On the relationship between tariff levels and the nature of mergers

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On the Relationship between Tariff Levels and the Nature of Mergers[*]

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Abstract

This paper employs an endogenous merger formation approach in a two-country oligopoly model of trade to examine the international linkages between the nature of mergers and tariff levels. Firms sell differentiated products and compete in a Bertrand fashion in product markets. We find two effects playing key roles in determining equilibrium market structure: *the tariff saving effect* and *the protection gain effect*. The balance between these two effects implies that, when foreign country practices free trade, unilateral tariff reduction by a domestic country yields international mergers irrespective of the substitutability levels. By contrast, when foreign tariffs are sufficiently high and products are close substitutes, national mergers obtain in the equilibrium. Therefore, the implications of unilateral trade liberalization on the equilibrium market structure depends on the trade regime in foreign country especially when products are close substitutes. Unlike this asymmetric result of unilateral trade liberalization, we find that when bilateral tariffs are sufficiently low, international mergers arise. These results fit well with the fact that global trade liberalization has been accompanied by an increase in international merger activities. Finally, from a welfare perspective, we show that international mergers are preferable to national mergers and thus social and private merger incentives become aligned together as trade gets bilaterally liberalized.

Keywords: Tariffs, international mergers, national mergers, tariff saving, protection gain. *JEL Classifications*: F13, F12.

1 Introduction

Over the last three decades, along with international trade liberalization, world economy has witnessed the largest ever merger movement with a particular characteristic of high incidence of cross-border mergers and acquisitions (M&A's).[1] New patterns of globalization have accelerated the internationalization of industries and reshaping of global industrial structure. According to the World Investment Report (WIR) 2007, international mergers and corporate take-overs have been the key driver of global foreign direct investment FDI flows since the late 1980s and cross-border M&As have been enlarged by 23% to $880 billion in 2006, and the number of transactions has been increased by 14% to 6,974 reflecting a strong global M&A activity in general. An interesting feature of the current wave of cross-border M&A's is that it is truly international, as opposed to the previous merger waves which involved primarily U.S. firms. It no longer makes sense to see takeover booms and busts as national phenomena. While most of the mega deals with transaction values of more than $1 billion were carried out in developed countries, 17% of the cross-border M&As were realized in developing countries and transition economies and China is the leading host country among developing countries by far.[2]

Most cross-border M&As have been horizontal in nature, aiming at free access to the export market via savings on tariffs and trade costs, increasing market power, economies of scale, technological synergies, eliminating excess capacity, or consolidating and streamlining innovation strategies and R&D budgets.[3] This paper attempts to provide an explanation for the high incidence of cross-border mergers by focusing on the first two of the above incentives. Specifically, we examine the implications of the fall in tariffs and trade costs on the nature of mergers. Despite the increase in cross-border M&A's, the literature on international trade and FDI has paid little attention to this phenomenon.[4] Instead, the focus has been the international location decisions of firms.[5] There exists an extensive literature on domestic

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[1] Over this period, countries have pursued trade liberalization along several front: unilaterally, preferentially with a few partner and multilaterally within the world trade organization (WTO). As a result, average tariff levels have fallen dramatically especially in manufacturing industries.

[2] For example, while the volume of cross-border M&A was less than a billion dollar in Turkey, it has reached to an unprecedented level of $50 billion for the 2005-2007 period.

[3] The leading industries in the manufacturing sector in terms of worldwide cross-border M&A activities have been automobiles, pharmaceuticals and chemicals, and food, beverages and tobacco. The immediate examples in the auto industry include the ones between Daimler-Chrysler, Renault and Nissan and GM and Saab.

[4] Recently, Horn and Persson (2001b), Norback and Persson (2004, 2006), Benchekroun and Chaudhuri (2006), Bjorvatn (2003) and Qiu and Zhou (2006) study cross border mergers as an alternative mode of entry.

[5] In this literature, firms typically face a trade-off between the fixed cost of an additional plant in the export market and the benefit of economizing on tariffs and trade costs. Markusen (1995) surveyed the theoretical literature on FDI and multinational enterprises (MNE). This literature includes papers by Dunning (1977), Horstmann and Markusen (1992), Markusen and Venables (1998).

mergers and merger policy while international merger activity is relatively under-researched.[6] We aim at filling these gaps in the literature along both dimensions.

What are the effects of unilateral and bilateral tariff reduction on the nature of mergers (national or international) that emerges in the equilibrium? Which type of mergers (national or international) is preferred from a welfare point of view? What if tariff determination and merger formation are both endogenous? To address these questions, the present paper uses the cooperative approach of endogenous merger formation developed by Horn and Persson (2001a, 2001b) in determining equilibrium market structure for different degrees of product differentiation and tariff levels.

The model considers an oligopolistic industry in which firms sell differentiated goods and compete in prices. The interaction between firms takes place in two stages. In the first stage, we determine the industry structure: firms decide whether to merge domestically, internationally or stay as competing units. In the second stage, firms compete over prices in the product markets (Bertrand fashion). Unlike much of the literature on mergers and competition policy, we follow Deneckere and Davidson's (1985) approach and utilize price competition in the product market. Since Salant et. al. (1985) it is well known that under quantity competition, merging firms can actually lose from a merger since the merged unit concedes market share to outside firms. As a result, it is important to examine merger and trade policies in an environment where firms actually gain from mergers. In other words, it seems unsatisfactory to examine a government's optimal degree of market concentration without ensuring that firms actually desire that level of concentration. Like much of the literature on trade policy under imperfect competition, we assume that markets are segmented – i.e. there is no arbitrage across international markets and firms make independent decisions regarding what price to charge in each market.

It is important to note that origins of merging firms are important due to the existence of trade policy in the model. If asset owners from the same country merge, the resulting firm is a national firm that faces a tariff disadvantage in the export market while enjoying protection in the domestic market. On the other hand, if asset owners from different countries merge, the resulting firm is international in nature and has the advantage of avoiding tariffs and trade costs in both markets.

In exploring the nature of merger incentives, two effects play crucial roles: the *protection gain* and the *tariff saving*. The first effect represents the anti-competitive impact of trade

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[6]See Cheung (1992), Farrell and Shapiro (1990), Levin (1990), Perry and Porter (1985), Salant et al. (1983) for the profitability of horizantal mergers. Benchekroun (2003) and Dockner and Gaunersdorfer (2001) examine the same question in the case of a dynamic competition. Another line of research explores regulation issues and the interaction between merger policies and trade liberalization. Examples of this line of research are: Barros and Cabral (1994), Collie(2003), Head and Ries (1997), Horn and Levinsohn (2001), Richardson (1999) and Saggi and Yildiz (2006).

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policy and arises when firms are national units while the *tariff saving* effect simply captures the incentive to avoid tariffs and trade costs by merging with a firm in the export market. The balance between these two counter-acting effects determine the bargaining structure among firms in merger formation. Within our model, the tariff levels and the degree of product differentiation together create a trade-off between the relative attractiveness of national and international mergers. When tariff levels and the degree of product market competition among firms (i.e. products are sufficiently close substitutes) are both sufficiently high, the former effect dominates the latter generating a tendency for national mergers. On the other hand, when tariffs are sufficiently low (close to free trade), the *tariff saving* effect dominates the *protection gain* and the higher the degree of product differentiation the more likely this result obtains.

The implications of unilateral home trade liberalization are examined at two extreme foreign trade policy regimes. When foreign country practices free trade, lowering home tariffs induces firms to form international mergers irrespective of the degree of product differentiation. However, when foreign tariffs are sufficiently high (at a prohibitive level), the impact of unilateral home trade liberalization depends upon the degree of product differentiation: the international mergers arise at the equilibrium when products are sufficiently differentiated whereas equilibrium mergers are national in nature when products are close substitutes.

Then, we examine the effects of bilateral trade liberalization on the nature of mergers by assuming a common exogenous tariff level in both markets and then by lowering it. In contrast to unilateral trade liberalization, the tariff reduction is realized in both markets so that both the *tariff saving* effect and the *protection gain* from tariffs decline. The main result here is that, as trade gets bilaterally liberalized, the resulting equilibrium market structure is the one with international mergers. This result is consistent with the fact that global trade liberalization has been accompanied by an increase in cross-border merger activities.

Furthermore, turning to welfare, three effects play crucial roles in determining preferred market structures from a welfare point of view: (i) the standard trade-off between the effects of market concentration on producer surplus and consumer welfare (ii) the standard anti-competitive effects of tariffs and (iii) the *free rider effect* that can be measured as the amount by which the profits of a non-merging firm increase when a merger happens and it arises under asymmetric market structures. Among equilibrium market structures, we find that the tariff saving feature tips the balance in favor of international mergers and thus we find that social and private merger incentives become aligned together as trade gets liberalized. This result provides support for the idea that there is scope for welfare-enhancing merger policies under a more liberal trade environment.

Finally, we allow that trade policy in each country may respond to changes in market structure and examine the equilibrium market structures under optimum tariffs. Our first

finding is that the relationship between protection incentives and market concentration depends on the nature of the concentration: while optimum tariffs rise as market gets more concentrated nationally, the opposite arises when higher concentration arises due to international mergers.[7] This result stems from the fact that when firms merge internationally, benefit of protection is shared with a foreign partner. Then, we find under endogenous trade policy that international mergers arise when products are sufficiently differentiated while national mergers arise in the equilibrium when products are close substitutes. This finding implies that when the products are sufficiently differentiated, private and social incentives tend to move together under endogenous trade policy.

The present paper is closely related to Horn and Persson (2001b) that employs a similar model to show that the international pattern of ownerships depends on trade and production costs. Unlike the present paper, Horn and Persson (2001b) does not exclude prohibitive trade cost levels and considers a homogeneous-good Cournot model. When trade costs are prohibitive, firms enjoy high market power (monopoly power if nationally merged) in the domestic market and thus national ownership structures necessarily arise in the equilibrium. However, once the prohibitive trade costs are excluded, the only surviving equilibrium market structure is the one with international mergers. The present paper argues that a market structure with national mergers emerges in equilibrium even under non-prohibitive tariff levels. Moreover, only bilateral (symmetric) trade liberalization is examined in Horn and Persson (2001b). Our analysis of unilateral trade liberalization is complementary to their analysis. More importantly, if one interprets trade costs as tariff levels, the equilibrium characterization in Horn and Persson (2001b) implies that an empty set of market structures (i.e. there is no equilibrium) arises for low tariff levels in their trade cost saving model. The present paper shows that the choice of price as a basic strategic variable instead of quantity overcomes this problem and this improvement stems from the fact that under price competition every single merger is profitable and there is no trivial elimination of concentrated market structures. Finally, unlike Horn and Persson (2001b), the present paper also examines equilibrium market structure under endogenous trade policy.

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[7]There are number of empirical studies that explores the interaction between the industry concentration and the level of protection. The results are inconclusive. Whereas Trefler (1993), Gawande (1997), and Bandyopadhyay and Gawande (2000) found significant positive relationships between industry concentration and the level of protection, Baldwin (1985), and Anderson and Baldwin (1987) report a negative relationship. The present paper provides one explanation for this ambiguity in the sense that the nature of the concentration (national or international) is important in determining optimal trade policy.

2 Model

The model is a two country partial equilibrium set-up in which countries are denoted by $z = H$ (home country), F (foreign country). In each country, there is a single industry consisting of two firms that produce symmetrically differentiated products. We denote the home firms by $i = h, h'$ and foreign firms by $i = f, f'$. Firms' assets are located in their own domestic country. We assume that entry to the industry is restricted.[8] Firms own the exclusive technology for their particular brand (e.g. through patents) and each firm is described by its brand demand function. The marginal cost of production for all firms is assumed to be constant ($c \geq 0$) and identical.

Following Shubik (1980), let the utility function be defined as:

$$U(\mathbf{q}_z) = \alpha \sum_i q_{iz} - \frac{1}{2}(\sum_i q_{iz})^2 - \frac{2}{1+\gamma}[\sum_i q_{iz}^2 - \frac{(\sum_i q_{iz})^2}{4}] \tag{1}$$

where α is a positive constant, $\mathbf{q}_z$ is a vector of quantities: $\mathbf{q}_z = (q_{hz}, q_{h'z}, q_{fz}, q_{f'z})$, q_{iz} denotes firm i's sales in country z and $\gamma \epsilon [0, \infty)$ is a measure of substitutability between products. Then, we obtain the following symmetric demand system:

$$q_{iz}(\mathbf{p}_z) = \frac{1}{4}(\alpha - p_{iz} - \gamma(p_{iz} - \frac{1}{4}\sum_{j=1}^{n} p_{jz})) \tag{2}$$

where $\mathbf{p}_z$ is a vector of prices and p_{iz} denotes the price charged by firm i in country z. It is important to note that the degree of product differentiation between any two goods is the same and when γ approaches zero, products become unrelated (extreme heterogeneity) while they become perfect substitutes when γ goes to infinity. From hereon, without loss of generality, we assume that $c = 0$.[9]

The game proceeds as follows. In the first stage, industry structure is determined through bargaining between the firm owners: they decide whether to merge domestically, internationally or stay as competing units. In the second stage, firms compete in the product markets in a Bertrand fashion. Constant marginal costs and price competition together indicate that markets are strategically separated from each other. Thus, we assume that markets are segmented.

In determining market structure, we utilize a cooperative approach of endogenous merger formation developed by Horn and Persson (2001a). However, unlike Horn and Persson (2001b), we utilize price competition as in Deneckere and Davidson (1985). In our model, a merger of two firms is equivalent to perfect collusion between them. In other words, merging firms are allowed to shut down the operation of some of their plants but may not alter the

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[8]It may be due to some firm-specific ownership advantages of the incumbent firms.

[9]Alternatively, one can always transform the variables as follows: $\alpha^* = \alpha - c$, $p^* = p - c$.

characteristics of their products. It is well known that under price competition, if allowed by the competition authority, firms have incentives to merge all the way to monopoly because the combined profits of all firms in other market structures are smaller than monopoly profits. Since the focus is on the distinction between national and international mergers, only two-firm mergers are allowed and highly concentrated market structures (monopoly and the duopoly with the international merger of three firms) are excluded.[10] The symmetry of the model indicates that there are 10 possible ownership structures that can be represented by 5 different market structures:[11]

1-) No mergers: $\langle \Phi \rangle = \{h, h', f, f'\}$

2-) Triopoly with one national merger: $\langle N \rangle = \{hh', f, f'\}$, $\langle \{N'\} \rangle = \{h, h', ff'\}$

3-) Triopoly with one international merger: $\langle I \rangle = \{hf, h', f'\}$; $\langle I' \rangle = \{hf', h', f\}$; $\langle I'' \rangle = \{h'f, h, f'\}$ and $\langle I''' \rangle = \{h'f', h, f\}$

4-) Duopoly with two national mergers: $\langle NN \rangle = \{hh', ff'\}$

5-) Duopoly with two international mergers $\langle II \rangle = \{hf, h'f'\}$ and $\langle II' \rangle = \{hf', h'f\}$

The impact of trade liberalization on the equilibrium market structure (EMS) is examined by assuming exogenous tariff levels faced by exporting firms and then lowering those tariffs. The existence of tariff protection implies that the origin of merging firms matters. National firms (either non merged units or domestic mergers involving firms from the same country) have trade protection in their own country but face a tariff disadvantage while serving in the export market. By contrast, an international firm (involving one firm from each country) is assumed to be able to produce each of its varieties in each of the two countries' markets, thereby avoiding tariffs in both markets.

In order to obtain a subgame perfect Nash equilibrium, we solve the game using backward induction. Thus, we first take the market structure and exogenous tariffs as given and analyze the product market equilibrium. We denote the tariffs per unit of output in the home and foreign country by t_H and t_F respectively.

2.1   No mergers $\langle \Phi \rangle$

The profit maximization problem of firm i in the export market of country z under $\langle \Phi \rangle$ is given by:[12]

$$\max_{\{p_i\}} \pi_{iz}^{\Phi} = \frac{(p_{iz} - t_z)[\alpha - p_{iz} - \gamma(p_{iz} - \overline{P_z})]}{4} \tag{3}$$

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[10] We simply assume that the competition authorities rule out these highly concentrated market structures.

[11] Hereafter, in order to save on notation, each market structure will be referred to its first ownership structure and denoted by the corresponding notation.

[12] While serving in the domestic market, tariffs drop out.

where $z = F$ if $i = h, h'$, $z = H$ if $i = f, f'$, and $\overline{P_z}$ denotes the average price realized in country z's market: $\overline{P_z} \equiv \dfrac{\sum\limits_j p_{jz}}{4}$, where $j = h, h', f, f'$. The first order condition for the above problem yields firm i's reaction function under $\langle \{\Phi\} \rangle$:

$$p_{iz} = \frac{4\alpha + \gamma P_{-iz}}{2(3\gamma + 4)} + \frac{t_z}{2} \tag{4}$$

where P_{-iz} denotes the sum of prices of firm i's competitors and it equals: $P_{-iz} = \sum\limits_{j \neq i} p_{jz}$. As expected, since prices are strategic complements, we obtain positively sloped reaction functions. The equilibrium price charged by firm i under $\langle \Phi \rangle$ is found by solving the first order conditions of all firms simultaneously. We denote the equilibrium price of firm i in country z under market structure S by p_{iz}^S. Due to symmetry and market segmentation, we focus on home country only:[13]

$$
\begin{aligned}
p_{hH}^{\Phi} &= p_{h'H}^{\Phi} = \frac{4\alpha}{(3\gamma + 8)} + \frac{2\gamma t_H(3\gamma + 4)}{(3\gamma + 8)(7\gamma + 8)} \\
p_{fH}^{\Phi} &= p_{f'H}^{\Phi} = \frac{4\alpha}{(3\gamma + 8)} + \frac{t_H(3\gamma + 4)(5\gamma + 8)}{(3\gamma + 8)(7\gamma + 8)}
\end{aligned} \tag{5}
$$

It is immediate from the above price levels that a country's tariff raises the price charged by the exporting firms more than the one of its own firms: $\dfrac{\partial p_{fH}^{\Phi}}{\partial t_H} > \dfrac{\partial p_{hH}^{\Phi}}{\partial t_H} > 0$. In order to ensure the market access of exporting firms under $\langle \Phi \rangle$, we exclude prohibitive tariff level (denoted by $\overline{t_z}^{\Phi}$):[14]

$$q_{iz}^{\Phi} \geq 0 \text{ iff } t_z \leq \overline{t_z}^{\Phi} = \frac{2\alpha(7\gamma + 8)}{3\gamma^2 + 18\gamma + 16} \text{ where } z = F \text{ if } i = h, h', z = H \text{ if } i = f, f'$$

2.2 One national merger

Now, consider the market structure $\langle N \rangle$ under which home firms merge while foreign firms stay as competing units.[15] While the profit maximization problem of foreign firms stay the same as under $\langle \Phi \rangle$, home merger solves the following problem in the export market:

$$\max_{\{p_{hF}, p_{h'F}\}} \pi_{mF}^N = \sum_{m = h, h'} \frac{(p_{mF} - t_F)[\alpha - p_{mF} - \gamma(p_{mF} - \overline{P_F})]}{4} \tag{6}$$

Then, the following equilibrium prices obtain in home and foreign markets under $\langle N \rangle$:

$$
\begin{aligned}
p_{hH}^N &= p_{h'H}^N = \frac{2\alpha(7\gamma + 8) + \gamma t_H(3\gamma + 4)}{4(2\gamma^2 + 9\gamma + 8)} \\
p_{fH}^N &= p_{f'H}^N = \frac{(3\gamma + 4)[2\alpha + t_H(\gamma + 2)]}{2(2\gamma^2 + 9\gamma + 8)}
\end{aligned} \tag{7}
$$

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[13] The explicit formulae of the equilibrium profits under each market structure are reported in the appendix.

[14] This is a reasonable assumption since such tariffs are rarely witnessed in today's world economy.

[15] Due to symmetry, we obtain the same expressions for foreign merger under $\langle N' \rangle$.

and

$$p_{hF}^N = p_{h'F}^N = \frac{2\alpha(7\gamma + 8) + t_F(\gamma + 2)(5\gamma + 8)}{4(2\gamma^2 + 9\gamma + 8)}$$

$$p_{fF}^N = p_{f'F}^N = \frac{2\alpha(3\gamma + 4) + \gamma t_H(\gamma + 2)]}{2(2\gamma^2 + 9\gamma + 8)} \tag{8}$$

In the pre-merger situation under $\langle \Phi \rangle$, when a firm contemplated raising price, it did not care about the positive externality it would confer upon the other firms. However, by internalizing this positive externality, home merging firms set a higher price under $\langle N \rangle$ relative to $\langle \Phi \rangle$: $p_{hH}^N > p_{hH}^\Phi$ and the increase in price due to a merger gets larger (smaller) as own (foreign) tariffs rise: $\frac{\partial[p_{hH}^N - p_{hH}^\Phi]}{\partial t_H} > 0 > \frac{\partial[p_{hF}^N - p_{hF}^\Phi]}{\partial t_F}$. More importantly, since the reaction function of foreign firms has a slope uniformly less than one, non-merged foreign firms free ride by raising their prices less than the home merger and thus enjoying price increase and market share gain together.[16]

Since home firms raise the price after merger, it is immediate that the condition $t_H \leq \overline{t_H}^\Phi$ still guarantees the market access of foreign firms in home market under $\langle N \rangle$:[17]

$$q_{fH}^N = q_{f'H}^N \geq 0 \text{ iff } t_H \leq \overline{t_H}^N = \frac{2\alpha(3\gamma + 4)}{\gamma^2 + 8\gamma + 8} > \overline{t_H}^\Phi$$

$$q_{hF}^N = q_{h'F}^N \geq 0 \text{ iff } t_H \leq \overline{t_H}^\Phi$$

2.3 One international merger

In our model, tariffs can be avoided by merging with local producers in the export market. Consider the market structure $\langle I \rangle$ under which firms h and f merge while other firms (h' and f') stay as competing units. While the profit maximization problem of non-merged firms stay the same as under $\langle \Phi \rangle$, international merger solves the following problem in each market:

$$\max_{\{p_{hz}, p_{fz}\}} \pi_{mz}^I = \sum_{m=h,f} \frac{p_{mz}[\alpha - p_{mz} - \gamma(p_{mz} - \overline{P_z})]}{4} \tag{9}$$

The simultaneous solution of first order conditions leads to the following equilibrium prices under $\langle I \rangle$:[18]

$$p_{hz}^I = p_{fz}^I = \frac{4\alpha(7\gamma + 8) + \gamma t_z(3\gamma + 4)}{8(2\gamma^2 + 9\gamma + 8)} \tag{10}$$

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[16]Under free trade, free rider effect can be so strong that the profits of non-merging firms exceed those of the merged unit.

[17]Note that the prohibitive tariff level under $\langle NN \rangle$ is the same as $\overline{t_H}^N$.

[18]$p_{f'}^F(I)$ and $p_{h'}^F(I)$ can be found easily by replacing t_H with t_F in $p_{h'}^H(I)$ and $p_{f'}^H(I)$.

and

$$p_{h'H}^{I} = \frac{(3\gamma + 4)[4\alpha(7\gamma + 8) + \gamma t_H(3\gamma + 4)]}{4(7\gamma + 8)(2\gamma^2 + 9\gamma + 8)} \tag{11}$$

$$p_{f'H}^{I} = \frac{(3\gamma + 4)[4\alpha(7\gamma + 8) + t_H(11\gamma^2 + 40\gamma + 32)]}{4(7\gamma + 8)(2\gamma^2 + 9\gamma + 8)}$$

Note that internationally merged firms h and f have free access in both markets under $\langle I \rangle$ while firm h' faces t_F and firm f' faces t_H in the export markets. Thus, the export market access of firms h' and f' is more limited relative to other market structures and this leads to a lower prohibitive tariff level under $\langle I \rangle$:

$$q_i^z(I) \geq 0 \text{ iff } t_z \leq \bar{t}^I = \frac{4\alpha(3\gamma + 4)(7\gamma + 8)}{23\gamma^3 + 152\gamma^2 + 256\gamma + 128} < \bar{t}_z^{\Phi} \text{ where } z = F \text{ if } i = h', z = H \text{ if } i = f'$$

As a result, in order to ensure market access under all possible market structures, we assume that $t_z < \bar{t}^I$ holds from hereon.

2.4   Two national mergers

When there exist two national mergers, merged home and foreign firms solve the same problem in the export markets as in (6) and the following prices obtain:[19]

$$p_{hH}^{NN} = p_{h'H}^{NN} = \frac{2\alpha}{(\gamma + 4)} + \frac{\gamma t_H(\gamma + 2)}{(3\gamma + 4)(\gamma + 4)} \tag{12}$$

$$p_{fF}^{NN} = p_{f'F}^{NN} = \frac{2\alpha}{(\gamma + 4)} + \frac{t_H(\gamma + 2)^2}{(3\gamma + 4)(\gamma + 4)}$$

As might be expected, among all possible market structures, the highest equilibrium price levels obtain under $\langle NN \rangle$ due to the existence of both tariff and merger effects.

2.5   Two international mergers

When all firms merge internationally, they save on tariffs and free trade emerges. Internationally merged firms solve the same problem as in (9) and the following prices obtain:

$$p_{iz}^{II} = \frac{2\alpha}{(\gamma + 4)} \tag{13}$$

Next, we sort out the equilibrium market structures using an endogenous formation approach.

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[19]Due to symmetry, we can obtain the profit maximization problem and equilibrium values in foreign country by replacing t_H with t_F.

2.6 Endogenous merger formation

The solution procedure in the present paper is based on the endogenous merger formation model developed by Horn and Persson (2001a).[20] Based upon the earlier literature on mergers, and on actual observations of firms' behavior, they take the view that merger formation can be treated as a cooperative game since parties involved in the formation process are free to communicate and sign binding contracts. This approach is a generalization of traditional merger analysis since comparisons are made *between all feasible market structures* rather than two exogenously given market structures one of which is a strict concentration of the other.

In this model, there are three basic components: (i) *decisive Firms*; (ii) *dominance Relation*; (iii) *solution criterion: Core*. The firms that have the power of enforcing a market structure $\langle s^a \rangle$ over another market structure $\langle s^b \rangle$ are called to be *decisive firms*. Given the definition of *decisive firms*, *dominance relation* works as follows: $\langle s^a \rangle$ dominates $\langle s^b \rangle$ if and only if the combined profit of the decisive firms is larger under s^a than the one under s^b.[21] Two assumptions are made in the merger formation process. First, any payments between coalitions are not allowed. Second, when forming a merger, participating firms can choose any payoff distribution among themselves subject to the constraint that the total payoff distributed be exactly equal to the merged unit's total profit in the second stage of the game.

In order to illustrate the main ideas behind these components, consider the comparison between $\langle N \rangle = \{hh', f, f'\}$ and $\langle I \rangle = \{hf, h', f'\}$ under both of which firm f' stays as a competing unit. Since payments between coalitions are not allowed, firm f' is not able to influence the ranking of these market structures so that it is not a *decisive firm*. Now turn to other firms. If the market structure $\langle N \rangle$ is formed, firm f does not participate in any merger. In order to prevent this, if firm f's profit is higher under $\langle I \rangle$, it may offer to firm h a larger share of payoff of the merger under the market structure $\langle I \rangle$. On the other hand, firm h' may make a counter-offer to induce a merger with firm h if it's profit is higher under $\langle N \rangle$. This bargaining process implies that firms h, h', and f have the ability to affect the ranking of market structures $\langle N \rangle$ and $\langle I \rangle$ so that these firms are defined to be *decisive firms* denoted by $D^{N\&I} = \{h, h', f\}$.[22]

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[20] There are other alternative approaches to endogenize merger formation. Kamien and Zang (1990) offered an acquisition process modeled as follows: Each owner makes offers or bids for every other firm and announces an asking price for her own simultaneously. Equilibrium market structure is determined following a general allocation scheme once all bids and asking prices are known. This approach applies to situations where there are many firms and owners. Chatterjee et al. (1993) and Ray and Vohra (1998) portray the merger formation as a non-cooperative extensive form bargaining game.

[21] See Horn and Persson (2001a) for formal definitions of decisive firms and dominance relation.

[22] It is important to note that the dominance relation is not transitive if decisive group(s) of firms is (are) not the same. Furthermore, it is clear that two market structures can not dominate each other simultaneously.

Note that there may be more than one group of decisive firms. As another example, consider now the ranking of the following two market structures: $\langle \Phi \rangle = \{h, h', f, f'\}$, and $\langle II \rangle = \{hf, h'f'\}$. All four firms are decisive with respect to these two market structures. However, merger formation processes are not linked so that there are two distinct groups decisive firms: $D_1^{\Phi \& II} = \{h, f\}$, $D_2^{\Phi \& II} = \{h', f'\}$. If there are two groups of decisive firms, it is required that domination holds for each of the groups.

Finally, the solution concept is the core: *equilibrium market structures are the ones that are undominated.*

3 Trade liberalization and equilibrium market structure

Before proceeding, let π_i^s denote the total profit (sum of domestic and export profit) firm i earns under market structure s: $\pi_i^s = \sum_{z=H,F} \pi_{iz}^s$. Now, we are ready to state the following lemma that will be useful in determining the set of equilibrium market structures:

Lemma 1: *Suppose that $t_z < \bar{t}^I$ holds. Then, a single concentrative merger is always profitable: (i)* $\sum_{i=h,h'} \pi_i^N \geq \sum_{i=h,h'} \pi_i^\Phi$; *(ii)* $\sum_{i=f,f'} \pi_i^{NN} \geq \sum_{i=f,f'} \pi_i^N$; *(iii)* $\sum_{i=h,f} \pi_i^I > \sum_{i=h,f} \pi_i^\Phi$ *and (iv)* $\sum_{i=h',f'} \pi_i^{II} > \sum_{i=h',f'} \pi_i^I$.

Note that the above lemma provides support to the traditional merger literature under price competition since non-merged units always have incentives to merge. Using the above lemma and the definition of decisive firms, it is immediate to argue that the market structures $\langle \Phi \rangle$, $\langle N \rangle$, and $\langle I \rangle$ are dominated and thus they fail to arise in the equilibrium and $\langle NN \rangle$ and $\langle II \rangle$ remain the only candidates that can arise at the core. Thus, in determining the set of equilibrium market structures, the comparison between the market structures $\langle NN \rangle$ and $\langle II \rangle$ is taken as a base scenario in order to highlight the decisive forces in the merger formation process. Since there is only one decisive group comprising all four firms with respect to $\langle NN \rangle$ and $\langle II \rangle$, aggregate industry profits are compared. Let R_i^s denote the total revenue of firm i under market structure s. Then we can define the *relative attractiveness of national mergers* denoted by $g^{II \& NN}(t_H, t_F)$ as follows:[23]

$$g^{II \& NN}(t_H, t_F) = \sum_i R_i^{NN}(t_H, t_F) - t_H \sum_{i=f,f'} q_{iH}^{NN} - t_F \sum_{i=h,h'} q_{iF}^{NN} - \sum_i R_i^{II}(t_H = 0, t_F = 0)$$

(14)

Using the differentiation technique, the function in (14) evaluated at $(\widehat{t_H}, \widehat{t_F})$ can be be rewritten as follows:

---

[23]Naturally, $g^{II \& NN}(t_H = 0, t_F = 0) = 0$.

$$g^{II\&NN}(\widehat{t_H},\widehat{t_F}) = \int_0^{\widehat{t_H}}\sum_i\frac{\partial R_i^{NN}(t_H,t_F=0)}{\partial t_H}dt_H + \int_0^{\widehat{t_F}}\sum_i\frac{\partial R_i^{NN}(\widehat{t_H},t_F)}{\partial t_F}dt_F - \widehat{t_H}\sum_{i=f,f'}q_{iH}^{NN} - \widehat{t_F}\sum_{i=h,h'}q_{iF}^{NN}$$
$$(15)$$

The sign of $g^{II\&NN}(t_H,t_F)$ hinges on two distinct effects: the protection gain effect and the tariff saving effect. The former effect represents the anti-competitive impact of the trade policy that arises when firms are national units and is captured by the first two terms in (15). They simply measure the change in the national merger's aggregate profits net of tariff payment relative to a scenario where both countries practice free trade. Since trade policy reduces the degree of competition in the domestic market, it tends to make the industry profits under $\langle NN \rangle$ higher. On the other hand, the tariff saving effect is captured by the last two terms in (15). They create incentives for firms to merge internationally in order to avoid tariffs in the export markets. The balance between these two effects helps determine which of these market structures ($\langle NN \rangle$ or $\langle II \rangle$) would arise in the equilibrium. Here, it is important to emphasize the fact that the degree of product differentiation γ acts as an important determinant of the relative strengths of these two counteracting effects since it measures the intensity of competition in the product markets. Next, we examine the implication of unilateral trade liberalziation on the set of equilibrium market structures.

3.1 Unilateral trade liberalization

To examine the impact of unilateral home trade liberalization on the nature of mergers, we assume exogenous tariff levels (t_H and t_F), and then we lower home tariffs keeping foreign tariffs unchanged. To this end, we isolate two distinct trade policy regimes in the foreign country. First, consider a scenario where foreign country practices free trade.

3.1.1 Free trade abroad

When there is free trade in foreign country, the type of mergers arising in the core is only governed by the difference in aggregate profits in the home market and thus we focus on the first term and the third term in (15).

$$g^{II\&NN}(t_H,t_F=0) = \int_0^{t_H}\sum_i\frac{\partial R_i^{NN}(t_H,t_F=0)}{\partial t_H}dt_H - t_H\sum_{i=f,f'}q_{iH}^{NN} \qquad (16)$$

Figures 1a, 1b and 1c represent the behavior of $g^{II\&NN}(t_H,t_F=0)$ for three different degrees of product differentiation.[24] When products are sufficiently differentiated ($\gamma = \gamma_l$),

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[24]Hereafter, α is normalized to 1 in order to illustrate critical tariff and substitutability levels that determine the set of equilibrium market structures.

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$g^{II\&NN}(t_H, t_F = 0) < 0$ for all admissible t_h implying that the tariff saving effect dominates the protection gain leading to international mergers. The intuition can be explained as follows. When products are highly differentiated, firms already have high market power and the marginal benefit of tariff protection is small relative to tariff saving incentives. On the other hand, when γ is in the intermediate range ($\gamma = \gamma_m$), $g^{II\&NN}(t_H, t_F = 0)$ takes a U-shape and is positive only when home tariffs are sufficiently high. Therefore, the tariff saving effect dominates the protection gain effect unless home tariffs are very high: international mergers arise in the EMS when $t_H < \overline{t_H}$ holds while national mergers obtain when $t_H > \overline{t_H}$ holds. [25] Finally, when products are close substitutes ($\gamma = \gamma_h$), product market competition is severe and firms are close to the Bertrand paradox. Under such a situation, tariff protection provides rooms for national firms to enjoy profits in a highly competitive trade environment so that the protection gain dominates the tariff saving effect for a larger range of tariff levels ($\overline{t_H}$ declines).

- insert figures 1a, 1b, 1c here -

These observations about the behavior of $g^{II\&NN}(t_H, t_F = 0)$ provide the basis for figure 2 that plots the critical tariff level $t_H^{II\&NN}(\gamma)$ at which aggregate profits under $\langle NN \rangle$ and $\langle II \rangle$ are the same:

$$g^{II\&NN}(t_H = t_H^{II\&NN}(\gamma), t_F = 0) = 0 \tag{17}$$

where

$$t_H^{II\&NN}(\gamma) = \frac{4\alpha(3\gamma + 4)^2}{\gamma^2 \left[\gamma^2 + 10(\gamma + 1)\right] + 32(\gamma + 1)^2} \tag{18}$$

- insert figure 2 here -

The following proposition is immediate:

Proposition 1 *Suppose that foreign country practices free trade. Then, the following obtains: (i) when $\gamma < \gamma^{\min} \cong 5.88$ holds, $\langle II \rangle$ is the equilibrium market structure for all t_H ; (ii) when $\gamma \geq \gamma^{\min} \cong 5.88$ holds, $\langle II \rangle$ is the equilibrium market structure iff $t_H < t_H^{II\&NN}(\gamma)$ while national mergers ($\langle NN \rangle$) arise iff $t_H > t_H^{II\&NN}(\gamma)$.*

First, it is important to note from figure 2 and proposition 1 that the set of equilibrium market structures is non-empty for all non-prohibitive tariff levels irrespective of the degree of product differentiation. In that sense, the model is well-behaved. Second, as expected from the analysis above, $t^{II\&NN}(\gamma)$ is downward sloping in γ and there exists a lower limit $\gamma^{\min}$ below which international mergers arise for all t_H levels. More importantly, the above

---

[25] Norbäck and Persson (2004, 2005) show that the similar U-shape relationship obtains for bilateral trade liberalization under Cournot competition with a strictly concave demand. Note that under price competition, U-shape obtains only when γ takes intermediate values (otherwise, monotonicity obtains).

result provides support for the idea that when foreign country practices free trade, unilateral home trade liberalization increases the incentives of firms to form international mergers irrespective of the substitutability levels. What if foreign country practices very restrictive trade policy? Next, we examine this question.

3.1.2 Restrictive Trade Policy Abroad

Now suppose that foreign country imposes the highest possible non-prohibitive tariff level $t_F = \bar{t}^I$. Under such a scenario, the function $g^{II\&NN}(t_H, t_F = \bar{t}^I)$ can be rewritten as follows:

$$g^{II\&NN}(t_H, t_F = \bar{t}^I) = g^{II\&NN}(t_H, t_F = 0) + \int_0^{\bar{t}^I} \sum_i \frac{\partial R_i^{NN}(t_H, t_F)}{\partial t_F} dt_F - \bar{t}^I \sum_{i=h,h'} q_{iF}^{NN} \quad (19)$$

Note that since t_F is sufficiently high, product market in foreign country approaches to a foreign firm monopoly under $\langle NN \rangle$. As discussed above, when products are sufficiently differentiated ($\gamma = \gamma_l$), firms' benefits from tariff protection is limited. On the other hand, relative to the case of free trade in foreign country, the tariff saving effect gets more pronounced when $t_F = \bar{t}^I$ and thus $g^{II\&NN}(t_H, t_F = \bar{t}^I) < g^{II\&NN}(t_H, t_F = 0)$ obtains (see figure 3a). As a result, $\langle II \rangle$ arises in the equilibrium for all t_H when products are sufficiently differentiated.

- insert figures 3a, 3b, 3c here -

When γ gets higher, the degree of product market competition and the existence of high tariffs in foreign country tip the balance more in favor of protection gain. As a result, $g^{II\&NN}(t_H, t_F = 0)$ shifts upward making national mergers more likely to arise as the equilibrium market structure. More specifically, when $\gamma = \gamma_m$, $g^{II\&NN}(t_H, t_F = \bar{t}^I)$ takes a U-shape yielding two critical home tariffs $\underline{t_H^{II\&NN}}(\gamma)$ and $\overline{t_H^{II\&NN}}(\gamma)$ (see figure 3b): $g^{II\&NN}(t_H, t_F = \bar{t}^I) \geq 0$ if either (i) $t_H \leq \underline{t_H^{II\&NN}}(\gamma)$ or (ii) $t_H \geq \overline{t_H^{II\&NN}}(\gamma)$ holds. Intuitively, when t_H is very low, home firms are ready to transfer a larger share of profits to foreign firms in order to form an international merger. However, as t_H falls below $\underline{t_H^{II\&NN}}(\gamma)$, it is not possible for home firms to convince foreign firms to engage in an international merger since the difference between the protection gain effect and the tariff saving effect for foreign firms is greater than what home firms are able to offer. On the other hand, when t_H exceeds $\overline{t_H^{II\&NN}}(\gamma)$, protectionist trade environment leads to national mergers due to merged firms' monopoly power in their own markets.

Finally, product markets are highly competitive when products are close substitutes ($\gamma = \gamma_h$) and thus regardless of home tariff levels it is impossible to attract foreign firms

in forming an international merger: $g^{II\&NN}(t_H, t_F = \bar{t}^I) \geq 0$ for all t_H (see figure 3c). The following proposition summarizes the above discussion and illustrated in figure 4:

Proposition 2 *Suppose that $t_F = \bar{t}^I$. Then, the following obtains: (i) when $\gamma < \gamma^{\min} \cong$ 5.88, $\langle II \rangle$ is the equilibrium market structure for all t_H; (ii) when $\gamma^{\max} \cong 8.06 > \gamma \geq \gamma^{\min} \cong 5.88$, $\langle II \rangle$ is the equilibrium market structure if $\overline{t_H^{II\&NN}(\gamma)} > t_H > \underline{t_H^{II\&NN}(\gamma)}$ holds; (iii) when $\gamma^{\max} \cong 8.06 \geq \gamma \geq \gamma^{\min} \cong 5.88$, $\langle NN \rangle$ is the equilibrium market structure if either $t_H < \underline{t_H^{II\&NN}(\gamma)}$ or $t_H > \overline{t_H^{II\&NN}(\gamma)}$ holds and (iv) when $\gamma > \gamma^{\max} \cong 8.06$, $\langle NN \rangle$ is the equilibrium market structure for all t_H.*

- insert Figure 4 here -

Combining proposition 1 and proposition 2 we argue that when products are highly differentiated, international mergers emerge in the set of EMS irrespective of trade policy regimes abroad. By contrast, when products are close substitutes and home tariff falls below certain treshold, reversal of trade policy abroad from free trade to a protectionist regime shifts the nature of equilibrium mergers from an international one to a national one.

Given the discussion above, it is natural to ask: what are the implications of bilateral trade liberalization on nature of mergers? We examine this question next.

3.2 Bilateral trade liberalization

The effects of bilateral trade liberalization on the set of equilibrium market structures is examined by assuming a common exogenous tariff level ($t_H = t_F = t$) in both countries and lowering it. The relative gain from national mergers is found as follows:

$$g^{II\&NN}(t) = \int_0^t \sum_i \frac{\partial R_i^{NN}(t)}{\partial t} dt - t \left[\sum_{i=f,f'} q_{iH}^{NN} + \sum_{i=h,h'} q_{iF}^{NN} \right] \tag{20}$$

It is immediate from (16) and (20) that $g^{II\&NN}(t) = 2g^{II\&NN}(t_H = t, t_F = 0)$. Consequently, $g^{II\&NN}(t)$ behaves the same way as $g^{II\&NN}(t_H, t_F = 0)$ illustrated in figure 1a, 1b and 1c. To save space, we show the equilibrium market structures for different t and γ levels in figure 5. Note from figure 5 that there exists no equilibrium market structure only when γ is at the intermediate range and t is very high. The intransitivity of the dominance relation leads to this non-existence problem. It is shown in the appendix that over the given region $\langle NN \rangle$ dominates all other market structures except for $\langle I \rangle$ which, in turn, is dominated by $\langle II \rangle$ for all t and γ levels (see Lemma 1).

- insert figure 5 here -

The following proposition is immediate:

Proposition 3 *Suppose that* $t_H = t_F = t$. *Then, the following obtains: (i) when* $\gamma < \gamma^{\min} \cong 5.88$ *holds,* $\langle II \rangle$ *is the equilibrium market structure for all* t; *(ii) when* $\gamma \geq \gamma^{\min} \cong 5.88$ *holds,* $\langle II \rangle$ *is the equilibrium market structure iff* $t < t^{II\&NN}(\gamma)$ *while national mergers (* $\langle NN \rangle$ *) arise iff* $t^{I\&NN}(\gamma) > t > t^{II\&NN}(\gamma)$ *and (iii) there is no EMS iff* $t > \max\{t^{I\&NN}(\gamma), t^{II\&NN}(\gamma)\}$.

The above result complements and improves the main findings by Horn and Persson (2001b) in two important ways. First, note that the set of EMS is empty under their benchmark trade cost saving model when $t < \frac{1}{15}$ holds and this can be interpreted as follows: when bilateral tariffs fall below a certain treshold, Horn and Persson (2001b) has no ability to conjecture an equilibrium market structure. On the contrary, we find that international mergers obtain over the same range of tariffs. The choice of price as a basic strategic variable instead of quantity overcomes this problem since every concentrative merger is profitable under price competition and there is no trivial elimination of concentrated market structures. Second, unlike us, Horn and Persson (2001b) does not exclude the prohibitive trade cost levels. When trade costs are at prohibitive levels, firms enjoy very high market power (monopoly power if nationally merged) in the domestic market and thus national ownership structures necessarily arise in the equilibrium. However, once the prohibitive trade costs are excluded in their model, the only surviving equilibrium market structure is the one with international mergers. The present paper argues that a market structure with national mergers emerges in equilibrium even under non-prohibitive tariff levels.

Finally, the above proposition fits well with the fact that global trade liberalization has been accompanied by an increase in cross border merger activities. One point deserves an attention: when products are close substitutes, we obtain national mergers in the equilibrium for sufficiently high tariffs. This result seems to provide an opposite intuition to the *tariff-jumping* argument in the existing FDI literature. However note that the tariff-jumping argument is made for a single firm by focusing on only two alternative modes of entry: export versus FDI. Unlike the present paper, these two alternatives are compared in the export market when the degree of market concentration remains the same. Moreover, FDI occurs via an international merger in oor model and all decisive firms involved in the merger formation process benefit from tariff saving and lose from tariff protection in their domestic markets. By contrast, under a greenfield entry, firms investing in the foreign country directly enjoy tariff saving without losing their gains from protection in the domestic market.

4 Welfare Implications and Merger Policy

We continue assuming a common exogenous tariff level ($t_H = t_F = t$) in both countries, and ask the following question: are the above equilibrium market structures the ones that are preferable from a welfare point of view? Focusing on home country, aggregate welfare under market structure s (denoted by w_H^s) is defined as the sum of its consumer surplus (CS_H^s), total profits earned by its firms in both markets (PS_H^s) and tariff revenue under the given market structures:

$$
w_H^s = \underbrace{\frac{\sum_i (\alpha_i - p_{iH}^s) q_{iH}^s}{2}}_{CS_H^s} + \underbrace{\sum_{i=h,h'} \pi_i^s}_{PS_H^s} + t_H \underbrace{\sum_{i=f,f'} q_{iH}^s}_{TR_H^s}, \text{ where } s = \langle \Phi \rangle, \langle N \rangle \text{ and } \langle NN \rangle \tag{21}
$$

$$
w_H^I = \underbrace{\frac{\sum_i (\alpha_i - p_{iH}^I) q_{iH}^I}{2}}_{CS_H^I} + \underbrace{\sum_{i=h,h'} \pi_i^I}_{PS_H^I} + \underbrace{t_H q_{f'H}^I}_{TR_H^I} \tag{22}
$$

and

$$
w_H^{II} = \underbrace{\frac{\sum_i (\alpha_i - p_{iH}^{II}) q_{iH}^{II}}{2}}_{CS_H^{II}} + \underbrace{\sum_{i=h,h'} \pi_i^{II}}_{PS_H^{II}} \tag{23}
$$

Even though no specific payoff division in any merger is assumed, from a welfare point of view it is reasonable to assume that profits are evenly divided between the merging firms since the feasible market structures are completely symmetric when $t_H = t_F = t$. We identify three main forces determining the welfare ranking of different market structures. First, as in the closed economy, there is a standard trade-off between the effects of market concentration on consumer and producer welfare. In the open economy, part of the cost of domestic concentration is transmitted to foreign consumers. Second, own tariffs protect national firms in the domestic country whereas foreign tariffs punish them in the export market and consumer welfare decreases in tariffs. Note that this second source of tension vanishes completely under a duopoly with two international mergers and partially under a triopoly with one international merger. Finally, under asymmetric market structures ($\langle N \rangle$ and $\langle N' \rangle$), a merger confers a large positive externality (free rider effect) on competing firms. The degree of the free rider effect can be measured as the amount by which the profits of a non-merging firm increase when a merger happens. As in Davidson and Deneckere (1985), the free rider effect of a merger is so strong that the profits of non-merging firms exceed those

of the merged unit: $\sum_{i=f,f'} \pi_i^N \geq \sum_{i=h,h'} \pi_i^N$ and $\sum_{i=h,h'} \pi_i^{N'} \geq \sum_{i=f,f'} \pi_i^{N'}$. Based on this discussion, figure 6 illustrates the pattern of the most preferred market structures for different tariff and substitutability levels.

- insert figure 6 -

First, we consider a scenario where the tariff levels are relatively low. Under such an environment, the anti-competitive effect of trade policy on consumer and producer welfare does not play a major role from a welfare point of view. Moreover, when products are sufficiently differentiated, the free rider effect under asymmetric market structures is not very strong too. Then, the most important concern is the anti-competitive effect of market concentration on consumer and producer welfare. Therefore, as might be expected, the least concentrated market structure $\langle \Phi \rangle$ is the most preferred market structure when products are highly differentiated. However, when products are close substitutes, there is a severe competition among firms so that the free rider effect of a foreign merger to home competing firms tips the balance in favor of $\langle N' \rangle$.

Now consider a relatively more protectionist regime where the tariff saving feature of international mergers gets more pronounced as do the anti-competitive effects of the trade policy on consumer welfare. For intermediate range of tariff levels, $\langle I \rangle$ arises as the most preferred market structure. When trade policy is very restrictive, the duopoly with two international mergers $\langle II \rangle$ is the most preferred market structure for all substitutability levels. Note that even though consumers lose from concentration and there is no tariff revenue, the tariff saving feature under international mergers dominates the other counteracting effects.

Among equilibrium market structures ($\langle NN \rangle$ and $\langle II \rangle$), which one is more preferable from a welfare point of view? The following result is immediate:

Proposition 4 *Under symmetric tariffs ($t_H = t_F = t$), the duopoly with two international mergers $\langle II \rangle$ yields higher national (as well as world) welfare relative to the duopoly with two national mergers $\langle NN \rangle$ for all t and γ.*

In the present paper, we assume that the competition authority in each government allows two firm mergers. Thus, firms' incentives to merge determine the set of equilibrium market structures in our model. Welfare of home country under $\langle NN \rangle$ can be rewritten as follows:

$$w_H^{NN} = w_H^{II} + \int \frac{\partial CS_H^{NN}(t)}{\partial t} dt + \int \frac{\partial PS_H^{NN}(t)}{\partial t} dt - t(\sum_{i=h,h'} q_{iF}^{NN} - \sum_{i=f,f'} q_{iH}^{NN}) \qquad (24)$$

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Note from a complete symmetry under $\langle NN \rangle$ and $\langle II \rangle$ that the last term equals zero since the tariff payments and tariff revenue are identical. Then, the comparison of home country's welfare under $\langle NN \rangle$ and $\langle II \rangle$ is reduced to the following:

$$w_H^{NN} - w_H^{II} = \int \frac{\partial CS_H^{NN}(t)}{\partial t} dt + \int \frac{\partial PS_H^{NN}(t)}{\partial t} dt \tag{25}$$

The first term in (25) measures the fall in consumer welfare due to tariffs relative to free trade. Thus, the first term has a negative sign. The second term, on the other hand, measures the change in aggregate profits net of tariff payment relative to a situation in which both countries practice free trade and has a positive sign unless products are very highly differentiated. Thus, the welfare ranking of equilibrium market structures depends on the balance between the anti-competitive effect of the trade protection on consumer and producer welfare. Given our modeling specifications, we show in the appendix that the former effect dominates the latter and $\langle II \rangle$ is welfare-preferred to $\langle NN \rangle$ for all t and γ. Note also that analogous results apply for the world welfare due to complete symmetry.

The above welfare analysis points out that there is a scope for welfare-enhancing merger policies. Along the line of the literature investigating international linkages between trade and merger policies, Proposition 3 and Proposition 4 together imply that competition authorities have less incentive to block mergers as trade gets liberalized: *trade liberalization induces more international mergers that are preferable to national mergers from a welfare perspective.* In other words, social and private incentives converge to each other as trade gets bilaterally liberalized.

Next, we examine the equilibrium market structures under optimal tariff levels. To this end, we add an additional stage to our original game in order to endogenize trade policy.

5   Equilibrium under optimum tariffs

Thus far, our analysis does not recognize the fact that trade policy in each country may respond to changes in market structure. To allow for this interaction, consider the following game. In the first stage, firm owners decide on the merger formation so that industry structure is determined. Next, each country chooses a specific tariff on imports. Finally, firms compete in prices in the product market. Solving the game backwards, we have the same product market equilibrium as a function of tariffs and market structure as before. It is obvious in our model that there exist no tariffs under a duopoly with two international mergers $\langle II \rangle$ and under the remaining market structures, each country chooses its optimum tariff to maximize its welfare:

$$\max_{t_H^s} w_H^s = \underbrace{\frac{\sum_i (\alpha_i - p_{iH}^s) q_{iH}^s}{2}}_{CS_H^s} + \underbrace{\sum_{i=h,h'} \pi_i^s}_{PS_H^s} + \underbrace{t_H^s \sum_{i=f,f'} q_{iH}^s}_{TR_H^s}, \text{ where } s = \langle \Phi \rangle, \langle N \rangle \text{ and } \langle NN \rangle \quad (26)$$

$$\max_{t_H^I} w_H^I = \underbrace{\frac{\sum_i (\alpha_i - p_{iH}^I) q_{iH}^I}{2}}_{CS_H^I} + \underbrace{\sum_{i=h,h'} \pi_i^I}_{PS_H^I} + \underbrace{t_H q_{f'H}^I}_{TR_H^I} \quad (27)$$

The solution to the above problem yields the following optimum tariffs:

$$
\begin{aligned}
t_H^\Phi &= t_F^\Phi = \frac{8\alpha(\gamma+1)}{3\gamma^2 + 26\gamma + 24}; t_H^{NN} = t_F^{NN} = \frac{4\alpha(\gamma+1)}{\gamma^2 + 12\gamma + 12} \\
t_H^N &= t_F^{N'} = \frac{2\alpha \left[13\gamma^2(\gamma+6) + 64(2\gamma+1) \right]}{7\gamma^4 + 122\gamma^3 + 536\gamma^2 + 800\gamma + 384} \\
t_H^{N'} &= t_F^N = \frac{2\alpha \left[39\gamma^2(\gamma+2) + 120(\gamma+1)^2 + 8(6\gamma+1) \right]}{27\gamma^4 + 340\gamma^3 + 1276\gamma^2 + 1728\gamma + 768} \\
t_H^I &= t_F^I = \frac{16\alpha(\gamma+1)(3\gamma+4)}{31\gamma^3 + 224\gamma^2 + 384\gamma + 192}
\end{aligned}
$$

The tariff ranking shows that optimum tariffs rise as the market gets more concentrated nationally while they decrease in the number of international mergers. This result argues that the interaction between the optimum tariffs and the industry concentration depends on the nature of the mergers (national or international). Unlike national mergers, foreign firms share the benefits from home protection in an international merger and this reduces the incentives to impose tariffs. Two immediate questions arise: when countries can respond to mergers via optimal tariffs, what is the set of equilibrium market structures? and among these market structures, which are the ones that are preferred from a welfare point of view?

Proposition 5 *When tariffs are endogenously chosen, the following obtains: i-) the duopoly with two international mergers ($\langle II \rangle$) is the equilibrium market structure if $\gamma < 8.72$; ii-) the duopoly with two national mergers ($\langle NN \rangle$) is the equilibrium market structure if $\gamma > 8.72$; iii-) the duopoly with two international mergers ($\langle II \rangle$) is the most preferred market structure from a welfare point of view for all γ.*

In terms of equilibrium market structures, optimal trade policy regime yields results similar to those obtained in our analysis of unilateral and bilateral trade liberalization. The first two parts of proposition 5 states that the protection gain dominates the tariff saving when products are close substitutes while the opposite obtains when products are sufficiently differentiated. Part (iii) of the above proposition argues that whether welfare

superior market structure arises under endogenous tariffs depends on the degree of product differentiation. When products are close substitutes, optimal trade policy responses result in the least desired market structure ($\langle NN \rangle$) as the equilibrium market structure. When the products are sufficiently differentiated, private and social incentives tend to move together.

6   Conclusion

Using a model of endogenous merger formation, we examine the international linkages between the nature of mergers and tariff levels. By linking tariff levels and merger incentives, we aim at providing an explanation for the dominance of international mergers within the largest ever merger movement the world economy has experienced over the last three decades. Within the same framework, we focus on the merger policy implications of unilateral and bilateral trade liberalization as well.

In the merger formation process, we show that two effects play key roles: protection gain and tariff saving. The former effect represents the anti-competitive impact of trade policy that arises when firms are national whereas the latter captures the incentives to avoid tariffs via an international merger. An analysis of these two effects shows that the tariff level and the degree of product differentiation together create a trade-off between the relative attractiveness of national and international mergers.

Focusing on unilateral trade liberalization, we first show that lowering home tariffs leads to international mergers irrespective of the substitutability levels when foreign country practices free trade. By contrast, when foreign tariffs are sufficiently high and products are close substitutes, national mergers arises in the equilibrium. Therefore, the implications of unilateral trade liberalization on the equilibrium market structure depends on the trade regime in foreign country especially when products are close substitutes.

Our main result in the paper provides an opposite intuition to the tariff-jumping argument in the existing FDI literature: when bilateral tariffs are sufficiently low, the equilibrium market structure involves international mergers only. This result fits well with the fact that global trade liberalization has been accompanied by an increase in cross border merger activities. More complete analysis would also involve greenfield entry as a mode of entry. We leave this for future research.

Furthermore, from a welfare perspective, we show that international mergers are preferable to national mergers due to the fact that they help avoid deadweight loss of tariffs. Consequently, social and private incentives become aligned together as trade gets liberalized. This result provides support for the idea that there is scope for welfare-enhancing merger policies under a more liberal trade environment.

Following trade liberalization, other aspects of economic policy that are not harmonized

have begun to receive more attention. The reduction in tariff rates has raised the issue of harmonization of competition policies. In policy making, national mergers are often viewed differently from cross-border mergers. Even though this study does not model harmonization explicitly, it can be captured simply through different fixed regulation fees imposed on national and international mergers. We intend to pursue this in future research.

7 Appendix

Profit levels

The following profit levels are used to prove the lemma and propositions. Note that profit levels under common tariff can be found easily by assuming $t_H = t_F = t$.

Under $\langle \Phi \rangle$:

$$
\pi_{hH}^{\Phi} = (3\gamma + 4) \left[\frac{2\alpha(7\gamma + 8) + t_H \gamma(3\gamma + 4)}{2(3\gamma + 8)(7\gamma + 8)} \right]^2
$$

$$
\pi_{hF}^{\Phi} = (3\gamma + 4) \left[\frac{2\alpha(7\gamma + 8) - t_F(3\gamma^2 + 18\gamma + 16)}{2(3\gamma + 8)(7\gamma + 8)} \right]^2
$$

Under $\langle N \rangle$:

$$
\sum_{i=h,h'} \pi_{iH}^{N} = (\gamma + 2) \left[\frac{2\alpha(7\gamma + 8) + t_H \gamma(3\gamma + 4)}{8(2\gamma^2 + 9\gamma + 8)} \right]^2
$$

$$
\sum_{i=h,h'} \pi_{iH}^{N} = (\gamma + 2) \left[\frac{2\alpha(7\gamma + 8) - t_F(3\gamma^2 + 18\gamma + 16)}{8(2\gamma^2 + 9\gamma + 8)} \right]^2
$$

$$
\pi_{fH}^{N} = (3\gamma + 4) \left[\frac{2\alpha(3\gamma + 4) - t_H(\gamma^2 + 8\gamma + 8)}{8(2\gamma^2 + 9\gamma + 8)} \right]^2
$$

$$
\pi_{fF}^{N} = (3\gamma + 4) \left[\frac{2\alpha(3\gamma + 4) + \gamma t_F(\gamma + 2)}{8(2\gamma^2 + 9\gamma + 8)} \right]^2
$$

Under $\langle I \rangle$:

$$
\sum_{i=h,f} \pi_{iH}^{I} = (\gamma + 2) \left[\frac{4\alpha(7\gamma + 8) + t_H \gamma(3\gamma + 4)}{16(2\gamma^2 + 9\gamma + 8)} \right]^2
$$

$$
\sum_{i=h,f} \pi_{iF}^{I} = (\gamma + 2) \left[\frac{4\alpha(7\gamma + 8) + t_F \gamma(3\gamma + 4)}{16(2\gamma^2 + 9\gamma + 8)} \right]^2
$$

$$
\pi_{h'H}^{I} = (3\gamma + 4)^3 \left[\frac{4\alpha(7\gamma + 8) + t_H \gamma(3\gamma + 4)}{16(2\gamma^2 + 9\gamma + 8)(7\gamma + 8)} \right]^2
$$

$$
\pi_{h'F}^{I} = (3\gamma + 4) \left[\frac{4\alpha(3\gamma + 4)(7\gamma + 8) - t_F(23\gamma^3 + 152\gamma^2 + 256\gamma + 128)}{16(2\gamma^2 + 9\gamma + 8)(7\gamma + 8)} \right]^2
$$

Under $\langle NN \rangle$:

$$\sum_{i=h,h'} \pi_{iH}^N = (\gamma + 2) \left[\frac{2\alpha(3\gamma + 4) + t_H\gamma(\gamma + 2)}{2(\gamma + 4)(3\gamma + 4)} \right]^2$$

$$\sum_{i=h,h'} \pi_{iF}^{NN} = (\gamma + 2) \left[\frac{2\alpha(3\gamma + 4) - t_F(\gamma^2 + 8\gamma + 8)}{2(\gamma + 4)(3\gamma + 4)} \right]^2$$

Under $\langle II \rangle$:

$$\sum_{i=h,f} \pi_{iH}^I = \sum_{i=h,f} \pi_{iF}^I = \frac{\alpha^2(\gamma + 2)}{(\gamma + 4)^2}$$

Proof of Lemma 1

Using the above profit levels, the proof of the lemma is immediate. Let $\Omega = \frac{\gamma^2(57\gamma^3 + 274\gamma^2 + 352\gamma + 128)}{[8(2\gamma^2 + 9\gamma + 8)(3\gamma + 8)(7\gamma + 8)]^2}$, $\Psi = \frac{\gamma^2(5\gamma^3 + 28\gamma^2 + 40\gamma + 16)}{32[(2\gamma^2 + 9\gamma + 8)(\gamma + 4)(3\gamma + 4)]^2}$ Then,

$$\sum_{i=h,h'} \pi_i^N - \sum_{i=h,h'} \pi_i^\Phi = \Omega \left[[2\alpha(7\gamma + 8) + t_H\gamma(3\gamma + 4)]^2 + [2\alpha(7\gamma + 8) - t_F(3\gamma^2 + 18\gamma + 16)]^2 \right] \geq 0$$

where equality holds only when $\gamma = 0$.

$$\sum_{i=f,f'} \pi_i^{NN} - \sum_{i=f,f'} \pi_i^N = \Psi \left[[2\alpha(3\gamma + 4) - t_H(\gamma^2 + 8\gamma + 8)]^2 + [2\alpha(3\gamma + 4) + t_F\gamma(\gamma + 2)]^2 \right] \geq 0$$

where equality holds only when $\gamma = 0$.

$$\sum_{i=h,f} \pi_i^I - \sum_{i=h,f} \pi_i^\Phi = \sum_{z=H,F} (\gamma + 2) \left[\frac{4\alpha(7\gamma + 8) + t_z\gamma(3\gamma + 4)}{16(2\gamma^2 + 9\gamma + 8)} \right]^2 - (3\gamma + 4) \sum_{z=H,F} \left[\frac{2\alpha(7\gamma + 8) + t_z\gamma(3\gamma + 4}{2(3\gamma + 8)(7\gamma + 8)} \right.$$

$$(3\gamma + 4) \sum_{z=H,F} \left[\frac{2\alpha(7\gamma + 8) - t_z(3\gamma^2 + 18\gamma + 16)}{2(3\gamma + 8)(7\gamma + 8)} \right]^2$$

Finally,

$$\sum_{i=h',f'} \pi_i^{II} - \sum_{i=h',f'} \pi_i^I = \frac{2\alpha^2(\gamma + 2)}{(\gamma + 4)^2} - (3\gamma + 4)^3 \sum_{z=H,F} \left[\frac{4\alpha(7\gamma + 8) + t_z\gamma(3\gamma + 4)}{16(2\gamma^2 + 9\gamma + 8)(7\gamma + 8)} \right]^2$$

$$-(3\gamma + 4) \sum_{z=H,F} \left[\frac{4\alpha(3\gamma + 4)(7\gamma + 8) - t_z(23\gamma^2(\gamma + 1) + \gamma^2 + 128(\gamma + 1)^2)}{16(2\gamma^2 + 9\gamma + 8)(7\gamma + 8)} \right]^2$$

Note that $\sum_{i=h,f} \pi_i^I - \sum_{i=h,f} \pi_i^\Phi > 0$ and $\sum_{i=h',f'} \pi_i^{II} - \sum_{i=h',f'} \pi_i^I$ since $t_z < \bar{t}^I$.

Figures 2a, 2b, 2c and 3 and proof of proposition 1

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Given Lemma 1, market structures $\langle\Phi\rangle$, $\langle N\rangle$, and $\langle I\rangle$ are dominated and thus they are not in the set of EMS. Therefore, our focus is on $\langle NN\rangle$ and $\langle II\rangle$. Since the dominance relation is one sided, it is sufficient to show that $\langle NN\rangle$ and $\langle II\rangle$ dominate all other market structures over the specified range of t_H and γ.

(a) $\langle II\rangle$ & $\langle\Phi\rangle$: There are two completely symmetric groups of decisive firms. It is easy to verify that $\pi_{13}^{II} > \pi_1^O + \pi_3^O$ and $\pi_{24}^{II} > \pi_2^O + \pi_4^O$ hold for all t_H and γ since $t_H < \bar{t}^I$

(b) $\langle II\rangle$ & $\langle N\rangle$: The decisive group comprises all owners. Therefore, we compare total industry profits under these two market structures and find that (i) $\langle II\rangle$ dominates $\langle N\rangle$ if $\gamma \le 20.8$ for all t_H; (ii) $\langle II\rangle$ dominates $\langle N\rangle$ if $\gamma > 20.8$ and $t_H < t_H^{II\&N}(\gamma)$ hold; (iii) $\langle N\rangle$ dominates $\langle II\rangle$ if $\gamma > 20.8$ and $t_H^{II\&N}(\gamma) < t_H < \bar{t}^I$ hold.

(c) $\langle II\rangle$ & $\langle N'\rangle$: The decisive group comprises all owners. Therefore, we compare total industry profits under these two market structures and find that $\langle II\rangle$ dominates $\langle N'\rangle$ for all t_H and γ.

(d) $\langle II\rangle$ & $\langle I\rangle$: It is immediate from Lemma 1 that $\langle II\rangle$ dominates $\langle I\rangle$ for all t_H and γ.

(e) $\langle II\rangle$ and $\langle NN\rangle$: The decisive group comprises all owners. Therefore, we compare total industry profits under these two market structures and find that (i) $\langle II\rangle$ dominates $\langle NN\rangle$ if $\gamma \le 5.88$ for all t_H; (ii) $\langle II\rangle$ dominates $\langle NN\rangle$ if $\gamma > 5.88$ and $t_H < t^{II\&NN}(\gamma)$ hold; (iii) $\langle NN\rangle$ dominates $\langle II\rangle$ if $\gamma > 5.88$ and $t^{II\&NN}(\gamma) < t_H < \bar{t}^I$ hold where

$$t^{II\&NN}(\gamma) = \frac{4\alpha(3\gamma + 4)^2}{\gamma^2\left[\gamma^2 + 10(\gamma + 1)\right] + 32(\gamma + 1)^2} \tag{28}$$

Since $t^{II\&NN}(\gamma) \le t_H^{II\&N}(\gamma)$ for all γ, combining (a), (b), (c), (d), (e) we find that $\langle II\rangle$ is the EMS when (i) $\gamma \le 5.88$ for all t_H or (ii) $\gamma > 5.88$ and $t_H < t^{II\&NN}(\gamma)$ hold.

We apply the same procedure for $\langle NN\rangle$:

(f) $\langle NN\rangle$ & $\langle\Phi\rangle$: There are two completely symmetric groups of decisive firms. It is easy to verify that $\pi_{12}^{NN} > \pi_1^O + \pi_2^O$ and $\pi_{34}^{NN} > \pi_3^O + \pi_4^O$ hold for all t_H and γ when $t_H < \bar{t}^I$.

(g) $\langle NN\rangle$ & $\langle N\rangle$ and $\langle NN\rangle$ & $\langle N'\rangle$: It is immediate from Lemma 1 that $\langle NN\rangle$ dominates both $\langle N\rangle$ and $\langle N'\rangle$ for all t_H and γ.

(h) $\langle NN\rangle$ & $\langle I\rangle$: The decisive group comprises all owners. Therefore, we compare total industry profits under these two market structures and find that $\langle NN\rangle$ dominates $\langle I\rangle$ for all t_H and γ.

Combining (e), (f), (g), (h), we find that $\langle NN\rangle$ is the EMS when $\gamma > 5.88$ and $t_H > t^{II\&NN}(\gamma)$ hold. This completes our proof.

Figures 4a, 4b, 4c and 5 and proof of proposition 2

The same procedure is applied as above:

(a) $\langle II\rangle$ & $\langle\Phi\rangle$: There are two completely symmetric groups of decisive firms. We find that (i) $\langle II\rangle$ dominates $\langle\Phi\rangle$ if $\gamma < 18.02$ for all t_H;

(ii) $\langle II \rangle$ dominates $\langle \Phi \rangle$ if $\gamma > 18.02$ for all $t_H < t_H^{II\&O}(\gamma)$ and (iii) $\langle \Phi \rangle$ dominates $\langle II \rangle$ if $\gamma > 18.02$ and $t_H^{II\&O}(\gamma) < t_H < \bar{t}^I$ hold.

(b) $\langle II \rangle$ & $\langle N \rangle$: The decisive group comprises all owners. Comparing industry profits, we find that (i) $\langle II \rangle$ dominates $\langle N \rangle$ if $\gamma < 8.66$ for all t_H; (ii) $\langle II \rangle$ dominates $\langle N \rangle$ if $\gamma > 8.66$ for all $t_H < t_H^{II\&N}$ and (iii) $\langle N \rangle$ dominates $\langle II \rangle$ if $\gamma > 8.66$ and $t_H^{II\&N} < t_H < \bar{t}^I$ hold.

(c) $\langle II \rangle$ & $\langle I \rangle$: It is immediate from Lemma 1 that $\langle II \rangle$ dominates $\langle I \rangle$ for all t_H and γ.

(d) $\langle II \rangle$ and $\langle NN \rangle$: The decisive group comprises all owners. Therefore, we compare total industry profits under these two market structures and find that (i) $\langle II \rangle$ dominates $\langle NN \rangle$ if $\gamma \leq \gamma^{\min} \cong 5.88$ for all t_H; (ii) $\langle II \rangle$ dominates $\langle NN \rangle$ if $\gamma^{\max} \cong 8.06 > \gamma \geq \gamma^{\min} \cong 5.88$ and $\overline{t_H^{II\&NN}(\gamma)} > t_H > \underline{t_H^{II\&NN}(\gamma)}$ hold; (iii) $\langle NN \rangle$ dominates $\langle II \rangle$ if $\gamma^{\max} \cong 8.06 > \gamma \geq \gamma^{\min} \cong 5.88$ and $\overline{t_H^{II\&NN}(\gamma)} < t_H < \bar{t}^I$ hold. Note that $\overline{t_H^{II\&NN}(\gamma)}$ and $\underline{t_H^{II\&NN}(\gamma)}$ are critical tariff levels that equate the industry profits under $\langle II \rangle$ and $\langle NN \rangle$.

Combining (a), (b), (c) and (d), we find that $\langle II \rangle$ is the EMS (i) for all t_H when $\gamma < \gamma^{\min} \cong 5.88$ holds and (ii) if $\gamma^{\max} \cong 8.06 > \gamma \geq \gamma^{\min} \cong 5.88$ and $\overline{t_H^{II\&NN}(\gamma)} > t_H > \underline{t_H^{II\&NN}(\gamma)}$ hold. Now consider $\langle NN \rangle$.

(e) $\langle NN \rangle$ & $\langle \Phi \rangle$: There are two completely symmetric groups of decisive firms. We find that $\langle NN \rangle$ dominates $\langle \Phi \rangle$ for all t_H and γ:

(f) $\langle NN \rangle$ & $\langle N \rangle$ and $\langle NN \rangle$ & $\langle N' \rangle$: It is immediate from Lemma 1 that $\langle NN \rangle$ dominates both $\langle N \rangle$ and $\langle N' \rangle$ for all t_H and γ.

(g) $\langle NN \rangle$ & $\langle I \rangle$: The decisive group comprises all owners. Comparing industry profits, we find that $\langle NN \rangle$ dominates $\langle I \rangle$ for all t_H and γ. This completes our proof.

Figure 5 and proof of proposition 3

(a) $\langle II \rangle$ & $\langle \Phi \rangle$: There are two completely symmetric groups of decisive firms. We find that (i) $\langle II \rangle$ dominates $\langle \Phi \rangle$ if $\gamma < 18.02$ for all t;

(ii) $\langle II \rangle$ dominates $\langle \Phi \rangle$ if $\gamma > 18.02$ for all $t < t^{II\&O}(\gamma)$ and (iii) $\langle \Phi \rangle$ dominates $\langle II \rangle$ if $\gamma > 18.02$ and $t^{II\&O}(\gamma) < t < \bar{t}^I$ hold.

(b) $\langle II \rangle$ & $\langle N \rangle$ and $\langle II \rangle$ & $\langle N' \rangle$: The decisive group comprises all owners. Comparing industry profits, we find that (i) $\langle II \rangle$ dominates $\langle N \rangle$ if $\gamma < 8.66$ for all t; (ii) $\langle II \rangle$ dominates $\langle N \rangle$ if $\gamma > 8.66$ for all $t < t^{II\&N}$ and (iii) $\langle N \rangle$ dominates $\langle II \rangle$ if $\gamma > 8.66$ and $t^{II\&N} < t < \bar{t}^I$ hold.

(c) $\langle II \rangle$ & $\langle I \rangle$: It is immediate from Lemma 1 that $\langle II \rangle$ dominates $\langle I \rangle$ for all t and γ.

(d) $\langle II \rangle$ & $\langle NN \rangle$: The decisive group comprises all owners. Comparing total industry profits under these two market structures, we find that (i) $\langle II \rangle$ dominates $\langle NN \rangle$ if $\gamma \leq 5.88$ for all t; (ii) $\langle II \rangle$ dominates $\langle NN \rangle$ if $\gamma > 5.88$ and $t < t^{II\&NN}(\gamma)$ hold; (iii) $\langle NN \rangle$ dominates $\langle II \rangle$ if $\gamma > 5.88$ and $t^{II\&NN}(\gamma) < t < \bar{t}^I$ hold.

Next, we show that $\langle NN \rangle$ dominates all market structures other than $\langle II \rangle$ over the

specified range of t and γ in figure 5 and proposition 3.

(e) $\langle NN \rangle$ & $\langle \Phi \rangle$: There are two completely symmetric groups of decisive firms. We find that $\langle NN \rangle$ dominates $\langle \Phi \rangle$ for all t and γ:

(f) $\langle NN \rangle$ & $\langle N \rangle$ and $\langle NN \rangle$ & $\langle N' \rangle$: It is immediate from Lemma 1 that $\langle NN \rangle$ dominates both $\langle N \rangle$ and $\langle N' \rangle$ for all t and γ.

(g) $\langle NN \rangle$ & $\langle I \rangle$: The decisive group comprises all owners. Comparing industry profits, we find that $\langle I \rangle$ dominates $\langle NN \rangle$ if and only if $7.123 > \gamma > 5.88$ and $t^{NN\&I} < t < \bar{t}^{I}$ hold. This completes our proof.

Proof of Proposition 4

The comparison of welfare levels under $\langle II \rangle$ and $\langle NN \rangle$ leads to:

$$w_z^{II} - w_z^{NN} = \frac{(\gamma + 2)t \left[t\gamma^2(\gamma + 6)(\gamma + 14) + 64t(2\gamma + 1) + 8\alpha(3\gamma + 4)^2 \right]}{8(\gamma + 4)^2(3\gamma + 4)^2} \geqslant 0.$$

Note that due to symmetry, the same result applies for the world welfare.

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