either labor or non-labor cost savings, becomes larger.

4 Equilibrium Industry Structure

We now turn to the industry structures which will result in equilibrium as the outcomes of the merger formation process. A comparison of the relevant profit functions according to the method proposed by Horn and Persson (2001) yields that the equilibrium ownership

[12] Note that uniformity of wages in the domestic merger structure M^{D2} does not influence this result. Essentially, uniformity has no effect on total employment compared to plant-specific (discriminatory) wages when market demand is linear (Schmalensee, 1981; Yoshida, 2000). Assuming symmetric firms, total employment is the same as in the model analyzed by Lommerud et al. (2006). Differences in total employment are therefore only a result of firm asymmetries.

structure is two domestic mergers (M^{D2}), if firms differ according to their non-labor production costs and asymmetries between firms are sufficiently large.

Proposition 3. *Depending on the degree of product differentiation and the cost asymmetry between firms, either two-merger structure can result in equilibrium:*

a) If $\beta \in (0, 0.396)$ *and* $c \in (\Psi, \bar{c}]$, *then the equilibrium industry structure is given by* M^{D2}.

b) If $\beta \in (0, 0.396)$ *and* $c \in (0, \Psi) \cup \beta \in (0.396, 0.913)$ *and* $c \in (0, \bar{c})$ *then the equilibrium industry structure is given by* M^{C2s}.

c) If $\beta \in (0.913, 1)$ *and* $c \in (0, \bar{c})$ *then the equilibrium industry structure is given by* M^{C2a}.

Proof. *See Appendix.*

In contrast to previous work with homogenous firms and purely plant-specific wages, the equilibrium industry structure in our model can consist of either domestic or cross-border mergers. Two domestic mergers will be the unique equilibrium if products are sufficiently differentiated and sufficient firm asymmetries. Figure 3 illustrates these results. The result that either domestic or cross-border mergers can occur is in contrast to the findings by Lommerud et al (2006), where domestic mergers never occur in equilibrium.

The incentives for firms to merge domestically when plants are sufficiently asymmetric stem from the two effects described above. A domestic merger induces the labor unions to limit their wage demands from the efficient plant in order to maintain employment at the inefficient plant. The mergers decrease competition in the product market and induce a reduction in overall employment. Concerning the distribution of employment among the plants, merged firms domestically shift production from an inefficient to the efficient plant.

When these two effects dominate the gains from cross-border mergers - namely the reduction of market power of labor unions through the threat of reallocation- two domestic mergers will emerge as an equilibrium industry structure. More specifically, merging domestically becomes more attractive the more asymmetric firms become. Thus, we should expect that the threat effect will conversely dominate the uniformity effect if firms are rather symmetric or products are closer substitutes.

Interestingly, for c sufficiently large, two domestic mergers will occur in equilibrium, which results in two asymmetric firms merging. This is in contrast to previous work on mergers between heterogeneous firms, which shows that when asymmetries are large, mergers will occur (if any) between more symmetric firms (see e.g. Barros, 1998).

For a wide range of parameter values, we observe that cross-border mergers between symmetric firms ($M^{C2s} = \{13, 24\}$) will occur in equilibrium. In this region, the threat

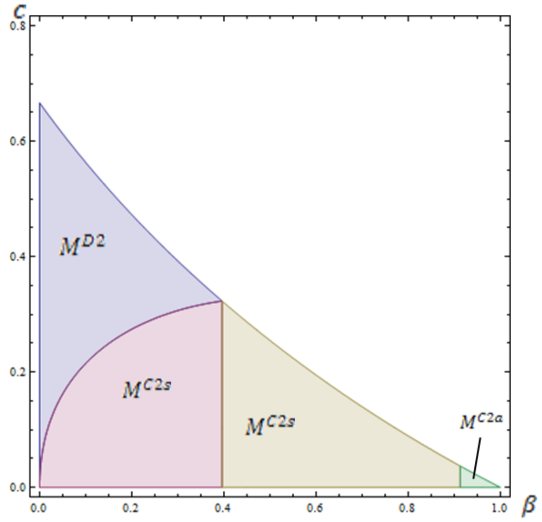

Figure 2: Equilibrium industry structures

effect of cross-border mergers dominates the benefits of uniformity for the firms. Note that equilibrium cross-border mergers will not necessarily lead to higher employment compared to a no-merger case. Only for the region $\beta \in (0.5, 1)$ cross-border mergers will increase total employment.

Finally, note that cross-border mergers between asymmetric firms will only be the equilibrium outcome of the merger formation process when products are close substitutes. In this case the opportunity to shift production is largest, because products are only slightly differentiated and at the same time, firms will be rather homogenous due to the upper bound on non-labor marginal cost, $\bar{c}$.

5 Welfare

Finally, we inspect the welfare implications of our results. At first glance, a domestic merger might have welfare improving effects because of the redistribution of production from less efficient to more efficient firms (Barros, 1998). However, the employment effect of domestic mergers gives rise to the following result.

Proposition 3. *The ownership structure involving two domestic mergers M^{D2} is never socially optimal. For $\beta \in (.46, .94)$ and a wide range of firm asymmetry, the welfare optimal industry structure is given by M^{C2a}.*

Proof. *See Appendix.*

Calculating the global welfare as the sum of firms' profits, labor union wage bills and consumer surplus, we see that industry structure M^{D2} is never welfare optimal.

For all parameter constellations of β and c, it is welfare dominated by other structures. Establishing which industry structure is welfare optimal (from a global welfare point of view) is, however, not easy in practice. We do find, following Lommerud et al. (2006), that two cross-border mergers (M^{C2s} or M^{C2a}) always welfare dominate the two domestic mergers structures. In contrast, we cannot establish a pattern leading to the conclusion that cross-border mergers are the welfare optimal industry structure for a wide range of parameters. Interestingly, for intermediate degrees of product differentiation, the welfare optimal industry structure is given by M^{C2a}.

A comparison with the results of the equilibrium outcomes of the merger formation shows that firms will not choose the optimal equilibrium industry structure from a welfare point of view for the given parameter range in Proposition 4. The result does support, however, empirical findings, namely an increasing trend in cross-border mergers where target and acquiring firms may strongly differ in size (see Gugler et al., 2003).

6 Concluding Remarks

We have presented an extension of the model analyzed by Lommerud et al. (2006) with regard to firm asymmetry and wage-setting institutions. Our results suggest that domestic mergers may result as an equilibrium outcome of the cooperative coalition formation process when firms are asymmetric in their non-labor costs of production. This result holds even when asymmetries become very large, which is in contrast to previous work on horizontal mergers between asymmetric firms without endogenous input costs (see e.g. Barros, 1998; Neubecker and Stadler, 2003).

The incentives for plants to merge are enforced by the assumption that labor unions respond to a domestic merger with a uniform wage rate. Thereby, firms face a trade-off between domestic and cross-border mergers in the coalition formation game: cross-border mergers give rise to the threat effect -the opportunity to reallocate production from one country to another- and thereby put downward pressure on wages. Domestic mergers constrain the labor unions in their freedom to extract surplus from efficient plants. This uniformity effect provides incentives for firms to merge domestically. On the one hand a domestic merger may lower the wage paid by the efficient plant, on the other hand production may be reshuffled within one country from the less to the more efficient producer.

We observe, therefore, that either domestic or cross-border mergers may occur on equilibrium, depending on the degree of product substitutability and the asymmetry between firms. If cross-border mergers occur, mergers between symmetric plants will be the prevailing industry structure for the widest range of parameter constellations.

A comparison with the optimal industry structures from a global welfare perspective reveals that firms do not choose the welfare optimal industry structures. While two domestic mergers are never welfare optimal, no unambiguous pattern in the industry structures according to welfare effects can be made. The welfare optimal structure can involve no mergers at all, one or two mergers. It can be said, however, that for a wide range of parameter constellations, the global welfare maximizing industry structures involves two mergers between asymmetric firms, i.e. between an efficient and an inefficient plant each. Obviously, this result is enforced by the positive welfare effect of these mergers because of the reallocation of production from less to more efficient firms. A comparison to the equilibrium industry structure chosen by firms, reveals that such an industry structure is however rarely chosen by firms.

Appendix

■ In the following, we explicitly solve our model for all possible industry structures. We report firms' profits, employment (quantities), wages and union wage bills for each merger structure.

No merger (M^0):

$$\Pi_1^0 = \Pi_3^0 = \frac{(8+\beta^2(-2+c)+6\beta c)^2}{64(4+(4-3\beta)\beta)^2} \tag{5}$$

$$\Pi_2^0 = \Pi_4^0 = \frac{(8+\beta^2(-2+c)-8c+6\beta c)^2}{64(4+(4-3\beta)\beta)^2} \tag{6}$$

$$q_1^0 = q_3^0 = \frac{8+\beta^2(-2+c)+6\beta c}{8(2-\beta)(2+3\beta)}$$

$$q_2^0 = q_4^0 = \frac{8+\beta^2(-2+c)-8c+6\beta c}{8(4+(4-3\beta)\beta)}$$

$$w_1^0 = w_3^0 = \frac{4+\beta(-2+c)}{8}$$

$$w_2^0 = w_4^0 = \frac{4+\beta(-2+c)-4c}{8}$$

$$U_A^0 = U_B^0 = \frac{4(-2+\beta)^2(2+\beta)-4(-2+\beta)^2(2+\beta)c+(16+\beta(8+(-2+\beta)\beta))c^2}{32(2-\beta)(2+3\beta)}$$

One domestic merger (M^{D1}): Assume, firms 1 and 2 in country A merge

$$\Pi_{12}^{D1} = \frac{-2(-1+\beta^2)(-4-\beta+\beta^3)^2+2(-1+\beta^2)(-4-6\beta+\beta^3)^2c+\Gamma c^2}{4(1-\beta)(-2+(-3+\beta)\beta)^2(4+\beta(6+\beta))^2} \tag{7}$$

$$\Pi_3^{D1} = \frac{(-8+\beta(\beta(2+\beta(5+\beta(-1+c)-c)-9c)-6(2+c)))^2}{4(4+(-4+\beta)(-1+\beta)\beta)^2(4+\beta(6+\beta))^2} \tag{8}$$

$$\Pi_4^{D1} = \frac{(8-8c+\beta(12-18c+\beta(-2-7c+\beta(-5+\beta+4c))))^2}{4(4+(-4+\beta)(-1+\beta)\beta)^2(4+\beta(6+\beta))^2} \tag{9}$$

where $\Gamma = (40+\beta(216+\beta(426+\beta(332+\beta(24+\beta(4+\beta)(-17+3\beta))))))$.

$$
\begin{aligned}
q_1^{D1} &= \frac{2(2+c)+\beta(2+11c-\beta(6-11c+\beta(1+\beta(-1+c)+c)))}{2(-1+\beta)(-2+(-3+\beta)\beta)(4+\beta(6+\beta))} \\
q_2^{D1} &= \frac{4-6c+\beta(2-13c+\beta(-6-5c+\beta(-1+\beta+2c)))}{2(-1+\beta)(-2+(-3+\beta)\beta)(4+\beta(6+\beta))} \\
q_3^{D1} &= \frac{8+\beta(6(2+c)+\beta(-2+9c+\beta(-5+\beta+c-\beta c)))}{2(-2+\beta)(-2+(-3+\beta)\beta)(4+\beta(6+\beta))} \\
q_4^{D1} &= \frac{8-8c+\beta(12-18c+\beta(-2-7c+\beta(-5+\beta+4c)))}{2(-2+\beta)(-2+(-3+\beta)\beta)(4+\beta(6+\beta))}
\end{aligned}
$$

$$
\begin{aligned}
w_{12}^{D1} &= \frac{(-2+(-2+\beta)\beta)(-2+c)}{2(4+\beta(6+\beta))} \\
w_3^{D1} &= \frac{4+\beta(4+\beta(-1+c)+c)}{2(4+b(6+\beta))} \\
w_4^{D1} &= \frac{4-4c-\beta(-4+\beta+5c)}{2(4+\beta(6+\beta))}
\end{aligned}
$$

$$
\begin{aligned}
U_A^{D1} &= \frac{(-2-\beta)(-2+(-2+\beta)\beta)^2(-2+c)^2}{4(-2+(-3+\beta)\beta)(4+\beta(6+\beta))^2} \\
U_B^{D1} &= \frac{-2(-2+\beta)(1+\beta)(-4+(-4+\beta)\beta)^2+2(-2+\beta)(1+\beta)(-4+(-4+\beta)\beta)^2c+\Delta c^2}{4(4+(-4+\beta)(-1+\beta)\beta)(4+\beta(6+\beta))^2}
\end{aligned}
$$

where $\Delta = (32+\beta(112-\beta(-124+\beta(-34+10\beta+\beta^3))))$.

Two national mergers (M^{D2}):

$$
\Pi_{12}^{D2} = \Pi_{34}^{D2} = \frac{4(-1+\beta)(1+\beta)^3-4(-1+\beta)(1+\beta)^3c-(5+\beta(22+3\beta(11+\beta(6+\beta))))^2}{8(-1+\beta)(2+\beta)^2(1+2\beta)^2} \tag{10}
$$

$$
\begin{aligned}
q_1^{D2} &= q_3^{D2} = \frac{2+c+5\beta c+\beta^2(-2+3c)}{8+12\beta-12\beta^2-8\beta^3} \\
q_2^{D2} &= q_4^{D2} = \frac{-2+3c+5bc+b^2(2+c)}{4(-2-3\beta+3\beta^2+2\beta^3)}
\end{aligned}
$$

$$
w_{12}^{D2} = w_{34}^{D2} = \frac{2-c}{4+2\beta}
$$

$$
U_A^{D2} = U_B^{D2} = \frac{(1+\beta)(-2+c)^2}{4(2+\beta)^2(1+2\beta)}
$$

One efficient symmetric international merger (M^{C1se}): Firms 1 and 3 merge

$$\Pi_{13}^{C1se} = \frac{(-2+\beta)^2(1+\beta)(-8+\beta^2-6\beta c)^2}{2(16+(-12+b)b)^2(-2+(-3+b)b)^2} \quad (11)$$

$$\Pi_{2}^{C1se} = \Pi_{4}^{C1se} = \frac{(8(-1+c)+\beta(2+\beta(4+\beta(-1+c)-7c)+4c))^2}{(16+(-12+\beta)\beta)^2(-2+(-3+\beta)\beta)^2} \quad (12)$$

$$q_{1}^{C1se} = q_{3}^{C1se} = \frac{(2-\beta)(-8+\beta^2-6\beta c)}{2(16+(-12+\beta)\beta)(-2+(-3+\beta)\beta)}$$

$$q_{2}^{C1se} = q_{4}^{C1se} = \frac{8(-1+c)+\beta(2+\beta(4+\beta(-1+c)-7c)+4c)}{(16+(-12+\beta)\beta)(-2+(-3+\beta)\beta)}$$

$$w_{1}^{C1se} = w_{3}^{C1se} = \frac{-2(-1+\beta)(4+\beta(-2+c))}{16+(-12+\beta)\beta}$$

$$w_{2}^{C1se} = w_{4}^{C1se} = \frac{(2-\beta)(4-3\beta+2(-2+\beta)c)}{16+(-12+\beta)\beta}$$

$$U_{A}^{C1se} = U_{B}^{C1se} = \frac{-(-2+\beta)(\beta(80+\beta(-2+\beta(-22+5\beta)))+64(-1+c)-\Theta}{(16+(-12+\beta)\beta)^2(-2+(-3+\beta)\beta)}$$

where $\Theta = 2\beta(32+(-4+\beta)\beta(-1+3\beta))c+2(-16+\beta^2(15+(-6+\beta)\beta))c^2)$.

One inefficient symmetric international merger (M^{C1si}): Firms 2 and 4 merge

$$\Pi_{24}^{C1si} = \frac{(-2+\beta)^2(1+\beta)(8+\beta^2(-1+c)-8c-6\beta c)^2}{2(16-12\beta+\beta^2)^2(-2-3\beta+\beta^2)^2} \quad (13)$$

$$\Pi_{1}^{C1si} = \Pi_{3}^{C1si} = \frac{(8+\beta^3-\beta^2(4+3c)+\beta(-2+6c))^2}{(16-12\beta+\beta^2)^2(-2-3\beta+\beta^2)^2} \quad (14)$$

$$q_{1}^{C1si} = q_{3}^{C1si} = \frac{-8-\beta^3+\beta^2(4+3c)-\beta(-2+6c)}{(16-12\beta+\beta^2)(-2-3\beta+\beta^2)}$$

$$q_{2}^{C1si} = q_{4}^{C1si} = \frac{(-2+\beta)(8+\beta^2(-1+c)-8c-6\beta c)}{2(-32-24\beta+50\beta^2-15\beta^3+\beta^4)}$$

$$w_{1}^{C1si} = w_{3}^{C1si} = \frac{(2-\beta)4+\beta(-3+c))}{16+(-12+\beta)\beta}$$

$$w_{2}^{C1si} = w_{4}^{C1si} = \frac{2(1-\beta)(4+\beta(-2+c)-4c)}{16+(-12+\beta)\beta}$$

$$U_{A}^{C1si} = U_{B}^{C1si} = \frac{(2-\beta)(\Phi-2\beta^3(11-9c+4c^2)+2\beta^2(-1+6c+10c^2))}{(16-12\beta+\beta^2)^2(-2-3\beta+\beta^2)}$$

where $\Phi = 16\beta(5-6c+c^2)+\beta^4(5-4c+c^2)-32(2-2c+c^2)$.

Two symmetric international mergers (M^{C2s}):

$$\Pi_{13}^{C2s} = \frac{(1+\beta)(8+\beta(-2-3\beta+(6+(-4+\beta)\beta)c))^2}{2(4-3\beta)^2(-4+\beta)^2(1+2\beta)^2} \quad (15)$$

$$\Pi_{24}^{C2s} = \frac{(1+\beta)(8(-1+c)+\beta(2+3\beta+(4+(-7+\beta)\beta)c))^2}{2(4-3\beta)^2(-4+\beta)^2(1+2\beta)^2} \quad (16)$$

$$q_1^{C2s} = q_3^{C2s} = \frac{8+\beta(-2-3\beta+(6+(-4+\beta)\beta)c)}{2(-4+\beta)(1+2\beta)(-4+3\beta)}$$

$$q_2^{C2s} = q_4^{C2s} = \frac{8-8c-\beta(2+3\beta+(4+(-7+\beta)\beta)c)}{2(-4+\beta)(1+2\beta)(-4+3\beta)}$$

$$w_1^{C2s} = w_3^{C2s} = \frac{-2(-1+\beta)(4+\beta(-3+c))}{(-4+b)(-4+3b)}$$

$$w_2^{C2s} = w_4^{C2s} = \frac{-2(-1+\beta)(4-3\beta+2(-2+\beta)c)}{(-4+\beta)(-4+3\beta)}$$

$$U_A^{C2s} = U_B^{C2s} = \frac{-2(4-3\beta)^2(-2+\beta+\beta^2)+2(4-3\beta)^2(-2+\beta+\beta^2)c+\Omega}{(4-3\beta)^2(-4+\beta)^2(1+2\beta)}$$

where $\Omega = (-1+\beta)(-32+\beta^2(30+(-14+\beta)\beta))c^2$.

One asymmetric international merger (M^{C1a}): Assume firms 1 and 4 merge

$$\Pi_{14}^{C1a} = \frac{\zeta-\eta+\theta c^2}{4(-1+\beta)(16+(-12+\beta)\beta)^2(-2+(-3+\beta)\beta)^2(-16+\beta(-12+7\beta))^2} \quad (17)$$

where $\zeta = 2(-2+\beta)^2(-8+\beta^2)^2(-1+\beta^2)(-16+\beta(-12+7\beta))^2$

and $\eta = 2(-2+\beta)^2(-8+\beta^2)^2(-1+\beta^2)(-16+\beta(-12+7\beta))^2c$

and $\theta = (-65536+\beta(-98304+\beta(159744+\beta(219136+\beta(-218880+\beta(-160640+$ $\beta(188192+$

$\beta(7568+\beta(-64620+\beta(27968+3\beta(-1551+\beta(71+4\beta)))))))))))$

$$w_1^{C1a} = \frac{4(-2+\beta)(-1+\beta)(-16+\beta(-12+7\beta))-\beta(64+\beta(8+\beta(-50+13\beta)))c}{-256+\beta^2(240+\beta(-96+7\beta))}$$

$$w_2^{C1a} = \frac{128(-1+c)+\beta(-32(-2+c)+\beta(128-120c+\beta(-106+3\beta(7-4c)+74c)))}{-256+\beta^2(240+\beta(-96+7\beta))}$$

$$w_3^{C1a} = \frac{-128+\beta(-32(-2+c)+\beta(-8(-16+c)+\beta(-106+\beta(21-9c)+32c)))}{-256+\beta^2(240+\beta(-96+7\beta))}$$

$$w_4^{C1a} = \frac{4(-2+\beta)(-1+\beta)(-16+\beta(-12+7\beta))+(128-\beta(32+\beta(128+\beta(-82+15\beta))))c}{-256+\beta^2(240+\beta(-96+7\beta))}$$

Two asymmetric international mergers (M^{C2a}):

$$\Pi_{14}^{C2a} = \Pi_{23}^{C2a} = \frac{4(2+\beta)^2(-1+\beta^2) - 4(2+\beta)^2(-1+\beta^2)c + \digamma c^2}{8(-1+\beta)(4+(7-2\beta)\beta)^2} \tag{18}$$

where $\digamma = (-8+\beta(-16+\beta(2+(16-3\beta)\beta)))$.

$$q_1^{C2a} = q_3^{C2a} = \frac{4-\beta^2(2+c)+\beta(-2+4c)}{4(4+3\beta-9\beta^2+2\beta^3)}$$

$$q_2^{C2a} = q_4^{C2a} = \frac{4-4c-2\beta(1+c)+\beta^2(-2+3c)}{(-4+\beta)(-4-4\beta+8\beta^2)}$$

$$w_1^{C2a} = w_3^{C2a} = \frac{2+\beta(-2+c)}{4-\beta}$$

$$w_2^{C2a} = w_4^{C2a} = \frac{2-2\beta-2c+\beta c}{4-\beta}$$

$$U_A^{C2a} = U_B^{C2a} = \frac{-\beta^3(-2+c)^2+12\beta(-1+c)-2\beta^2c^2+4(2+(-2+c)c)}{2(-4+\beta)^2(-1+\beta)(1+2\beta)}$$

■In the following we provide proofs of Lemmas 1 to 3 and Propositions 1 to 4.

Proof of Proposition 1. In order to establish that insiders gain from mergers in all industry structures, we need to compare the profits of the insiders in each structure with the sum of profits the plants would obtain in a no-merger structure; i.e. in M^0. We provide the proof for all possible industry structures listed in Section 2 sequentially.

One domestic merger (M^{D1}**)**: Using (7) as well as (5) and (6), we need to show that $\Pi_{12}^{D1} - (\Pi_1^0 + \Pi_2^0) > 0$.

Two domestic mergers (M^{D2}**)**: Using (10) as well as (5) and (6), we need to show that $\Pi_{12}^{D1} - (\Pi_1^0 + \Pi_2^0) > 0$.

One symmetric efficient cross-border merger (M^{C1se}): Using (11) as well as (5) and (6), we need to show that $\Pi_{13}^{C1se} - (\Pi_1^0 + \Pi_3^0) > 0$.

One symmetric inefficient cross-border merger (M^{C1si}): Using (13) as well as (5) and (6), we need to show that $\Pi_{24}^{C1si} - (\Pi_2^0 + \Pi_4^0) > 0$.

Two symmetric cross-border mergers (M^{C2s}): Using (15) and (16) as well as (5) and (6), we need to show that $\Pi_{13}^{C2s} - (\Pi_1^0 + \Pi_3^0) > 0$ and $\Pi_{24}^{C2s} - (\Pi_2^0 + \Pi_4^0) > 0$.

One asymmetric cross-border merger (M^{C1a}): Using (17) as well as (5) and (6), we need to show that $\Pi_{14}^{C1a} - (\Pi_1^0 + \Pi_4^0) > 0$.

Two asymmetric cross-border mergers (M^{C2a}): Using (18) as well as (5) and (6), we need to show that $\Pi_{14}^{C2a} - (\Pi_1^0 + \Pi_4^0) > 0$.

Proof of Lemma 1 The lemma states that industry structures involving no merger or one merger cannot be equilibrium industry structures, because they are always dominated by at least one of the industry structures involving two mergers. The proof is based on the establishment of bilateral dominance relationship between the two-merger structures M^{D2}, M^{C2a}, M^{C2s} and the remaining no- and one-merger industry structures. Within the range of valid parameter values, i.e. $\beta \in (0,1)$ and $c \in (0,\bar{c})$ each of the industry structures M^{D1}, M^{0}, M^{C1se}, M^{C1si} and M^{C1a} is dominated by at least one of the two-merger structures. Thus, neither of the five structures is a candidate for an equilibrium industry structure, as only undominated structures are in the core.

Proof of Proposition 2. Let us first consider Part (a) of the Proposition. The ranking presented is unique. It is sufficient to show that $w_E^{C2a} - w_E^{C2s} = w_I^{C2s} - w_I^{C2a} = \frac{(2-\beta)\beta c}{(4-\beta)(4-3\beta)}$,and $w_E^{C2s} - w_I^{C2s} = \frac{2(1-\beta)c}{4-3\beta}$are positive. Obviously, this is the case for $\beta \in (0,1)$ and $c \in (0,\bar{c})$.

For Part (b) of the Proposition, we need to show how the uniform wage w^{D2} is ranked with regard to the other wage rates. Taking into account the results displayed in Figure 1, it can easily be shown that $w^{D2} > w_E^{C2a}$ reduces to $\frac{2\beta+4\beta^2-4c-3\beta c-2\beta^2 c}{2(4-\beta)(2+\beta)} > 0$. As the denominator of the upper expression is clearly positive for $\beta \in (0,1)$, we need to solve the quadratic equation $(4-2c)\beta^2 + (2-3c)\beta - 4c = 0$.

Next, we need to consider the case when $w_E^{C2a} > w^{D2} > w_E^{C2s}$. From the previous case, we know that $w_E^{C2a} > w^{D2}$ whenever β ... Thus, we need to show when $w^{D2} - w_E^{C2s} > 0$ holds. Simplifying this, we get the expression $\frac{8\beta+10\beta^2-12\beta^3-16c+8bc+\beta^2 c+4\beta^3 c}{2(2+\beta)(16-16\beta+3\beta^2)} > 0$. As the numerator is again positive, we need to show when $8\beta + 10\beta^2 - 12\beta^3 - 16c + 8bc + \beta^2 c + 4\beta^3 c > 0$.

Finally, we consider the case $w_E^{C2s} > w^{D2} > w_I^{C2s}$. From above, we can establish when $w_E^{C2s} > w^{D2}$ holds. The expression $w^{D2} - w_I^{C2s} > 0$ reduces to $\frac{8\beta+10\beta^2-12\beta^3+16c-16bc-11\beta^2 c+8\beta^3 c}{2(2+\beta)(16-16\beta+3\beta^2)} > 0$. Again, we need to establish when $8\beta + 10\beta^2 - 12\beta^3 + 16c - 16bc - 11\beta^2 c + 8\beta^3 c$ is positive.

Proof of Lemma 2 The proof of Lemma 2 is straightforward. For Part (a), the inequality $Q^{C2a} - Q^{D2} > 0$ reduces to $\frac{\beta(c-2)}{(-4+\beta)(2+\beta)} > 0$, which holds -given the restrictions on parameters- for all $\beta \in (0,1)$ and $c \in (0,\bar{c})$. Concerning Part (b), we need to inspect $Q^0 - Q^{C2s}$ which is given by$\frac{-\beta(2+\beta)(-1+2\beta)(-2+c)}{2(-4+\beta)(1+2\beta)(2+3\beta)}$. Note that the denominator of the previous expression is always negative. Thus, the sign of the above expression hinges upon the term $(-1+2\beta)$. Obviously, the whole expression changes sign at $\beta = 1/2$.More specifically, the difference $Q^0 - Q^{C2s}$ is positive for $\beta < 1/2$ and negative for $\beta > 1/2$.

Proof of Proposition 3. From Lemma 1, we have that the only candidates for equilibrium industry structures are those structures involving two mergers. In order to determine the equilibrium industry structures, we need to compare bilaterally the profits of the decisive owners in each of the two-merger industry structures against those of the other two structures. Only when a structure dominates both other structures, it will be the equilibrium outcome of the merger formation process. We say that in these instances, an industry structure is in the core. We consider the comparison of all merger structures sequentially.

For two domestic mergers (M^{D2}) to be an equilibrium, we need to have that M^{D2} *dom* M^{C2s} and M^{D2} *dom* M^{C2a},i.e. $\Pi_{12}^{D2} + \Pi_{34}^{D2} - (\Pi_{13}^{C2s} + \Pi_{24}^{C2s}) > 0$ and $\Pi_{12}^{D2} + \Pi_{34}^{D2} - (\Pi_{14}^{C2a} + \Pi_{23}^{C2a}) > 0$.

Conversely, for two cross-border mergers (symmetric) to be the equilibrium result of the merger formation process, we need to determine when $\Pi_{13}^{C2s}+\Pi_{24}^{C2s}-(\Pi_{12}^{D2}+\Pi_{34}^{D2}) > 0$ and $\Pi_{13}^{C2s} + \Pi_{24}^{C2s} - (\Pi_{14}^{C2a} + \Pi_{23}^{C2a}) > 0$.

Finally, we can establish when two asymmetric cross-border mergers will result in equilibrium. This is the case whenever $\Pi_{14}^{C2a} + \Pi_{23}^{C2a} - (\Pi_{12}^{D2} + \Pi_{34}^{D2}) > 0$ and $\Pi_{14}^{C2a} + \Pi_{23}^{C2a} - (\Pi_{13}^{C2s} + \Pi_{24}^{C2s}) > 0$.

From each profit comparison, we receive restrictions on the parameters β and c. Usually, industry profits of all two-merger structures can be ranked depending on β and c. Thus, for one structure to result in equilibrium, it will be sufficient to show that it dominates one other structure, if this dominated structure in turn dominates the third industry structure.

Proof of Proposition 4. To prove Proposition 4, we need to calculate the global welfare resulting in each of the industry structures analyze. We define global welfare as the sum of consumer surplus, firm profits and union wage bills. More specifically, denote global welfare in structure M^l to be

$$W^l = V^l - \sum_{i=1}^{4}(p_i^l q_i^l) + \sum_{i=1}^{4}\Pi_i^l + U_A^l + U_B^l,$$

where V^l denotes the utility function of a representative consumer in industry structure M^l and is given by $\sum_{i=1}^{4} q_i^l - \frac{1}{2}\left(\sum_{i=1}^{4} q_i^2 + \beta \sum_{i=1}^{4}\sum_{j=1}^{4} q_i q_j\right) + z$, where z denotes the outside numeraire good and $i,j = 1,2,3,4$; $i \neq j$.

Comparing the global welfare in M^{D2}, W^{D2}, to all other merger structures, it is easily confined that W^{D2} is dominated for all $\beta \in (0,1)$ and $c \in (0,\bar{c})$. Conversely, finding the optimal industry structure from a welfare perspective is not easily done. As for the proof of the EIS, we need to bilaterally compare the global welfare of one structure to those of all others. This procedure gives rise to the result stated in the proposition, namely that M^{C2a} is the welfare optimal industry structure for a rather wide range of parameter values. Comparing this result to Proposition 3, it is easily checked that M^{C2a} may be the best industry structure from a welfare point of view even in the range of parameters where the coalition formation process results in an equilibrium outcome other that M^{C2a}.

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