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Partial Cross-Ownership and Merger Control in International Trade*

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Abstract

Given the rising trend of cross-ownership and mergers and acquisitions, this study builds an oligopoly model with general demand to analyze how partial cross-ownership (PCO) affects market competition and merger control policies in international trade. In our model, ad valorem tariffs are imposed on imports. If the extent of PCO is sufficiently large, international PCO becomes more anti-competitive than domestic PCO, resulting in a higher price. This contrasts with previous results indicating that an international merger is always less anti-competitive than a domestic merger. Additionally, international PCO can result in a higher price than both domestic and international mergers, even without merger synergy effects. Moreover, when competition authorities employ a consumer surplus standard as the merger control policy, pre-merger PCO facilitates approval of the subsequent merger. Trade liberalization encourages the approval of domestic mergers but blocks international mergers from being approved. By way of policy implications, these results suggest that competition authorities should regulate international PCO more heavily.

Keywords: Partial cross-ownership; Merger control; tariffs; International oligopoly JEL classification: F12, F23, L13, L41

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1 Introduction

Mergers and acquisitions (M&A) are prevalent globally, and they affect the market competition in both domestic and foreign countries. According to a report by Refinitiv, the global number of M&A cases in 2021 was 63,215 and the global value of those M&A deals reached nearly USD 5.9 trillion.¹ Of these, the number of cross-border M&A cases was 17,849 (28%), with a combined value of more than USD 2.1 trillion (36%).² Although mergers generate synergies between the merged firms, which can improve economic efficiency, a merger between firms that were competitors may weaken competition in that market because the overall number of firms has decreased. Hence, owing to the growing number of merger cases, the role of the competition authorities has become increasingly important. Critical policy issues include how these authorities assess the impacts of domestic and international mergers and decide how to control them.

Overshadowed by M&A, more modest forms of firms' alliances are also prevalent. The partial cross-ownership (PCO) of firms is one of them, which refers to the situation where participating firms hold a (minor) share of other firms but do not intervene to the latter's decisions. For instance, Toyota Motor Corp. acquired a 4.6% stake of another Japanese auto maker, Isuzu Motor Ltd. in 2021. Isuzu also acquired a minor share of Toyota.³ Cathay Pacific Airways Limited, a Hong-Kong based airline company, owns 18.13% of Air China Limited, and Air China owns 22.8% of Cathay Pacific, as of 2023. The cross-ownership is also made between firms in different countries. A Japanese steelmaker, Nippon Steel Corporation, owns about 3% stake of a South Korean steelmaker, POSCO, while POSCO owns about 2.5% stake of Nippon Steel. Nissan Motor Co. and Renault SA, Japanese and French carmakers, mutually owned 15 percent of their partners' stake, as of 2023.⁴ It is important for both business persons and policy makers to evaluate the effects of PCO on market competition.⁵

Although PCO, both domestically and internationally, might not generate significant synergy effects, it is easier to implement than a merger for firms because (i) minor shareholdings do not

¹See https://www.refinitiv.com/perspectives/market-insights/dealmakers-ring-out-2021-as-the-year-of-ma/, accessed on December 7, 2022.

²See https://www.fdiintelligence.com/content/data-trends/cross-border-ma-reaches-alltime-high-of-21tn-in-2021-80599, accessed on December 7, 2022.

³See https://www.japantimes.co.jp/news/2021/03/25/business/corporate-business/toyota-isuzu-joint-venture/, accessed on April 6, 2023.

⁴See https://english.kyodonews.net/news/2023/01/dc8d9c11e145-urgent-renault-agrees-to-lower-stake-in-nissan-in-capital-tie-up-review.html, accessed on April 6, 2023.

⁵PCO is also related to common ownership, where firms competing in the product market are partially owned by the same owner, like an institutional investor. In this situation, firms maximize the weighted sum of their own and rivals' profits. Liu and Matsumura (2024) analyzed common ownership in an international dupoly model and showed that its welfare effect depends on trade costs.

allow control over other firms and (ii) the competition authorities usually overlook PCO.⁶ However, despite the prevalence of international PCO, few studies analyze its effects or its differences from domestic PCO. Further, as PCO affects market outcomes, it also influences the decisions of the competition authorities on proposed mergers by PCO firms. For instance, Jovanovic and Wey (2014) highlight the case of "sneaky takeovers" in which a firm makes a partial shareholding of a rival firm to obtain approval for a future merger with that firm. However, how domestic and international PCO affect merger policies when firms sell their products both domestically and overseas remains an open question.

Against this backdrop, this study builds an international oligopoly model to analyze the impacts of domestic and international PCO on market competition and compares their price effects. It also explores their differences from the price effects of domestic and international mergers. In the presented model, there are many firms in each country. The domestic PCO/merger involves two domestic firms, whereas the international PCO/merger involves one domestic firm and one foreign firm. Tariffs are imposed on the imported goods. In contrast to an international merger that is always more pro-competitive than a domestic merger, we find that international PCO can be more anti-competitive than domestic PCO. What distinguishes an international merger from a domestic merger is that the former enables the merged firms to avoid import tariffs because the newly created firm distributes its product from local production sites. Hence, an international merger is always less anti-competitive than a domestic merger and leads to a lower equilibrium price if evaluated at the same synergy effect.

The comparison of domestic and international PCO is more complicated. Suppose that each of two PCO firms owns θ (< 1/2) of the share of the other firm. To maximize its profit in each market, each PCO firm is only concerned about $1 - \theta$ of its own profit and θ of the profit of the other PCO firm. Despite holding no control over the partner firm, international PCO also enables the PCO firms to reduce a part of the tariff burden. In each market, the two PCO firms are only concerned about $1 - \theta$ of their marginal costs in the market. Therefore, the two firms' combined "perceived" marginal costs in their profit maximization decrease by $(1 - \theta) \times$ (the combined marginal costs). The decrease in "perceived" marginal costs is larger when one of the PCO firms is a foreign firm because it incurs an import tariff. This "partial tariff-jumping" effect makes international PCO less anti-competitive than domestic PCO.

However, international PCO reduces "the effective number of firms" in the market more than

⁶Ghosh and Morita (2017) analyze the welfare implications of partial ownership when a firm acquiring an equity stake transfers its superior knowledge to the partner firm.

domestic PCO, making international PCO more anti-competitive. The changes in the effective number of firms correspond to the changes in the combined marginal revenues of the two PCO firms. For instance, if there are *N* firms in the market, domestic PCO changes the effective number of firms from *N* to $N - 2\theta$. The domestic PCO firms are only concerned about $1 - \theta$ of their own marginal revenues and therefore the symmetry among them ensures that the changes in marginal revenues through their consideration of the other PCO firms are canceled out. In international PCO, ad valorem tariffs cause heterogeneous changes in the marginal revenues between the two PCO firms: the response of the foreign-producing PCO firm is larger than that of the domestically producing PCO firm. Hence, the two firms' combined reduction in marginal revenues rises under international PCO, reducing the effective number of firms further. This difference does not happen for international and domestic mergers because they both reduce the number of firms from *N* to N - 1.

We find that the equilibrium price under international PCO is higher than that under domestic PCO if the extent of PCO is sufficiently large such that the anti-competitive effect of the reduced effective number of firms exceeds the pro-competitive effect from the reduction in the tariff burden. As the extent of PCO rises, the price under international PCO is more likely to exceed that under domestic PCO. Besides that, if the extent of PCO is large enough, the price under international PCO is higher than the prices under both domestic and international mergers, even if these mergers do not generate any merger synergy effect. However, this happens only if ad valorem-type tariffs (or iceberg-type trade costs) are imposed, and it cannot be obtained if specific tariffs are imposed. This complicated price effect of international PCO has not been shown in previous studies.

Given the price effects of PCO, this study also examines how it affects the merger control strategies of the competition authorities when the PCO firms subsequently merge to become a single firm. Following studies such as Nocke and Whinston (2010, 2013) and Breinlich et al. (2019), we employ a consumer surplus standard as the merger control. In other words, a proposed merger is approved only if it does not reduce the consumer surplus. Pre-merger PCO and the increase in its degree facilitate the approval of both domestic and international mergers. On the one hand, the pre-merger PCO increases the pre-merger price and the market power effect of the subsequent merger, increasing the required synergy effect that keeps the post-merger prices at the pre-merger level. On the other hand, because the pre-merger PCO has already reduced the number of firms, it diminishes the decrease in the number of firms and market power effect caused by the subsequent merger, reducing required synergy effect. Since the latter effect dominates the former, the pre-merger PCO decreases the required synergy effect. Furthermore, we explore the effects of trade liberalization on the merger control strategy. Trade liberalization makes the competition authority more lenient to the domestic merger but stricter on the international merger. Therefore, if the PCO firms set the degree of PCO at the minimum level to gain approval of the merger, trade liberalization increases the degree of international PCO, while it decreases the degree of domestic PCO. Since an increase in the degree of PCO harms consumers by increasing prices, international PCO diminishes consumers' gains from trade liberalization, while domestic PCO enhances them.

1.1 Related literature

This study contributes to the growing literature on PCO between rival firms. Reynolds and Snapp (1986) suggest that holding equity in a rival firm makes PCO firms less aggressive in the product market. However, a similar mechanism to the "merger paradox" (Salant et al., 1986) applies to PCO, and PCO firms reduce their profits in the presence of other firms under a homogeneousgood Cournot oligopoly with symmetric costs. Some studies investigate the profitability of PCO by considering a Bertrand oligopoly setting and cost asymmetries (Flath, 1991; Shelegia and Spiegel, 2012), tacit collusion (Gilo et al., 2006), and multilateral PCO with asymmetric technologies (Ma et al., 2021). Papadopoulos (2022) derives the minimum number of symmetric PCO cases that increases the profits of PCO firms. Analyses also consider international PCO. Lee (1990) shows that international PCO reduces both the optimal subsidies of exporting countries and the optimal tariffs of importing countries. Cai and Karasawa-Ohtashiro (2015) investigate how PCO affects the privatization of a public firm. Fanti and Buccella (2021) suggest that PCO can make the strategic trade policies of two exporting countries Pareto-improving compared with free trade when their products are differentiated. None of these studies, however, have compared domestic PCO with international PCO. In particular, this study demonstrates the strong anti-competitive nature of international PCO with ad valorem tariffs.

It also contributes to the literature on merger policy in international trade.⁷ Barros and Cabral (1994) employ the welfare standard for approving domestic mergers: a domestic merger is approved only if it improves the welfare of the home country. They also show that when a country is a net exporter of a good, it tends to approve a domestic merger that worsens the welfare of foreign countries and world welfare. By contrast, when foreign firms' presence in the domestic market is large and the country is a net importer of the good, the approved merger in the domestic country is unlikely to harm foreign countries or world welfare. Breinlich et al. (2019) employ a consumer

⁷Breinlich et al. (2017) provide an excellent survey of the international aspects of competition policy.

surplus standard for approving domestic mergers. They consider heterogeneous demands and costs across countries as well as iceberg trade costs and show that approving a domestic merger that benefits domestic consumers is either too lenient or too stringent from the viewpoint of foreign consumers.⁸ However, the focus of these studies is on whether there are conflicts of interest in competition policies across countries when a domestic merger occurs in one country.

Some studies have investigated how trade policies affect mergers and merger policies. Ross (1988) shows that freer trade mitigates the anti-competitive effect of domestic mergers, but can enhance the anti-competitive effect of international mergers. Saggi and Yildiz (2006) consider the welfare effects of domestic mergers in an exporting country when the importing country endogenously determines its import tariff. Despite the positive externality of the merger to non-merged firms, the domestic merger in one country can reduce the profits of the non-merged firms in the other country because the merger increases the optimal tariff of the importing country. Several researchers have examined the interactions between trade policies and merger policies. Both Richardson (1999) and Horn and Levinson (2001) show that trade liberalization leads to tougher competition policies because governments prefer to increase the number of domestic firms for committing to the larger overall quantities of those domestic firms. In other words, countries use competition policy to pursue "Stackelberg leadership" in the product market. By contrast, De Stefano and Rysman (2010) show that countries employ a "national champion policy" and reduce the number of domestic firms to one when firms' products are differentiated and they engage in price competition in a thirdcountry market. Unlike these studies, we show that trade liberalization facilitates the approval of a domestic merger but prevents the approval of an international merger.

Finally, our study is associated with research investigating the effects of partial ownership on mergers. Using a closed-economy model, Jovanovic and Wey (2014) show that the anti-competitive effect of partial ownership facilitates the competition authority's approval of subsequent takeovers. Serbera and Fry (2019) demonstrate that PCO plays a role in preventing a hostile takeover by outsiders. This study is distinct from these works in that it compares the approval of domestic mergers with that of international mergers and examines how pre-merger PCO affects merger policies.

The rest of this paper is organized as follows. Section 2 formulates the model and derives the equilibria under domestic and international PCO. It also compares the price effects of domestic and international PCO. Section 3 determines the equilibria under domestic and international mergers as well as derives the minimum synergy required for a merger to be approved. It also considers

⁸Although Breinlich et al. (2019) briefly discuss the case of an international merger in an online appendix, they do not compare it with a domestic merger, let alone the effects of PCO.

how pre-merger PCO and trade liberalization affect the merger control strategy. Section 4 discusses possible extensions and demonstrates that ad valorem tariffs and cross-ownership are critical for the main results. Section 5 concludes.

2 Model and Equilibrium with PCO

There are two countries, A and B, in which a homogeneous product is consumed. Firms in these countries produce a homogeneous good and supply it to both markets. The two markets are segmented because we assume away international price arbitrages, enabling firms to make independent decisions in each market. In each country i, there is a set of firms producing the good, \mathcal{N}^i . The number of firms producing in country i is fixed and given by $N^i \equiv |\mathcal{N}^i| (\geq 1)$ and The total number of firms before mergers is $N = N^A + N^B \geq 2$. Each firm $s \ (\in \mathcal{N}^A \cup \mathcal{N}^B)$ supplies q_s^i of the good in country $i \ (\in \{A, B\})$. The total supply in country i is given by $Q^i = \sum_s q_s^i$.

The inverse demand function in country *i* is given by $P^i(Q^i)$. We assume $P^{i\prime}(Q^i) < 0$ for any Q^i such that $P^i(Q^i) > 0$ and $P^{i\prime}(Q^i) + P^{i\prime\prime}(Q^i)Q^i := \Omega^i(Q^i) < 0$. This assumption ensures a stable and unique Nash equilibrium in each country. The profit of firm *k* in country *i* is

$$\pi_s^i = \left[\frac{P^i(Q^i)}{\tau_s^i} - c_s\right] q_{s\prime}^i \tag{1}$$

where c_s is the marginal cost of firm s and $\tau_s^i (\geq 1)$ is one plus the ad valorem tariff rate that country i imposes on the supplies of firm s. τ_s^i can be an iceberg-type trade cost. If firm s produces in country i, the tariff is not imposed and $\tau_s^i = 1$ hold. If firm s produces in country j ($j \neq i$), $\tau_s^i = \tau^i > 1$ holds. The marginal costs of non-merged firms are constant and given by $c_s = c$. The marginal cost of the merged firm will be explained later.

We consider the situation in which two firms pursue PCO, where each firm owns a minority share of the other firm. Let $\theta \in [0, 1/2)$ denote the minority share. When $\theta = 0$, there is no cross-ownership. Even under PCO, we assume that the majority shareholder independently makes its decision on the quantity supplied in each market. We also assume that PCO generates no synergy effect.⁹ Domestic PCO involves two domestic firms and international PCO involves two firms producing in different countries.

⁹As Ghosh and Morita (2017) suggest, partial ownership can come with a certain degree of knowledge transfers. The main results would not change even if we consider a synergy effect of PCO, which should be weaker than the synergy effect of mergers. See also footnote 14.

2.1 Equilibrium

Suppose that firm $k \in N^i$ producing in country *i* and firm *l* mutually own θ of the other firm. Firm *l* can be either producing in country *i* or country *j*. The type of PCO is domestic PCO if firm *l* is producing in country *i* and international PCO if it is producing in country *j*. We focus on the situation in which all firms supply to both markets. This requires $\tau^i < 3$ (see Appendix B).

The shareholders of firm k set q_k^i in country i such that it maximizes its income in country i given by $V_k^i = (1 - \theta)\pi_k^i + \theta\pi_l^i$, while the shareholders of l set q_l^i in country i such that it maximizes $V_l^i = (1 - \theta)\pi_l^i + \theta\pi_k^i$. The other firms maximize π_s^i with regard to q_s^i . The firms face the same maximization problems in country j. Without loss of generality, let us consider the market equilibrium in country i. The first-order conditions of profit maximization for the PCO firms are given by¹⁰

$$(1-\theta) \left[P^{i}(Q^{i}) + P^{i\prime}(Q^{i})q_{k}^{i} \right] + \frac{\theta}{\tau_{l}^{i}}P^{i\prime}(Q^{i})q_{l}^{i} = (1-\theta)c,$$
(2)

$$\frac{(1-\theta)}{\tau_l^i} \left[P^i(Q^i) + P^{i\prime}(Q^i)q_l^i \right] + \theta P^{i\prime}(Q^i)q_k^i = (1-\theta)c.$$
(3)

Note that $\tau_l^i = 1$ holds under domestic PCO (i.e., firm *l* producing in country *i*) and $\tau_l^i = \tau^i > 1$ holds under international PCO (i.e., firm *l* producing in country *j*). By combining (2) and (3), we have

$$2(1-\theta)P^{i}(Q^{i}) + P^{i\prime}(Q^{i})(q_{k}^{i}+q_{l}^{i}) - \left(\frac{\tau_{l}^{i}-1}{\tau_{l}^{i}}\right)\left[(1-\theta)P^{i}(Q^{i}) + P^{i\prime}(Q^{i})q_{l}^{i}\right] = 2(1-\theta)c.$$
(4)

The right-hand side of (4) represents the combined marginal costs of the two PCO firms. Since each firm's marginal cost is discounted by θc , the combined marginal cost is reduced by $2\theta c$.

The first two terms of the left-hand side represent the fundamental marginal revenues of the two PCO firms in country *i*, which is common in both domestic and international PCOs. The two PCO firms' combined marginal revenue is discounted by $2\theta P^i(Q^i)$, and it is reflected in the first term. The second term is the same as the case without PCO because each PCO firm's concerns about the other PCO firm's marginal revenue through price changes are mutually canceled out by the reduced concerns about its own marginal revenue. Since $\theta[P^i(Q^i) - c] > 0$, the reduced marginal revenues dominate the reduced marginal costs, giving these firms less incentive to increase their supply levels.

The third term provides the additional effects of international PCO in the presence of the tariff,

 $[\]overline{\frac{^{10}\text{The second-order conditions of these firms are given by } 2(1-\theta) P^{i\prime}(Q^i) + P^{i\prime\prime}(Q^i)[(1-\theta) q_k^i + \theta \frac{1}{\tau_l^i} q_l^i < 0 \text{ and } \frac{2(1-\theta)}{\tau_l^i} P^{i\prime}(Q^i) + P^{i\prime\prime}(Q^i) \left[\frac{(1-\theta)}{\tau_l^i} q_l^i + \theta q_k^i\right] < 0.$

 $\tau_l^i = \tau^i > 1$. Specifically, the tariff further decreases the combined marginal revenues of the two firms by $\{(\tau^i - 1)/\tau^i\}(1 - \theta)P^i(Q^i)$ because firm *l* faces the ad valorem tariff when supplying to country *i*. This effect reduces the total supply of the two firms more than under domestic PCO. Meanwhile, the tariff makes firm *k* less concerned about how its increase in q_k^i reduces the profit of firm *l*, giving firm *k* less incentive to decrease its supply. This effect is reflected in $-\{(\tau^i - 1)/\tau^i\}P^{i\prime}(Q^i)q_l^i$. In other words, the two firms can pursue "tariff jumping" to some extent because firm *l* reduces its supply more than firm *k*, decreasing the tariff burden in country *i*. If $(1 - \theta)P^i(Q^i) + P^{i\prime}(Q^i)q_l^i > 0$ holds, the former effect dominates the latter and international PCO reduces the total supply less. In Section 2.2, we provide a more detailed comparison of domestic and international PCO. In order to ensure that the marginal revenues of the two PCO firms are positive with $\tau_l^i > 1$, the extent of PCO must be below the upper bound (see Appendix A for the details):

$$\theta < \overline{\theta}^i = \frac{2\tau_l^i}{(\tau_l^i + 1)^2}.$$
(5)

 $\overline{\theta}^i$ is decreasing in τ_l^i and $\overline{\theta}^i = 1/2$ with $\tau_l^j = 1$.

The first-order conditions of the other firms are given by

$$P^{i}(Q^{i}) + P^{i'}(Q^{i})q^{i}_{s} = \tau^{i}_{s}c,$$
(6)

where $\tau_s^i = 1$ if firm *s* produces in country *i* and $\tau_s^i = \tau^i > 1$ if firm *s* produces in country *j*. By summing all firms' first-order conditions in country *i*, the equilibrium supply \hat{Q}^i is determined such that it satisfies

$$[N - m^{i}(\theta)]P^{i}(\widehat{Q}^{i}) + P^{i'}(\widehat{Q}^{i})\widehat{Q}^{i} = [N - 2\theta - (\tau_{l}^{i} - 1)\theta + (\tau^{i} - 1)N_{j}]c,$$
(7)

where $N_i = N - N_i$ and

$$m^{i}(\theta) = 2\theta + \frac{\theta(1-\theta)(\tau_{l}^{i}-1)^{2}}{(1-2\theta)\,\tau_{l}^{i}}.$$
(8)

 $m^{i}(\theta) \geq 0$ captures how PCO reduces the "effective" number of firms in country *i*, where $m^{i}(\theta) = 0$ with $\theta = 0$ and $m^{i}(\theta) = 2$ with $\theta = \overline{\theta}^{i}$. The detailed derivation of this equation is in Appendix A. $N > m^{i}(\theta)$ always holds because N > 2. Under domestic PCO, $\tau_{l}^{j} = 1$, and we have $m^{i}(\theta) = 2\theta$. Since $m^{i}(\theta) > 2\theta$ with $\theta > 0$ and $\tau_{l}^{i} = \tau^{i} > 1$, international PCO decreases the effective number of firms more than domestic PCO. We have

$$\frac{\partial m^{i}(\theta)}{\partial \theta} \equiv m^{i\prime}(\theta) = 2 + \frac{\{(1-\theta)^{2} + \theta^{2}\}(\tau_{l}^{j} - 1)^{2}}{(1-2\theta)^{2}\tau_{l}^{j}} > 0.$$
(9)

Therefore, an increase in the extent of PCO decreases the effective number of firms and the magnitude is larger under international PCO. Note that $m^i(\theta)$ exceeds one when θ is sufficiently large, implying that international PCO can decrease the number of firms more than a merger between the two firms does. We also confirm that, when $\tau_l^j = \tau^j > 1$, an increase in the tariff reduces the effective number of firms:

$$\frac{\partial m^{i}(\theta)}{\partial \tau^{i}} = \frac{\theta(1-\theta)[(\tau^{i})^{2}-1]}{(1-2\theta)(\tau^{i})^{2}} > 0.$$
(10)

Equation (9) implies that the left-hand side of (7) is decreasing in θ . However, the right-hand side of (7) is also decreasing in θ . As the degree of PCO increases, each PCO firm is less concerned about its own marginal cost. Therefore, the marginal costs of the two PCO firms also decrease. Nevertheless, we can confirm that an increase in θ decreases the total output in country *i*:

$$\frac{d\widehat{Q}^{i}}{d\theta} = \frac{m^{i\prime}(\theta)[P^{i}(\widehat{Q}^{i}) - \tau_{l}^{i}c] + (\tau_{l}^{i} - 1)\lambda^{i}(\theta)c}{[N - m^{i}(\theta)]P^{i\prime}(\widehat{Q}^{i}) + \Omega^{i}(\widehat{Q}^{i})} < 0,$$
(11)

where $\lambda^i(\theta) = 1 + (\tau_l^i - 1)\{(1 - \theta)^2 + \theta^2\} / (1 - 2\theta)^2 > 0$. Although a larger θ decreases the PCO firms' marginal costs, it decreases their marginal revenues by more as well as reduces the their supply levels. We thus confirm that the reduction in the effective number of firms decreases the total supply, even though non-PCO firms supply more due to strategic substitutability.

2.2 Comparison of domestic and international PCO

We have thus far investigated the market equilibria under domestic and international PCO. Here, we discuss which of them has a higher equilibrium price if it is evaluated at the same degree of PCO. The equilibrium quantity in country *i* under domestic PCO is determined by (7) with $\tau_l^j = 1$, which is denoted by Q_D^i . Similarly, the equilibrium quantity under international PCO is obtained from (7) with $\tau_l^i = \tau^i > 1$, which is denoted by Q_I^i . The corresponding equilibrium prices in country *i* are given by $P_D^i = P^i(Q_D^i)$ and $P_I^i = P^i(Q_I^i)$, respectively.

International PCO enables the PCO firms to avoid a part of the tariff burden, while domestic PCO does not. However, international PCO reduces the effective number of firms more than domestic PCO. The former effect increases the quantity, while the latter effect decreases it. If $[m^i(\theta) - 2\theta] P_D^i > (\tau^i - 1)\theta c$ holds, the anti-competitive effect from a larger decrease in the number of firms dominates the cost-saving effect from the partial tariff-jumping effect. Hence, the equilibrium price under international PCO is higher than that under domestic PCO, $P_I^i > P_D^i$. See Appendix C for the detailed calculation.

Proposition 1. If $[m^i(\theta) - 2\theta]P_D^i > (\tau^i - 1)\theta c$ holds, the equilibrium price under international PCO is strictly higher than that under domestic PCO in country *i*. Otherwise, the equilibrium price under domestic PCO is lower.

Whether $[m^i(\theta) - 2\theta] P_D^i > (\tau^i - 1)\theta c$ holds depends on the levels of θ and τ^i . We prove that there always exists the cutoff level of θ , $\tilde{\theta}^i (\in [0, \overline{\theta}^i))$, above which this inequality holds and $P_I^i > P_D^i$ is realized. Therefore, despite the decrease in the tariff burden, international PCO becomes more anti-competitive than domestic PCO if the extent of PCO is sufficiently large.¹¹ There is also a case in which $\tilde{\theta}^i = 0$ and $P_I^i > P_D^i$ holds with any $\theta > 0.^{12}$ This implies that international PCO can be more anti-competitive than domestic PCO even with an infinitesimal level of cross-ownership.

Corollary 1. There always exists the cutoff level of θ , $\tilde{\theta}^i$ ($\in [0, \bar{\theta}^i)$, above which the equilibrium price under an international PCO is strictly higher than the equilibrium price under a domestic PCO in country *i*.

The anti-competitive nature of international PCO critically depends how the import tariff is levied. If the import tariff is a specific tariff (or a per-unit trade cost) rather than an ad valorem tariff (or an iceberg-typ trade cost), the equilibrium price under international PCO is always lower than that under domestic PCO. Section 4.4 provides more details. With the ad valorem tariff, which is the most popular method of imposing tariffs globally, a higher price increases foreign firms' tariff burden. Therefore, as (2) and (3) show, the domestic firm in country *j* is concerned about $(1 - \theta)$ of its profit and θ/τ^i of the foreign partner's profit, while the foreign firm is concerned about $(1 - \theta)/\tau^i$ of its profit and θ of the domestic firm's profit in country *i*. Owing to this asymmetry of each firm's weight on the profits due to the ad valorem tariff, international PCO reduces the combined marginal revenues of the two firms. This enhanced anti-competitive effect with ad valorem tariffs decreases the outputs of the PCO firms, and this negative effect on outputs can dominate the positive effect from the reduced tariff burden.

By contrast, specific tariffs do not affect the two firms' combined marginal revenues and they only reduce the tariff burden because the foreign country is less concerned about the tariff burden under international PCO. Therefore, with specific tariffs, the equilibrium quantity is always larger

¹¹By contrast, the effect of an increase in τ^i on the price difference is ambiguous because it decreases the number of firms under international PCO, but increases the gains from the reduction in the tariff burden (see Appendix C).

¹²Appendix C provides a numerical example of $\tilde{\theta}^i$ with a specific demand function and constant price elasticity.

and the equilibrium price is always lower under international PCO. Furthermore, $P_I^i > P_D^i$ holds only if the partial shareholdings between rival firms are reciprocal. If a firm unilaterally owns a share of a rival firm, international PCO always realizes a lower equilibrium price. Section 4.5 provides more details.

3 Merger and Merger Control

We have thus far demonstrated how domestic and international PCO affect market outcomes. The changes in equilibrium prices also influence how a subsequent merger by the two PCO firms affects the consumer surplus and countries' merger controls.

This section derives the merger equilibrium at which the two firms, firm k and firm l, initially pursue domestic PCO to merge and become a single firm, firm M. Then, we explore how cross-ownership and trade liberalization affect the merger control policies of the competition authorities. The competition authority in each country employs the consumer surplus standard as its merger control policy and approves mergers involving (at least) one firm producing in the domestic country if and only if such mergers do not reduce the domestic consumer surplus from the pre-merger level.

The synergy effect between the two firms reduces the marginal cost of the merged firm to $c_M = c - z$, where $z \in [0, c]$. Thus, *z* captures the extent of the synergy effect. Under an international merger, the merged firm supplies its product to each market from its local production facilities. Therefore, an international merger not only reduces the marginal cost from *c* to c - z but also avoids tariffs. In other words, the international merger is regarded as a "tariff-jumping" foreign direct investment.

Since a firm in country i (firm k) is involved in either a domestic or an international merger, the first-order condition of the profit maximization of the merged firm in country i becomes

$$P^{i}(Q^{i}) + P^{i'}(Q^{i})q^{i}_{M} = c - z.$$
(12)

In the other country (country *j*), however, the merged firm incurs an import tariff, τ^{j} (> 1), under a domestic merger (i.e., firm *l* is producing in country *i*), whereas it avoids this tariff under an international merger (i.e., firm *l* is producing in country *j*). The first-order condition in country *j* becomes

$$P^{j}(Q^{j}) + P^{j\prime}(Q^{j})q^{j}_{M} = \tau^{j}_{l}(c-z),$$
(13)

where $\tau_l^j = \tau^j$ under a domestic merger and $\tau_l^j = 1$ under an international merger. The other firms'

first-order conditions in country i are unchanged and given by (6).

Let us consider the market equilibrium in country *i*. By summing all the firms' first-order conditions, the total quantity under a merger, \hat{Q}_{M}^{i} , is determined by

$$(N-1) P^{i}(\widehat{Q}_{M}^{i}) + P^{i\prime}(\widehat{Q}_{M}^{i})\widehat{Q}_{M}^{i} = \left[(N-1) - (\tau_{l}^{i}-1) + (\tau^{i}-1)N_{j} \right] c - z.$$
(14)

Here, τ_l^i represents the tariff imposed on firm l before the international merger. The merged firm saves τ_l^i under international merger. Since $\tau_l^i = \tau^i > 1$ for an international merger and $\tau_l^i = 1$ for a domestic merger, the industry-level marginal cost is always lower under an international merger than under a domestic merger without changing the industry-level marginal revenues. Therefore, the equilibrium quantity is always larger and the equilibrium price is always lower under an international merger. This result contrasts with the comparison of international and domestic PCO.

We can compare the equilibrium prices under mergers with those under PCO. The merger synergy effect lowers the prices, so the prices under mergers can be lower than those under PCO. If the merger synergy effect is small, however, the prices under PCO can be higher than the prices under mergers. Let us consider the extreme case where there is no merger synergy effect, z = 0. We can confirm that the equilibrium price under a domestic PCO cannot be higher than the equilibrium price under a domestic merger, although it can be higher than the equilibrium price under an international merger due to the tariff-jumping effect of the international merger.

By contrast, the equilibrium price under international PCO can be higher than the equilibrium price under an international merger, and it can be even higher than the equilibrium price under a domestic merger. As discussed in Section 2.1, the international PCO decreases the effective number of firms more than the international merger does (i.e., one) when θ is large. Although the international PCO avoids a part of tariff burdens, it still realizes a higher price than the domestic merger when θ is sufficiently large. The detailed calculation is provided in Appendix D. Since the equilibrium price under an international merger is lower than the that under a domestic merger, the international PCO can also realize a higher price than an international merger. The following proposition summarizes the results.

Proposition 2. The equilibrium price under a domestic merger is higher than that under an international merger. Even without the merger synergy effect, the equilibrium price under a domestic merger is lower than that under international PCO if the extent of PCO is sufficiently large. The equilibrium price under a domestic merger without the synergy effect is always higher than that under domestic PCO.

The proposition implies that, when the merger synergy effect is small, international PCO can be

more anti-competitive than both domestic and international mergers. This strong anti-competitive nature of international PCO has not been explored in the literature.

3.1 Merger control

The proposed merger is approved in country *i* if and only if it does not reduce the consumer surplus in that country, $P^i(\hat{Q}_M^i) \leq P^i(\hat{Q}^i)$. This condition is satisfied if $\hat{Q}_M^i \geq \hat{Q}^i$ holds. Since the merger internalizes the competition externality between the merged firms, it decreases the supply and raises the price without the merger synergy effect (i.e., the market power effect). If the synergy effect is large and the merged firm has a sufficiently lower cost than the non-merged firms, however, the merger decreases the equilibrium price and benefits domestic consumers.

Let $\tilde{z}^i(\theta)$ be the threshold level of the synergy effect of the merged firm, above which the competition authority in country *i* approves the merger. Since the merger does not affect the consumer surplus if $\hat{Q}^i_M = \hat{Q}^i$, we can replace \hat{Q}^i_M with \hat{Q}^i in (14) and derive $\tilde{z}^i(\theta)$ as

$$(N-1) P^{i}(\widehat{Q}^{i}) + P^{i'}(\widehat{Q}^{i})\widehat{Q}^{i} = c - \widetilde{z}^{i}(\theta) + \left[(N-2) - (\tau_{l}^{i}-1) + (\tau^{i}-1)N_{j} \right] c.$$
(15)

By subtracting (15) from (7), we have

$$\widetilde{z}^{i}(\theta) = \left[1 - m^{i}(\theta)\right] P^{i}(\widehat{Q}^{i}) - \left[1 - 2\theta + (\tau_{l}^{i} - 1)(1 - \theta)\right]c.$$

$$(16)$$

The competition authority in country *j* approves the merger if $z \ge \tilde{z}^i(\theta)$ holds. A higher pre-merger price, ceteris paribus, *increases* the merger synergy effect required to approve the merger. This is because a higher pre-merger price implies that pre-merger market competition is less intense, amplifying the market power effect of the merger. The effect of θ on this threshold is discussed later in this section.

3.1.1 Domestic merger

Under a domestic merger in country i, $\tau_l^i = 1$ and the upper bound of θ is $\overline{\theta}^i = 1/2$. Then, the threshold of the synergy effect for the domestic merger, $z_{Di}^i(\theta)$, is given by

$$z_{Di}^{i}(\theta) = (1 - 2\theta) (P_{D}^{i} - c).$$
(17)

Even if the domestic merger benefits consumers in country i, whether it benefits consumers in the foreign country (country j) is ambiguous. This is because the difference in demand levels and



Figure 1: Domestic merger in country A

presence of tariffs generate different effects on the consumers in the other country. We can calculate $z_{Di}^{j}(\theta)$, above which the domestic merger in country *i* improves the consumer surplus in country *j*:

$$z_{Di}^{j}(\theta) = (1 - 2\theta) \left(\frac{P_{D}^{j}}{\tau^{j}} - c\right).$$
(18)

From the viewpoint of country *j*, the import price of the good, P_D^j/τ^j , matters to determine the threshold because the merger occurred in the foreign country and the merged firm's exports are subject to the import tariff of country *k*. By comparing these two thresholds, we have $z_{Di}^j(\theta) > z_{Di}^i(\theta)$ if $P_D^j/\tau^j > P_D^i$, and $z_{Di}^j(\theta) \le z_{Di}^i(\theta)$ otherwise.

These two cases are illustrated in Figure 1, where i = A and j = B. If the pre-merger price is higher in country *B* and the tariff imposed by country *B* is low, a domestic merger in country *A* approved by country *A* harms consumers in country *B* for $z \in [z_{DA}^{A}(\theta), z_{DA}^{B}(\theta))$. If the pre-merger import price is lower in country *B*, however, the approved domestic merger in country *A* always benefits consumers in country *B*. These possible conflicts of interest in merger policies are consistent with the results of Breinlich et al. (2019).

$$ar{z}_{I}^{i}(heta) = \max[z_{I}^{A}(heta), z_{I}^{B}(heta)]$$



Figure 2: International merger

3.1.2 International merger

Under an international merger, $\tau_l^i = \tau^i > 1$ and the upper bound of θ is $\overline{\theta}^i = \tau^i / (\tau^i + 1)^2 < 1/2$. The threshold synergy effect for the merger to be approved in country *i* becomes

$$z_{I}^{i}(\theta) = [1 - m^{i}(\theta)]P_{I}^{i} - [1 - 2\theta + (\tau^{i} - 1)(1 - \theta)]c.$$
⁽¹⁹⁾

As in the domestic merger, the threshold synergy effect is increasing in the pre-merger price level. Hence, the international merger is approved in country *i* if $z \ge z_I^i(\theta)$. Since an international merger requires the approval of both governments, it is realized only if $z \ge \overline{z}_I(\theta) := \max[z_I^A(\theta), z_I^B(\theta)]$ holds, as Figure 2 shows.

Without PCO ($\theta = 0$), $z_I^i(0) < z_{Di}^i(0)$ always holds and an international merger is easier to be approved in the sense that it requires a lower synergy effect. With PCO, however, this threshold can be either higher or lower than the threshold of the domestic merger: an international merger can be harder to be approved than a domestic merger. Section 4.2 compares the two thresholds.

Note that $z_I^i(\theta)$ can be negative if $1 < m^i(\theta)$ holds, or $1 > m^i(\theta)$ and $[1 - m^i(\theta)]P_I^i < [1 - 2\theta + (\tau^i - 1)(1 - \theta)]c$ hold. In this case, an international merger always improves consumer surplus irrespective of the extent of merger synergy effect. As discussed in the beginning of this section, international PCO can realize a higher equilibrium price than an international merger even without the merger synergy effect. Therefore, the subsequent international merger always lower the equilibrium price. By contrast, a domestic merger cannot benefit consumers without the merger synergy effect since $z_{Di}^i(\theta)$ and $z_{Di}^j(\theta)$ are always positive.

3.2 The effect of PCO on the merger control

Here, we explore how the changes in the degree of domestic PCO affect the merger control policy used for a domestic merger by changing the thresholds of the synergy effect. From (16), the effect

of an increase in θ on $\tilde{z}^{i}(\theta)$ is given by

$$\frac{d\widehat{z}^{i}\left(\theta\right)}{d\theta} = -m^{i\prime}\left(\theta\right)\left[P^{i}(\widehat{Q}^{i}) - c\right] - \left[m^{i\prime}\left(\theta\right) - 2\right]c + \left[1 - m^{i}\left(\theta\right)\right]P^{i\prime}(\widehat{Q}^{i})\frac{d\widehat{Q}^{i}}{d\theta} + (\tau_{l}^{i} - 1)c < 0.$$
(20)

Regardless of whether PCO is domestic or international, an increase in θ reduces $\tilde{z}^i(\theta)$, implying that the domestic merger is less likely to harm consumers because the required synergy effect falls.¹³

Intuitively, because pre-merger PCO has already reduced the effective number of firms, it diminishes the decrease in the number of firms and market power effect caused by the subsequent merger. This is reflected in the first term of (20). For an international merger followed by international PCO, the marginal decrease in the number of firms is greater than that under domestic PCO ($m^{it}(\theta) > 2$), further diminishing the market power effect of the merger (the second term). Meanwhile, an increase in θ increases $P^i(\hat{Q}^i)$ and enhances the market power effect of the merger (the third term). It also diminishes the tariff-jumping effect of the international merger because international PCO has already realized partial tariff jumping. Despite these contrasting effects, the former two effects always dominate the latter two and the increased degree of PCO reduces the threshold.¹⁴ The following proposition summarizes the result.

Proposition 3. An increase in the extent of PCO decreases the merger synergy effect required to approve a merger.

In the following, we elaborate on how pre-merger PCO affects the approval of domestic and international mergers.

3.2.1 PCO and domestic mergers

In a domestic merger ($\tau_l^i = 1$) in country *i*, $\partial z_{Di}^i(\theta) / \partial \theta < 0$ from (20). We can also confirm that $\partial z_{Di}^j(\theta) / \partial \theta < 0$ holds. This implies that an increase in θ also increases the threshold synergy effect above which the merger in country *i* benefits consumers in country *j*. Suppose that $z_{Di}^i(\theta) < z_{Di}^j(\theta)$ holds and the domestic merger approved in country *i* harms consumers in the other country. As θ decreases $z_{Di}^j(\theta)$, the increased cross-ownership makes an initially consumer-harming merger in country *j* benefit consumers. Since an increase in θ also decreases $z_{Di}^i(\theta)$, however, the increased degree of PCO makes an initially unapproved domestic merger approved, and the newly approved

¹³By substituting $d\hat{Q}^{i}/(d\theta)$ in (11), we have $d\tilde{z}^{i}(\theta)/(d\theta) = -[(N-1)\{m^{i\prime}(\theta)P^{i}(\hat{Q}^{i}) - \tau_{l}^{i}c\}P^{i\prime}(\hat{Q}^{i}) + \{m^{i\prime}(\theta)P^{i}(\hat{Q}^{i}) - (\tau_{l}^{i}+1)c\}\Omega^{i}(\hat{Q}^{i})]/[\{N-m^{i}(\theta)\}P^{i\prime}(\hat{Q}^{i}) + \Omega^{i}(\hat{Q}^{i})] < 0$. Note that $m^{i\prime}(\theta)P^{i}(\hat{Q}^{i}) > (\tau_{l}^{i}+1)c$ holds in this equation, because We have $m^{i\prime}(\theta)P^{i}(\hat{Q}^{i}) - (\tau_{l}^{i}+1)c > m^{i\prime}(\theta)c/\tau_{l}^{i} - (\tau_{l}^{i}+1)c = [\tau_{l}^{i}\{(\tau_{l}^{i}-1)(1-2\theta+2\theta^{2})+6\theta(1-\theta)\}+2\theta(1-\theta)]c/(1-2\theta)^{2} > 0$, where the first inequality is due to $P^{i}(\hat{Q}^{i}) > \tau_{l}^{i}c$.

¹⁴If there exists a synergy effect in PCO that is proportional to θ , an increase in θ may increase the synergy effect of the subsequent merger required for the merger approval.



Figure 3: Increase in θ and a domestic merger in country *A*

domestic merger in country *i* harms consumers in country *j*.¹⁵ Figure 3 shows the effects of an increase in θ on the competition authority's decision on a domestic merger, when *i* = *A* and *j* = *B*.

If the PCO firms freely choose θ and there is a merger synergy effect (z > 0), they can always make an initially unapproved merger approved by manipulating θ . Suppose $z > z_{Di}^{i}(0)$ holds and a domestic merger in country *i* without PCO is unapproved. Since $\lim_{\theta \to \frac{1}{2}} h z_{Di}^{i}(\theta) = 0$, there always exist the cutoff levels of θ , θ_{Di}^{i*} ($\in (0, \frac{1}{2})$), above which the domestic merger in country *i* benefits consumers in country *i*.

Corollary 2. If the merger synergy effect is positive, there always exists the cutoff level of θ , θ_{Di}^{i*} ($\in [0, \frac{1}{2})$), above which the domestic merger benefits consumers in country *i*.

However, this does not necessarily mean that consumers in country *i* benefit from PCO and the subsequent merger. Since PCO increases the pre-merger price in country *i*, the manipulation of θ makes consumers worse off even if the subsequent merger leaves the price unchanged. The domestic competition authority does not regulate PCO as long as each PCO firm's minor shareholding does not come with any control over the other firm. For instance, if the two PCO firms set θ to satisfy $\theta = \theta_{Di}^{i*}$ from $\theta = 0$, PCO makes an unapproved domestic merger approved because the merger does not affect the consumer price. The initial PCO, however, increases the pre-merger consumer price and harms consumers in country *i* as well as in country *j*.

3.2.2 PCO and international mergers

For an international merger to be approved, a higher threshold is critical. For instance, if $z_I^A(\theta) > z_I^B(\theta)$ holds and an increase in θ does not change the ranking; rather, an increase in θ makes an international merger more likely to be approved. Figure 4 summarizes this result.

As in the domestic merger case, pre-merger PCO facilitates the approval of the international

¹⁵An increase in θ may change the ranking of the thresholds from $z_{Di}^{i}(\theta) < z_{Di}^{j}(\theta)$ to $z_{Di}^{i}(\theta) > z_{Di}^{j}(\theta)$. However, this does not happen with linear demand since $dz_{Di}^{i}(\theta) / d\theta - dz_{Di}^{j}(\theta) / d\theta < 0$. Further, $dz_{Di}^{i}(\theta) / d\theta - dz_{Di}^{j}(\theta) / d\theta < 0$ is more likely to hold as τ^{j} is higher.



Figure 4: Increase in θ and an international merger

merger. Suppose $z > \overline{z}_I (\theta = 0)$ holds and the international merger is unapproved without PCO. Since $\lim_{\theta \to \overline{\theta}^i} z_I^i(\theta) = -P_I^i - [1 - 2\overline{\theta}^i + (\tau_I^i - 1)(1 - \overline{\theta}^i)]c < 0$, there always exist the cutoff levels of $\theta, \theta_I^{i*} (\in (0, \overline{\theta}^i))$, above which the international merger benefits consumers in country *i*.¹⁶

Corollary 3. There always exists the cutoff level of θ , θ_I^{i*} ($\in [0, \overline{\theta}^i)$), above which the international merger is consumer-benefiting for country *i*.

3.3 Trade liberalization and the merger control

Here, we investigate the effects of trade liberalization on the merger control strategy to explore the relationship between trade policy and merger policy. Under domestic PCO, $\tau_l^j = 1$ holds and the effect of a change in τ^i on \hat{Q}^i is given by

$$\frac{d\widehat{Q}^{i}}{d\tau^{i}} = \frac{(N_{j}-1)c}{(N-2\theta)P^{i\prime}(\widehat{Q}^{i}) + \Omega^{i}(\widehat{Q}^{i})} < 0.$$

$$(21)$$

Under international PCO, $\tau_l^i = \tau^i > 1$ holds and the tariff effect on \widehat{Q}^i becomes

$$\frac{d\widehat{Q}^{i}}{d\tau^{i}} = \frac{(N_{j} - \theta)c}{(N - 2\theta)P^{i\prime}(\widehat{Q}^{i}) + \Omega^{i}(\widehat{Q}^{i})} < 0.$$
(22)

Therefore, an increase in the import tariff always increases the price and harms domestic consumers.

Regarding the domestic merger, let us first consider the effect of the tariff imposed by country i on its merger policy when the two firms in country i aim to merge. We have

$$\frac{\partial z_{Di}^{i}(\theta)}{\partial \tau^{i}} = (1 - 2\theta) P^{i\prime}(Q_{D}^{i}) \left(\frac{\partial Q_{D}^{i}}{\partial \tau^{i}}\right) > 0.$$
(23)

Hence, trade liberalization makes the competition authority formulate more lenient competition policy on the domestic merger in the sense that it increases the range of z that realizes a merger that

¹⁶Note that $\lim_{\theta \to \overline{\theta}^i} m^i(\theta) = 2$.



Figure 5: Trade liberalization and a domestic merger in country A

benefits consumers. By contrast, trade liberalization in country *j* increases $z_{Di}^{j}(\theta)$, as we confirm that

$$\frac{\partial z_{Di}^{j}(\theta)}{\partial \tau^{j}} = -\frac{\left(1-2\theta\right)}{\left(\tau^{j}\right)^{2}} \left[P^{j}(Q_{D}^{j}) - \tau^{j}P^{j\prime}(Q_{D}^{j})\left(\frac{\partial Q_{D}^{j}}{\partial \tau^{j}}\right)\right] < 0$$
(24)

holds.¹⁷ Although trade liberalization in country *j* decreases the pre-merger price in country *j*, it also increases the import price of the good, $P^j(Q_D^j)/\tau^j$, given $P^j(Q_D^j)$. As the latter effect dominates the former, trade liberalization in the foreign country makes the domestic merger in the home country less likely to benefit consumers in the foreign country.

Proposition 4. Trade liberalization decreases the minimum synergy effect required to approve a domestic merger, whereas it increases the minimum synergy effect that makes the domestic merger benefit consumers in the foreign country.

As discussed above, a domestic merger approved by country *i* harms consumers in country *j* if $z_{Di}^{j}(\theta) > z > z_{Di}^{i}(\theta)$ holds. Then, trade liberalization by either country widens the gap between the two thresholds and makes the merger approval of country *i* more likely to be consumer hurting for country *j*. In other words, the approval on the domestic merger becomes a *too-lenient-for-thy-neighbor policy* (Breinlich et al., 2019). Figure 5 shows the effect of trade liberalization in each country on country *A*'s merger policy on a domestic merger, when $z_{DA}^{B}(\theta) > z_{DA}^{A}(\theta)$ holds. Therefore, the effects of trade liberalization become more complicated if we take into account its effect on merger policies.

For instance, suppose that the import tariff of country *i* is reduced from $\tau^i = \tau_0$ to $\tau^i = \tau_1$ (< τ_0). If $z_{Di}^i(\theta)|_{\tau^i = \tau_1} < z \le z_{Di}^i(\theta)|_{\tau^i = \tau_0}$ holds, trade liberalization makes an initially unapproved domestic merger in country *i* approved. If $z_{Di}^j(\theta) > z_{Di}^i(\theta)|_{\tau^i = \tau_0}$ holds, however, the newly approved merger

 $[\]overline{[1^{7}\text{By using (21), we have } \partial z_{Di}^{j}(\theta)/(\partial \tau^{j}) = -(1-2\theta)[\{N_{i}\{P^{j}(Q_{D}^{j}) - \tau^{j}c\} + (N_{j} - 2\theta)\}P^{j\prime}(Q_{D}^{j}) + \Omega^{j}(Q_{D}^{j})]/[(\tau^{j})^{2}\{(N-2\theta)P^{j\prime}(Q_{D}^{j}) + \Omega^{j}(Q_{D}^{j})\}] < 0.$



Figure 6: Trade liberalization and an international merger

harms consumers in country *j*. Therefore, although the markets in the two countries are segmented, trade liberalization in one country affects the price in the other country and can harm consumers if it changes the merger policy. This result proposes an important policy implication: countries must cooperate more in formulating competition policies as trade liberalization proceeds.

Let us next consider the effect of tariffs under an international merger. From (10), trade liberalization increases the effective number of firms, $N - m^i(\theta)$, in the pre-merger PCO equilibrium. Then, the tariff effect on the threshold merger synergy becomes

$$\frac{dz_I^i(\theta)}{\partial \tau^i} = [1 - m^i(\theta)]P^{i\prime}(Q_I^i)\frac{dQ_I^i}{d\tau^i} - P^i(Q_I^i)\frac{\partial m^i(\theta)}{\partial \tau^i} - (1 - \theta)c < 0,$$
(25)

which is always negative.¹⁸ Figure 6 shows how trade liberalization changes the minimum synergy effect when $\overline{z}_I(\theta) = z_I^i(\theta)$. Although trade liberalization decreases the pre-merger price and weakens the market power effect of the international merger (the first term), the lower decrease in the number of firms under international PCO (the second term) and the decrease in the tariff-jumping effect (the third term) dominate the first term. Hence, trade liberalization in country *i* makes the international merger less likely to benefit consumers in country *i*, and the competition authority in country *i* then formulates more stringent competition policy on the international merger in the sense that it increases the level of *z* above which an international merger is approved.

Proposition 5. *Trade liberalization increases the minimum merger synergy effect that makes an international merger benefit consumers.*

In contrast to a domestic merger, trade liberalization affects the required synergy effect through not only the change in the pre-merger price but also the diminished anti-competitive effect of international PCO and reduced gains from the tariff-jumping effect. These results are consistent with Breinlich's (2008) empirical analysis, which demonstrates that trade liberalization increases domes-

¹⁸By using (22), we have $dz_{I}^{i}(\theta) / \partial \tau^{i} = -P^{i}(Q_{I}^{i})(\partial m^{i}(\theta) / \partial \tau^{i}) - [[N_{i}(1-2\theta)(1-\theta)\tau^{i} + (N_{j}-1)\theta\{(\tau^{i}-1)(\tau^{i}-1+\theta)+\tau^{i}\}]P^{i'}(Q_{I}^{i}) + (1-\theta)\Omega^{i}(Q_{I}^{i})]/[(1-2\theta)(\tau^{i})^{2}[\{N-m^{i}(\theta)\}P^{i'}(Q_{I}^{i}) + \Omega^{i}(Q_{I}^{i})]] < 0.$

tic M&A in the liberalizing country, whereas it has no robust effects on domestic M&A in foreign countries or cross-border M&A.

Suppose that the PCO firms set θ such that the subsequent merger is approved: $z = z_{Di}^{i}(\theta)$ and $z = z_{I}^{i}(\theta)$. Since trade liberalization in country *i* decreases $z_{Di}^{i}(\theta)$ and increases $z_{I}^{i}(\theta)$, it makes these firms set a higher θ for the international merger and a lower θ for the domestic merger. In this case, trade liberalization can enhance the anti-competitive effect of international PCO and diminish the anti-competitive effect of domestic PCO.

4 Discussion

This study investigated domestic and international PCO and how its effects on market competition differ. It also examined how these two types of PCO affect the competition authorities' merger control policies for subsequent mergers when they employ a consumer surplus standard. This section discusses additional points worth considering as well as explains the extent to which the results depend on the assumptions made earlier.

First, we examine whether two firms have an incentive to pursue domestic and international PCO. Second, we examine whether international mergers are easier to be approved than domestic mergers by comparing the thresholds of the merger synergy effect. Third, we consider a possible extension to a multiple-country model. Fourth, we demonstrate that international PCO cannot be more anti-competitive than domestic PCO if specific tariffs, rather than ad valorem tariffs, are imposed or if the partial ownership of a rival firm is unilateral.

4.1 Strategic PCO for approving a merger

We showed that initial PCO affects the approval of subsequent mergers. However, we did not investigate whether firms have an incentive to pursue PCO and mergers, which we examine next. Since PCO in this study does not affect the technologies of the involved firms and firms produce a homogeneous good and engage in Cournot competition, we have an effect similar to the "merger paradox." In other words, the two firms can lose out by pursuing PCO despite the competition between them weakening because the other firms increase their outputs in response. We use the example of linear demand to show that domestic PCO always reduces the profit of each PCO firm. However, international PCO can still increase the profits of the PCO firms because they can jointly reduce the tariff burden by adjusting their supply levels.

Moreover, even if PCO reduces the profits of the two firms, it may increase their overall prof-

its if it leads to the merger being approved. As suggested by Nocke and Whinston (2010, 2013) and Breinlich et al. (2019), an approved merger that leaves the consumer surplus unchanged or improved increases the joint profit of the merged firm because its marginal cost declines without its equilibrium outputs decreasing. Therefore, a domestic merger that does not harm consumers in either country is always profitable for the merging firms. Even if $z_{Di}^{i}(\theta) < z < z_{Di}^{j}(\theta)$ holds and an approved domestic merger in country *i* harms consumers in the foreign country (country *j*), the merger is still profitable if the profit increase in the domestic market outweighs the loss in the foreign market. Furthermore, an approved international merger always increases the joint profit of the merged firm because it must not harm consumers in either country, and the merged firm also benefits from the tariff-jumping effect.

As Corollaries 2 and 3 suggest, the PCO firms always have an option to set θ that subsequently leads to the merger being approved, unless the government does not set its upper bound. If the initial losses from PCO are lower than the future gains from a merger, the two firms have an incentive to pursue PCO for the approval of the merger.

4.2 Comparison of the thresholds between domestic and international mergers

We derived the synergies required for the merger to be approved for a domestic merger and an international merger. Even if evaluated at the same level of θ , the differences in the equilibrium prices and other characteristics lead to different thresholds of the merger synergy effect. By comparing (17) with (19), we have

$$z_{I}^{i}(\theta) - z_{Di}^{i}(\theta) = -(\tau^{i} - 1)(1 - \theta)c - [m^{i}(\theta) - 2\theta]P_{I}^{i} + (1 - 2\theta)(P_{I}^{i} - P_{D}^{i}).$$
(26)

The first term represents the tariff-jumping effect of an international merger: since the merged firm is free from tariffs, an international merger lowers the post-merger equilibrium price more than a domestic merger does. The second term represents the anti-competitive effect of international PCO: since the effective number of firms is smaller in international PCO than in domestic PCO, the decreases in the effective number of firms caused by the subsequent mergers are also smaller in international merger. This decreases the required synergy effect that makes the post-merger price equal to the pre-merger price. The third term, which captures the market power effect of the merger, is negative when $P_I^i < P_D^i$ and positive when $P_I^i > P_D^i$. Since $P_I^i \le P_D^i$ holds for $\theta \le \tilde{\theta}^i$, $z_I^i(\theta) < z_{Di}^i(\theta)$ holds and the required synergy effect for the approval of the merger is smaller when the extent of PCO is sufficiently small to satisfy $\theta \le \tilde{\theta}^i$. If $\theta > \tilde{\theta}^i$ and the anti-competitive effect under international PCO is sufficiently large to realize $P_I^i > P_D^i$, the market power effect of an international merger is larger than that of a domestic merger. We have $z_I^i(\theta) > z_{Di}^i(\theta)$ if P_I^i is sufficiently large to satisfy $P_I^i > [(1 - 2\theta)P_D^i + (\tau^i - 1)(1 - \theta)c]/[1 - m^i(\theta)]$ holds. Otherwise, $z_I^i(\theta) \le z_{Di}^i(\theta)$ holds. Thus, the competition authority is more likely to approve an international merger if the price increase of international PCO relative to that of domestic PCO is small, or it is not so large such that it is dominated by the tariff-jumping effect. If the relative price increase of an international PCO is large, however, a domestic merger is more likely to be approved.

Further, since an international merger needs the approval of both countries, $z_I^j(\theta) > z_{Di}^i(\theta)$ is possible even if $z_I^i(\theta) < z_{Di}^i(\theta)$ holds. This inequality is likely to hold when the market size is sufficiently larger in country *j* than in country *i* such that $P_I^j > P_I^i$ holds, while the tariffs are lower in country *j*, $\tau^j < \tau^i$. In this case, the international merger needs a larger synergy effect to be approved by the foreign country.

Even if $\bar{z}_{I}(\theta)$ (= max[$z_{I}^{A}(\theta), z_{I}^{B}(\theta)$]) < $z_{Di}^{i}(\theta)$ holds, it does not necessarily mean that the consumer surplus is higher in the domestic merger equilibrium than in the international merger equilibrium. This is because the merger is approved based on the changes in consumer prices, rather than the post-merger level of these prices. For instance, suppose that $\bar{z}_{I}(\theta) < z = z_{Di}^{i}(\theta)$ holds. In this case, both the international merger and the domestic merger are approved; however, while the international merger decreases the equilibrium price, the domestic merger retains the price at the pre-merger level. If the pre-merger price satisfies $P_{I}^{i} > P_{D}^{i}$, the post-merger price under the international merger can still be higher than that under the domestic merger if the gap between $\bar{z}_{I}(\theta)$ and $z_{Di}^{i}(\theta)$ is small and the price decrease of the international merger is limited.

4.3 Multiple countries

We can extend the model to a multiple-country model. If tariffs are imposed based on the Most Favored Nation principle of the World Trade Organization, an increase in the number of countries directly corresponds to an increase in N_j and this does not affect the main results. Even if countries set different tariffs for their partner countries, the tariff effects on domestic PCO and domestic mergers remain unchanged, although their magnitudes will differ. However, the effects of tariffs on international PCO and international mergers become more complicated.

For instance, suppose that a country forms a regional trade agreement (RTA) with another country and these countries reduce the tariffs between them. If the two firms from each member country pursue international PCO and international mergers, the tariff reduction has the same effect as in the baseline model. If the partner of international PCO is a firm outside the RTA, however, the RTA's tariff reduction decreases the equilibrium prices without affecting the gains from avoiding tariffs in international PCO and international mergers. Concerning the price comparisons in Section 1, the RTA only reduces $[m^i(\theta) - 2\theta] P_D^i$ through the price decrease and does not affect $(\tau^i - 1)\theta c$. Therefore, if a country forms an RTA with the country in which the PCO partner is absent, it makes $P_I^i > P_D^i$ less likely to hold. In the baseline model, however, the relationship between a tariff reduction and the likelihood of this inequality is ambiguous.

Moreover, contrary to in the baseline model, forming an RTA without involving the international PCO partner *decreases* the minimum synergy effect necessary for the approval of the subsequent international merger. This is because such an RTA only decreases P_I^i in (19). Furthermore, although the consumers of the countries involved in an international merger must approve it, such a merger can still harm consumers in other countries. Although a deeper analysis considering multilateral countries would provide additional insights not obtained in the two-country model, we leave this for future research.

4.4 Specific tariff

In our model, we consider ad valorem tariffs (iceberg-type trade costs) rather than specific tariffs (unit trade costs). Here, we show that some of the results are obtained only with ad valorem tariffs. Let t_s^i be the specific tariff imposed by country *i* on the supplies of firm *s*. Then, each firm's profit earned in country *i* becomes $\pi_s^i = [P^i(Q^j) - c - t_s^i]q_s^i$, where $t_s^i = 0$ if firm *s* produces in country *i* and $t_s^i = t^i > 0$ if it produces in country *j*.

Under domestic PCO in country *j*, the equilibrium quantity in country *i*, $\overline{Q}^{i,S}$, is determined by

$$(N-2\theta) P^{i}(\overline{Q}^{i,S}) + P^{i\prime}(\overline{Q}^{i,S})\overline{Q}^{i,S} = (N-2\theta) c + N_{j}t^{i}.$$
(27)

Then, the subsequent domestic merger is approved only if $z \ge z_{Di}^{i,S}(\theta) = (1-2\theta) [P^i(\overline{Q}^{i,S}) - c]$. Under international PCO, the equilibrium quantity in country *i*, $\hat{Q}^{i,S}$, is determined by

$$(N-2\theta) P^{i}(\widehat{Q}^{i,S}) + P^{i\prime}(\widehat{Q}^{i,S})\widehat{Q}^{i,S} = (N-2\theta) c + (N_{j}-\theta) t^{i}.$$
(28)

The subsequent international merger is approved only if $z \ge z_I^{i,S}(\theta) = (1-\theta) t^i - (1-2\theta) [P^i(\widehat{Q}^{i,S}) - c]$. By comparing (27) with (28), it is straightforward that $\widehat{Q}^{i,S} > \overline{Q}^{i,S}$ always holds because the

industry-level marginal cost is lower under international PCO than domestic PCO. Therefore, the equilibrium price is always lower under international PCO, $P^i(\widehat{Q}^{i,S}) < P^i(\overline{Q}^{i,S})$. This is because the effective number of firms is the same in the case of specific tariffs, while the "tariff jumping" under international PCO decreases the cost. Thus, international PCO can be more anti-competitive and realize a higher price than domestic PCO only if ad valorem tariffs are imposed.

4.5 Unilateral partial ownership

Here, we investigate the situation with a unilateral partial ownership (UPO) under which one firm owns a minor share of the equity of a rival firm, whereas the rival firm holds no equity. Let us start with domestic UPO. Suppose that firm *k* in country *i* owns θ of the equity of firm *l* also producing in country *i*, but firm *l* does not own any equity of other firms. The first-order condition of profit maximization for firm *k* in country *i* is given by $[P^i(Q^i) + P^{i'}(Q^i)q_k^i] + \theta P^{i'}(Q^i)q_l^i = c$. Further, the first-order conditions of the other firms, including firm *l*, are given by $P^i(Q^i) + P^{i'}(Q^i)q_s^i = \tau_s^i c$ in country *i*. By summing all the firms' first-order conditions, the equilibrium quantity in country *i*, $\overline{Q}^{i,U}$, is determined by

$$(N-\theta) P^{i}(Q_{D}^{i,U}) + P^{i'}(Q_{D}^{i,U})Q_{D}^{i,U} = [N-\theta + (\tau^{i}-1)N_{j}]c.$$
⁽²⁹⁾

Let us next consider international UPO. Suppose firm k owns θ of the equity of firm l producing in country j. The first-order condition of the profit maximization for firm k in country i is given by $P^i(Q^i) + P^{i'}(Q^i)q_k^i + \theta\{P^{i'}(Q^i)/\tau^i\}q_l^i = c$. The other firms' first-order conditions, including firm l, are given by $P^i(Q^i) + P^{i'}(Q^i)q_s^i = \tau_s^i c$ in country i. By summing all the firms' first-order conditions, the equilibrium quantity in country j, $Q_I^{j,U}$, is determined to satisfy

$$\left(N - \frac{\theta}{\tau^{i}}\right) P^{i}(Q_{I}^{i,U}) + P^{i\prime}(Q_{I}^{i,U})Q_{I}^{i,U} = [N - \theta + (\tau^{i} - 1)N_{j}]c.$$
(30)

By comparing (29) with (30), we confirm that $Q_I^{i,U} > Q_D^{i,U}$ always holds. Therefore, $P^i(Q_I^{i,U}) < P^i(Q_D^{i,U})$ always holds with UPO. Hence, the price under international UPO cannot be higher than that under domestic UPO in the same country. By contrast, the price under international PCO can be higher than that under domestic PCO.

5 Conclusion

By adopting an oligopoly model with general demand functions, this study explored the effects of domestic and international PCO on the nature of market competition. If the extent of PCO is sufficiently large, international PCO becomes more anti-competitive than domestic PCO in the sense that it generates a higher equilibrium price. Although international PCO enables PCO firms to reduce the tariff burden, it reduces the number of firms more since ad valorem tariffs cause PCO to have heterogeneous effects on the marginal revenues of the PCO firms. By contrast, in the merger case, an international merger is always less anti-competitive than a domestic merger because of the tariff-jumping effect. Even without the merger synergy effect, international PCO can be more anti-competitive and realize a higher price than both domestic and international mergers. This strong anti-competitive nature of international PCO has not been explored in the existing studies. By way of policy implications, these results suggest that the competition authorities should more heavily regulate international PCO by introducing an upper bound of cross-ownership.

The study also examined the effects of PCO on the merger control policy when the competition authority in each country employs a consumer surplus standard to approve proposed mergers. Pre-merger PCO facilitates the approval of the subsequent merger in the sense that it reduces the required merger synergy that prevents mergers that harm consumers. Even if a merger benefits consumers, consumers become worse off if the initial PCO strategically aims to reduce the required merger synergy effect. We also found that trade liberalization encourages a domestic merger to be approved, whereas it prevents the approval of an international merger.

This study is one of the first to analyze partial cross-ownership and its connections to mergers in the context of international trade. However, one of its limitations is that we only considered PCO and mergers between two firms to avoid complicating the analyses. Hence, it would be intriguing for future research to consider multiple PCO and mergers among different pairs of firms to examine whether PCO and merger waves arise.

Appendix

A. Derivation of the equilibrium quantity under international PCO

By combining (2) and (3), we have

$$q_l^i = \tau_l^i q_k^i + \frac{(\tau_l^i - 1) (1 - \theta) P^i(Q^i)}{(1 - 2\theta) P^{i\prime}(Q^i)}.$$
(31)

By substituting (31) into (4), this is rewritten as

$$q_{k}^{i} = -\frac{(1-\theta)}{P^{i\prime}(Q^{i})\tau_{l}^{i}} \left[\frac{\{\tau_{l}^{i} - (\tau_{l}^{i}+1)\theta\}P^{i}(Q^{i})}{(1-2\theta)} - \tau_{l}^{i}c \right].$$
(32)

By rearranging (4) and using (32), we have

$$\frac{(1-\theta)\left[2\tau_l^i - (\tau_l^i + 1)^2\theta\right]}{(1-2\theta)\,\tau_l^i}P^i(Q^i) + P^{i\prime}(Q^i)(q_k^i + q_l^i) = (1-\theta)\,(\tau_l^i + 1)c.$$

For the two firms producing goods, $2\tau_l^i/(\tau_l^i + 1)^2 \equiv \overline{\theta}^i > \theta$ must hold. By summing this equation and the other firms' first-order conditions, we have (7).

B. Positive exports under cross-ownership

Let us consider international PCO ($\tau_l^i = \tau^i > 1$). By combining (31) and (32), we have the equilibrium exports of firm *l* to country *j*:

$$\widehat{q}_l^i = -rac{(1- heta)}{P^{i\prime}(\widehat{Q}^i)} \left[rac{\{1-(au^i-1) heta\}P^i(\widehat{Q}^i)}{(1-2 heta)} - au^i c
ight].$$

Note that \hat{q}_l^i is the smallest of all exporting firms. Since \hat{q}_l^i is increasing in $P^i(\hat{Q}^i)$ and $P^i(\hat{Q}^i) > \tau^i c$ is necessary for $q_l^i > 0$, we have

$$\left. \widehat{q}_{l}^{i} > \left. \widehat{q}_{l}^{i} \right|_{P^{i}(\widehat{Q}^{i}) = \tau^{i}c} = -\frac{(1-\theta)}{P^{i\prime}(\widehat{Q}^{i})} \left[\frac{\{-\theta\left(\tau^{i}-3\right)\}}{(1-2\theta)} \right] = -\frac{(3-\tau^{i})\left(1-\theta\right)\theta\tau^{i}c}{P^{i\prime}(\widehat{Q}^{i})\left(1-2\theta\right)}$$

Therefore, the sufficient condition for $\hat{q}_l^j > 0$ is $\tau^i < 3$.

C. Price comparison between domestic PCO and international PCO

Set $\tau_l^i = \tau^i$ to consider international PCO in (7). We have $[N - m^i(\theta)]P^i(Q_I^i) + P^{i'}(Q_I^i)Q_I^i = [N - (1 + \tau^i)\theta + N_j(\tau^i - 1)]c$. By replacing Q_I^i with Q_D^i and adding γ^i , as the additional marginal cost that needs to be included to realize Q_D^i in the equilibrium under international PCO, we have

$$[N - m^{i}(\theta)]P^{i}(\overline{Q}^{i}) + P^{i\prime}(\overline{Q}^{i})\overline{Q}^{i} = \gamma^{i} + [N - (1 + \tau^{i})\theta + N_{j}(\tau^{i} - 1)]c.$$

 $Q_I^i > Q_D^i$ and $P^i(Q_I^i) < P^i(Q_D^i)$ holds if $\gamma^i > 0$, and $Q_I^i < Q_D^i$ and $P^i(Q_I^i) > P^i(Q_D^i)$ holds if $\gamma^i < 0$. Since $(N - 2\theta) P^i(Q_D^i) + P^{i\prime}(Q_D^i) Q_D^i = [N - 2\theta + N_j(\tau^i - 1)]c$ holds under domestic PCO,

 γ^i is given by

$$\gamma^{i} = (\tau^{i} - 1)\theta c - \left[m^{i}\left(\theta\right) - 2\theta\right]P^{i}(Q_{D}^{i}).$$

Note that $m^i(\theta) > 2\theta$ holds under international PCO. This proves Proposition 1. We have $\gamma^i = 0$ when $\theta = 0$ and

$$\gamma^i \Big|_{\theta = \overline{\theta}^i} = -2 \frac{[(\tau^i)^2 + 1][P^i(Q_D^i) - c] + (\tau^i + 1)c}{(\tau^i + 1)^2} < 0.$$

Differentiating γ^i with respect to θ yields

$$\frac{\partial \gamma^{i}}{\partial \theta} = (\tau^{i} - 1)c - [m^{i\prime}(\theta) - 2]P^{i}(Q_{D}^{i}) - [m^{i}(\theta) - 2\theta]P^{i\prime}(Q_{D}^{i})\frac{dQ_{D}^{i}}{d\theta}.$$

Since $m^{i'}(\theta) - 2 = (\tau^i - 1)^2 (1 - 2\theta + 2\theta^2) / (1 - 2\theta)^2 \tau^i > 0$, the first term is positive, while the second and third terms are negative. We have

$$\left. \frac{\partial \gamma^i}{\partial \theta} \right|_{\theta=0} = \frac{(\tau^i - 1)}{\tau^i} \left[\tau^i c - (\tau^i - 1) P^i(Q_D^i) \right].$$

Therefore, $(\partial \gamma^i / \partial \theta) \big|_{\theta=0} > 0$ holds if $\tau^i c / (\tau^i - 1) > P^i(Q_D^i)$ and $(\partial \gamma / \partial \theta) \big|_{\theta=0} < 0$ holds otherwise. Note that $(\partial \gamma^i / \partial \theta) \big|_{\theta=0} < 0$ always holds if $\tau^i > 2$. Since

$$\frac{\partial \gamma^{i}}{\partial \theta}\Big|_{\theta = \overline{\theta}^{i}} = -\frac{[1 + 6(\tau^{i})^{2} + (\tau^{i})^{4}][P^{i}(Q_{D}^{i}) - c] + [3(\tau^{i})^{2} + 1](\tau^{i} + 1)}{\tau^{i}(\tau^{i} - 1)^{2}} - 2(1 - \theta)P^{i\prime}(Q_{D}^{i})\frac{dQ_{D}^{i}}{d\theta} < 0,$$

there always exists the cutoff level of θ , $\tilde{\theta}^i$ ($\in [0, \overline{\theta}^i)$), where $\gamma^i < 0$ holds for $\theta > \tilde{\theta}^i$. $\tilde{\theta}^i = 0$ is possible only if $(\partial \gamma^i / \partial \theta)|_{\theta=0} < 0$ holds. This proves Corollary 1.

We provide a numerical example of $\tilde{\theta}^i$. Suppose that the price elasticity of demand in country i is constant and given by $\epsilon^i := -P^i(Q^i) \setminus \{P^{i\prime}(Q^i)Q^i\} > 1$. Then, we have $P_D^i = [\{N - 2\theta + (\tau^i - 1)N_j\}c]/[N - 2\theta - 1/\epsilon^i]$. and $P_I^i = [\{N - (1 + \tau^i)\theta + (\tau^i - 1)N_j\}c]/[N - m^i(\theta) - 1/\epsilon^i]$. By comparing these prices, we obtain

$$P_{I}^{i} - P_{D}^{i} = \frac{\left[\tau^{i} - 1 + \epsilon^{i}\left[\left(m^{i}\left(\theta\right) - 2\theta\right)\left(N - 2\theta\right) + \left(\tau^{i} - 1\right)\left\{N_{j}\left(m^{i}\left(\theta\right) - 2\theta\right) - \left(N - 2\theta\right)\theta\right\}\right]\right]c}{\left[N - m^{i}\left(\theta\right) - \frac{1}{\epsilon^{i}}\right]\left[N - 2\theta - \frac{1}{\epsilon^{i}}\right]}.$$

Suppose that the parameters are set at $\tau^i = 1.5$, N = 20, $N_j = 10$, and $\epsilon^i = 2$. The upper bound of θ is given by $\overline{\theta}^i = 12/25 = 0.48$. We can calculate that $P_I^i > P_D^i$ holds if $\theta > \widetilde{\theta}^i = (23 - \sqrt{394})/10 \approx 0.31506$. In this demand function, $P_I^i \le P_D^i$ holds if $\theta \le \widetilde{\theta}^i$. As τ^i rises, $\widetilde{\theta}^i$ falls. For instance, if we set $\tau^i = 1.8$ keeping the same value of the other parameters, we have $\widetilde{\theta}^i = (109 - \sqrt{10369})/56 \approx 0.12807$ ($< \overline{\theta}^i = 45/98 \approx 0.45918$). Furthermore, if we set $\tau^i = 2.5$ keeping the same value of the other

parameters, $P_I^i > P_D^j$ holds for any $\theta \in (0, \overline{\theta}^i)$, where $\overline{\theta}^i = 20/49 \approx 0.40816$. In this case, $\tilde{\theta}^i = 0$.

The effect of τ^i on γ^i is ambiguous. Differentiating γ^i with respect to τ^i yields

$$\frac{\partial \gamma^{i}}{\partial \tau^{i}} = \theta c - \frac{\partial m\left(\theta\right)}{\partial \tau^{i}} P^{i}(Q_{D}^{i}) - \left[m^{i}\left(\theta\right) - 2\theta\right] P^{i\prime}(Q_{D}^{i}) \frac{dQ_{D}^{i}}{d\tau^{i}}.$$

If evaluated at $\tau^i = 1$,

$$\left. \frac{\partial \gamma^{i}}{\partial \tau^{i}} \right|_{\tau^{i}=1} = \frac{\theta}{1-2\theta} \left[2\theta c - \{ P^{i}(Q_{D}^{i}) - c \} \right],$$

which is positive if market competition is intense and $P^i(Q_D^i) - c$ is small, while it is negative if $P^i(Q_D^i) - c$ is large.

D. Price comparison between PCO and mergers

By (17) and (18), $z_{Di}^{i}(\theta) > 0$ and $z_{Di}^{j}(\theta) > 0$ always hold and domestic PCO cannot realize a higher price than a domestic merger when z = 0. In a domestic merger, we have $(N - 1) P^{i}(\hat{Q}_{M}^{i}) + P^{i'}(\hat{Q}_{M}^{i})\hat{Q}_{M}^{i} = c - z + [(N - 2) + (\tau^{i} - 1)N_{j}]c$ holds. Let $\hat{z}^{j}(\theta)$ be the threshold level of the synergy effect, above which a domestic merger realizes a lower price than international PCO. By substituting \hat{Q}^{i} into this equilibrium condition of the domestic merger and comparing it with the equilibrium conditions of international PCO, $[N - m^{i}(\theta)]P^{i}(\hat{Q}^{i}) + P^{i'}(\hat{Q}^{i})\hat{Q}^{i} = [N - 2\theta + (\tau^{i} - 1)(N_{j} - \theta)]c$, we derive

$$\widehat{z}^i(heta) = [1 - m^i(heta)]P^i(\widehat{Q}^i) - [1 - 2 heta - (au^i - 1) heta]c.$$

If $\hat{z}^{i}(\theta) < 0$, international PCO realizes a higher equilibrium price than a domestic merger even without the synergy effect. Because $\hat{z}^{i}(0) > 0$ and we have

$$\lim_{\theta \to \overline{\theta}^i} \widehat{z}^i\left(\theta\right) = -[P^i(\widehat{Q}^i) - c] - \frac{2c}{\tau^i + 1} < 0,$$

there exists a threshold level of θ , $\hat{\theta}^i$ ($\in (0, \overline{\theta}^i)$), above which an international PCO is more anticompetitive than a domestic merger even without the merger synergy effect.

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