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Abstract

We investigate the role of firm heterogeneity in considering profitability and desirability of mergers in the international economy. Analysis shows that higher trade costs make only cross-border mergers profitable whereas larger firm heterogeneity is likely to increase both domestic and cross-border mergers. Furthermore, it is shown that whether or not a merger leads to merger waves depends on the types of firms involved in it. It is also demonstrated that larger firm heterogeneity can reduce the discrepancy between profitability and desirability of mergers when the trade cost is sufficiently low.

JEL Classification: F12, G34, L13

Key words: M&As, trade, firm heterogeneity, Cournot competition

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1 Introduction

During the past two decades, we have observed the world wide proliferation of mergers and acquisitions (M&As). The number of M&As worldwide in excess of one million dollar during 2000-2001 is more than twice as that during 1990-1991 (Hijzen et al [15]). This trend is common for both domestic and cross-border M&As: from 1990-1991 to 2000-2001, the number of domestic M&As has risen from 6,281 to 13,557 and the number of cross-border M&As has risen from 2,161 to 5,319. It is then natural to investigate the causes and consequences of this proliferation of both types of mergers in a unified framework.

In investigating these, we focus on firm heterogeneity, which is already shown to play key roles in the international economy. In particular, in the face of new established facts regarding differences in the performance of firms in the trade environment (see Bernard and Jensen [4][5], among others), the impact of trade in the presence of heterogeneous firms has been intensively investigated by studies such as Melitz [21], Helpman et al. [13], Melitz and Ottaviano [22] and Antras and Helpman [1].[1][2] These scholars developed monopolistic competition models with heterogeneous firms and uncovered trade impacts on the industrial structure and firms, which include the fact that trade in the presence of firm heterogeneity leads to self-selection of firms: efficient firms sell goods both domestically and internationally whereas inefficient firms sell goods only domestically.

In this paper, we introduce firm heterogeneity into a Cournot oligopoly model with trade a la Brander [7] and Brander and Krugman [8], and examine the profitability (i.e., causes) and desirability (i.e., consequences) of M&As.[3] This modeling strategy fits quite well to the analysis of M&As because there is a long tradition of industrial organization literature to use Cournot models in analyzing M&As. Salant et al [28] established the well-known "Cournot merger paradox," which claims that mergers between identical firms are unprofitable unless the merged firm produces a very high proportion of pre-merger industry output over 80% when firms engage in Cournot competition and demand is linear. Subsequent studies showed that mergers are possible in Cournot competition

[1] Mannase and Turrini [20] considered a model in which the heterogeneity of firms arises from differences in the skills of entrepreneurs and obtained results regarding industrial changes due to trade openness that were similar to those of Melitz [21].

[2] For recent surveys, see Baldwin [2], Greenaway and Kneller [10], and Helpman [14].

[3] Of course, in the enormous trade literature, there are studies that introduce firm heterogeneity into a Cournot model with trade. Very recent examples include Ishikawa and Komoriya [18], who examined the effects of countervailing duties when subsidies provided in exporting countries cause serious injuries.

once we introduce additional factors such as cost synergies (see Farrell and Shapiro [11]), fixed stock of production factors (see Perry and Porter [26]), spatial competition (see Levy and Reitzes [19]), and demand uncertainty (see Qiu and Zhou [27]).[4]

In the model developed in this paper, we consider two countries in each of which firms are different in their marginal cost of production. We consider horizontal M&As and hence there is no upstream and downstream distinction among firms. We investigate how the cost difference could interplay with trade environments such as trade costs to determine profitability and desirability of mergers. We first build our arguments on the simple case in which there are two firms in each country, one of which is efficient and can produce at a lower cost and the other of which is inefficient and produce at a higher cost. This simple setting enables us to investigate fully the profitability and desirability of merger waves as well as a pairwise merger. Analysis shows that it is likely that larger firm heterogeneity leads to proliferation of both domestic and cross-border mergers. Moreover, we characterize discrepancy between profitability and desirability for each type of a merger. It is also shown that whether or not the first pairwise merger leads to merger waves depends on the type of firms involved in it. We next focus on the asymmetry between countries regarding firm heterogeneity by assuming that the share of efficient firms can be different between countries. We then confirm that larger heterogeneity would lead to more mergers. Furthermore, we show that profitable mergers are socially undesirable (resp. desirable) when cost difference is small (resp. large) when the trade cost is sufficiently low.

Existing studies such as Barros [3] and Neary [24] showed that mergers between firms with different marginal costs could be profitable even under Cournot competition. However, they consider a world without trade costs.[5] In contrast, our primary focus is on the case in which trade costs play an important role. Of course, several existing studies has already investigated the role of trade costs in M&As and showed that in the presence of trade costs, a cross-border merger provides access to a foreign market. This effect is called the "tariff jumping" and leads to merger incentives, which is empirically shown to exist by Hijzen et al [15]. Recent studies that showed this effect theoretically include Horn and Persson [17], Fumagalli and Vasconcelos [12], and Salvo [29].[6] Especially, Salvo

[4]For further detail on this literature, see Huck et at [16] and Chapter 16 of Pepall et al [25].

[5]Barros [3] considered only domestic mergers. Neary [24] considered two countries, in one of which all firms produce at a lower costs and in the other of which all firms produce at a higher costs. Moreover, Neary [24] assumed no trade costs.

[6]Note here that the effects of trade costs on merger incentives are not as simple as it may look at first sight. For example, Bjorvatn [6] showed that economic integration may trigger cross-border M&As by reducing the business

[29] examined profitability of mergers with both trade costs and international difference in quality of goods, and showed that higher trade costs and larger quality difference lead to higher incentives of mergers. His results are quite consistent with the results obtained in this paper. The important departure of our analysis from his analysis is that we consider firm heterogeneity within each country, which yields much richer results. Moreover, we provide welfare arguments, which are absent from Salvo [29].

This paper is organized as follows. In Section 2, we present a basic model and analyze the trade patterns. Section 3 examines the simple pairwise mergers whereas Section 4 focuses on the merger waves. In Section 5, we explore the role of asymmetry between countries regarding firm heterogeneity. Section 6 concludes the paper.

2 Basic setup

2.1 Model

We first derive the trade patterns, and then examine the profitability and the desirability of mergers. Consider two countries, H (home) and F (foreign), in each of which two firms (1 and 2) are playing the Cournot competition. Within each country, firms are heterogeneous in the sense that they differ in their marginal cost: firm 1 has lower marginal cost, which is normalized to zero, whereas the marginal cost of firm 2 is $c > 0$. For the moment, we assume that two countries are symmetric and the cost distribution is the same across two countries.[7]

We assume that demand for the homogeneous good Q is determined by a simple linear demand function:

$$P = 1 - Q, \tag{1}$$

where P is the price. Assume that $c < 1/2$, under which both firms 1 and 2 obtain positive operating profits in the closed economy. Firms can export goods to a foreign market incurring the trade cost $\tau > 0$ as well as supply goods in a domestic market with no trade cost. When τ is sufficiently high, no firms export and the economy is in the autarky. When all firms are supplying in both countries,

stealing effect and by reducing the reservation price of the target firm. Chaudhuri and Benchekroun [9] demonstrated that marginal and non-marginal reductions in trade costs have different effects on the social desirability of mergers.

[7] In the later section, we consider n firms in each country and consider the effects of asymmetric cost distribution across countries.

firms' profits in country j ($j = H, F$) are given as

$$\pi_{1j} = P_j q_{1jj} + (P_k - \tau) q_{1jk} \qquad \text{for firm 1,} \tag{2}$$
$$\pi_{2j} = (P_j - c) q_{2jj} + (P_k - c - \tau) q_{2jk} \qquad \text{for firm 2,}$$

where q_{ijj} and q_{ijk} represent the supply of goods of firm i located at country j in country j (i.e., in a domestic market) and that in country k ($k \neq j$, $k = H, F$) (i.e., in a foreign country). Here, the total supply Q in country j is given by $Q_j = q_{1jj} + q_{2jj} + q_{1kj} + q_{2kj}$. Each firm supplies goods whenever the price exceeds the cost of supply:

$$r_{1jd} \equiv P_j > 0 \Rightarrow q_{1jj} > 0 \qquad \text{and} \qquad r_{1jx} \equiv P_k - \tau > 0 \Rightarrow q_{1jk} > 0, \tag{3}$$
$$r_{2jd} \equiv P_j - c > 0 \Rightarrow q_{2jj} > 0 \qquad \text{and} \qquad r_{2jx} \equiv P_k - c - \tau > 0 \Rightarrow q_{2jk} > 0.$$

r_{ijd} and r_{ijx} represent the profits per unit supply from domestic sales and from export, respectively. Exploring these conditions, we can see how trade patterns emerge according to the level of the trade cost τ.

2.2 Trade patterns

We consider the following cases that are relevant to our analysis.[8] Pattern (i): All firms supply goods in both countries. Pattern (ii): All firms supply goods in a domestic market but only efficient firms export. Pattern (iii): only efficient firms are active, and they supply goods in both countries. Pattern (iv): all firms supply goods in a domestic market but no firms export (i.e., autarky). When the cost difference between firms is small ($0 < c \leq 1/3$), patterns (i), (ii), and (iv) appear for different values of τ. When the cost difference is large ($1/3 < c < 1/2$), we observe patterns (ii), (iii), and (iv).

We start from the case in which the cost difference is small by assuming that $0 < c \leq 1/3$. In pattern (i), firms' profits are given by (2), leading to the following supply:

$$q_{1jj} = \frac{1 + 2c + 2\tau}{5} \qquad \text{and} \qquad q_{1jk} = \frac{1 + 2c - 3\tau}{5},$$
$$q_{2jj} = \frac{1 - 3c + 2\tau}{5} \qquad \text{and} \qquad q_{2jk} = \frac{1 - 3c - 3\tau}{5}.$$

From (3), we can see that for this pattern to hold true, $r_{ijd} > 0$ and $r_{ijx} > 0$ must be satisfied for both firms. Substituting the above equations into (1), we obtain that $r_{ijd} > 0$ holds true for all

[8] Other cases are not possible in our model. See Appendix A for the full description of the arguments here.

positive values of τ because $0 < c \leq 1/3$. Furthermore, we have

$$r_{1jx} > 0 \Leftrightarrow \tau < \frac{1+2c}{3} \qquad \text{and} \qquad r_{2jx} > 0 \Leftrightarrow \tau < \frac{1-3c}{3}. \tag{4}$$

Therefore, when the trade cost τ is smaller than $(1-3c)/3$, we have pattern (i). When the trade cost is high and τ becomes equal to $(1-3c)/3$, exporting is no longer profitable for inefficient firms. And the economy turns into pattern (ii), which hold true if $r_{ijd} > 0$ for both firms and $r_{1jx} > 0$ are satisfied but the economy is not in pattern (i) (i.e., $\tau \geq (1-3c)/3$). Again, $r_{ijd} > 0$ holds true for all positive values of τ. Furthermore, export is profitable for firm 1 as long as $\tau < (1+c)/3$, that is,

$$r_{1jx} > 0 \Leftrightarrow \tau < \frac{1+c}{3}, \tag{5}$$

which implies that pattern (ii) emerges when $(1-3c)/3 \leq \tau < (1+c)/3$. When τ is larger than $(1+c)/3$, no firms export and the economy is in pattern (iv) (in autarky).

Next, we consider the case in which the cost difference is large ($1/3 < c < 1/2$). In this case, pattern (i) is never possible because no positive τ satisfies (4), and hence it is convenient to start from pattern (ii). When $1/3 < c < 1/2$, $r_{1jd} > 0$ holds true for all positive values of τ whereas we can see that

$$\begin{aligned} r_{2jd} > 0 &\Leftrightarrow \tau > 3c-1, \\ r_{1jx} > 0 &\Leftrightarrow \tau < \frac{1+c}{3}. \end{aligned} \tag{6}$$

Hence, pattern (ii) happens when $3c-1 < \tau < (1+c)/3$. When τ is larger than $(1+c)/3$, no firms export and the economy is in pattern (iv) (in autarky). Finally, when $0 < \tau \leq 3c-1$, inefficient firms stop producing goods and only efficient firms are active. Moreover, efficient firms supply goods in both countries as long as $\tau < 1/2$, which, combined with the fact that $1/3 < c < 1/2$ leads to $3c-1 < 1/2$, implies that pattern (iii) holds true when $0 < \tau \leq 3c-1$.

The following proposition summarizes the above arguments.

Proposition 1 *Assume that the cost difference is small ($0 < c \leq 1/3$). Then, when the trade cost τ is smaller than $(1-3c)/3$, all firms supply goods in both countries (pattern (i)). When $(1-3c)/3 \leq \tau < (1+c)/3$, all firms supply goods in a domestic market but only efficient firms export (pattern (ii)). When $\tau > (1+c)/3$, all firms supply goods in a domestic market but no firms export (pattern (iv)). Next assume that the cost difference is large ($1/3 < c < 1/2$). Then, when*

$0 < \tau \leq 3c-1$, only efficient firms are active, and they supply goods in both countries (pattern (iii)). Pattern (ii) happens when $3c - 1 < \tau < (1 + c)/3$, and pattern (iv) holds true when $\tau > (1 + c)/3$.

Put differently, although reductions in trade cost induce firms to engage in trade, its effects are quite different among heterogeneous firms. It is efficient firms that are most likely to enjoy the benefits from reductions in the trade cost. In fact, they first start exporting and for a certain range of trade cost, only they export. When the cost difference is not large, sufficiently low trade cost enables inefficient firms to export. However, when the cost difference is sufficiently large, low trade cost may make inefficient firms quit production. These trade patterns are fully consistent with the results obtained in Melitz [21] and Melitz and Ottaviano [22], which introduced firm heterogeneity into trade models of monopolistic competition and showed that the self-selection of exporting firms are observed according to the cost difference among firms as seen in Proposition 1. Therefore, results here indicate that it is fairly common to have these self-selection of exporting firms in a trade model of imperfect competition with heterogeneous firms.

3 Analysis of mergers: a pairwise merger

3.1 Types of a pairwise merger

In this section, we analyze the incentive and outcome of a pairwise merger, and in the next section, we examine the possibility of merger waves. Before we provide the complete result of a pairwise merger in this model, we mention four types of pairwise mergers respectively: Type (I): a cross-border merger of efficient firms (i.e., a merger of firms 1 and 1 located at countries H and F), Type (II): a cross-border merger of efficient and inefficient firms (i.e., a merger of firm 1 located at country H and firm 2 located at country F), Type (III): a domestic merger of efficient and inefficient firms (i.e., a merger of firms 1 and 2 located at country H), and Type (IV): a cross-border merger of inefficient firms (i.e., a merger of firms 2 and 2 located at countries H and F).

Here, we assume the perfect spillover of technology and once heterogeneous firms merge, the merged firm can produce goods at a low cost. This assumption is especially relevant when we consider cross-border mergers with trade cost. Perfect spillover implies that a cross-border merger between efficient and inefficient firms makes it possible for a merged firm to produce goods at low costs in both countries. Without this assumption, there is a trade off for a merged firm: it must

choose between producing goods at low costs while it must bear transport costs to the other country and producing goods in both countries at low costs in one country and at high costs in the other country. In the latter case, it bears no trade cost.

In this paper, for the analytical simplicity, we assume that each merger consists of two firms and we use simple gains from merger as a criterion of merger incentive. Therefore, when we consider a pairwise merger, we compare the profit of a merged firm to the joint profit of firms involved in the merger described in Section 2.2. If the former is larger than the latter, we consider that this merger is profitable and these two firms have incentive to merge. More formally, a merger between firm i in country j and firm h in country k is profitable if

$$\pi_M - \pi_{ij} - \pi_{hk} > 0, \tag{7}$$

where π_M is the profit of a merged firm, and π_{ij} and π_{hk} represent the pre-merger profit of firm i in country j and that of firm h in county k, respectively.

Type (I): By symmetry, we only have to consider country H. There are potentially three firms: the merged efficient domestic firm, the inefficient domestic firm, the inefficient foreign firm. Depending on the values of τ and c, two cases appear in the presence of a merger: (a) the merged firm and the inefficient domestic firm supply, (b) all firms supply. In the followings, π_{Mj} and π_{ijk} represent the profits of a merged firm from sales in country j and of firm i located in country j from sales in country k, respectively.

Case (a) ($\tau \geq (1-2c)/3$): The profits of the firms from sales in country H are:

$$\pi_{MH} = \frac{(1+c)^2}{9}, \ \pi_{2HH} = \frac{(1-2c)^2}{9}.$$

Case (b) ($\tau < (1-2c)/3$): The profits of the firms are:

$$\pi_{MH} = \frac{(1+2c+\tau)^2}{16}, \ \pi_{2HH} = \frac{(1-2c+\tau)^2}{16}, \ \pi_{2FH} = \frac{(1-2c-3\tau)^2}{16}.$$

Type (II): The market structure in country H is equivalent to the basic one except the absence of the inefficient foreign firm. From Proposition 1, we have the following result.

Case (a) ($\tau \geq (1+c)/3$): The profits of the firms are:

$$\pi_{MH} = \frac{(1+c)^2}{9}, \ \pi_{2HH} = \frac{(1-2c)^2}{9}.$$

Case (b) ($c < 1/3$ and $\tau < (1+c)/3$): The profits of the firms are:

$$\pi_{MH} = \frac{(1+c+\tau)^2}{16}, \ \pi_{2HH} = \frac{(1-3c+\tau)^2}{16}, \ \pi_{1FH} = \frac{(1+c-3\tau)^2}{16}.$$

Case (c) ($c \geq 1/3$ and $(3c-1) \leq \tau < (1+c)/3$): The profits of the firms are:

$$\pi_{MH} = \frac{(1+c+\tau)^2}{16}, \ \pi_{2HH} = \frac{(1-3c+\tau)^2}{16}, \ \pi_{1FH} = \frac{(1+c-3\tau)^2}{16}.$$

Case (d) ($c \geq 1/3$ and $\tau < (3c-1)$): The profits of the firms are:

$$\pi_{MH} = \frac{(1+\tau)^2}{9}, \ \pi_{1FH} = \frac{(1-2\tau)^2}{9}.$$

In country F, the former inefficient foreign firm becomes efficient because of spillover via integration. There are potentially three firms: the merged (efficient) firm, the efficient foreign firm, and the inefficient domestic firm. Depending on the values of τ and c, two cases appear in equilibrium: (a') the merged firm and the efficient foreign firm supply, (b') all firms supply.

Case (a') ($\tau \geq (1-3c)/3$): The profits of the firms are:

$$\pi_{MF} = \frac{1}{9}, \ \pi_{1FF} = \frac{1}{9}.$$

Case (b') ($\tau < (1-3c)/3$): The profits of the firms are:

$$\pi_{MF} = \frac{(1+c+\tau)^2}{16}, \ \pi_{1FF} = \frac{(1+c+\tau)^2}{16}, \ \pi_{2HF} = \frac{(1-3(c+\tau))^2}{16}.$$

Type (III): In this case, there are potentially three firms: the merged firm, the efficient foreign firm, and the inefficient foreign firm. In country H, depending on the values of τ and c, two cases appear in the presence of a merger: (a) the merged firm and the efficient foreign firm supply, (b) all firms supply.

Case (a) ($(1-3c)/2 \leq \tau < 1/2$): The profits of the firms are:

$$\pi_{MH} = \frac{(1+\tau)^2}{9}, \ \pi_{1FH} = \frac{(1-2\tau)^2}{9}.$$

Case (b) ($\tau < (1-3c)/2$ (if $c \geq 1/3$, this case does not appear)): The profits of the firms are:

$$\pi_{MH} = \frac{(1+c+2\tau)^2}{16}, \ \pi_{1FH} = \frac{(1+c-2\tau)^2}{16}, \ \pi_{2FH} = \frac{(1-3c-2\tau)^2}{16}.$$

The market structure in country F is equivalent to the basic one except the export of the inefficient domestic firm. From Proposition 1, we have the following result.

Case (a') ($\tau \geq (1+c)/3$): The profits of the firms are:

$$\pi_{1FF} = \frac{(1+c)^2}{9}, \ \pi_{2FF} = \frac{(1-2c)^2}{9}.$$

Case (b') ($c < 1/3$ and $\tau < (1+c)/3$): The profits of the firms are:

$$\pi_{MF} = \frac{(1+c-3\tau)^2}{16},\ \pi_{1FF} = \frac{(1+c+\tau)^2}{16},\ \pi_{2FF} = \frac{(1-3c+\tau)^2}{16}.$$

Case (c') ($c \geq 1/3$ and $(3c-1) \leq \tau < (1+c)/3$): The profits of the firms are:

$$\pi_{MF} = \frac{(1+c-3\tau)^2}{16},\ \pi_{1FF} = \frac{(1+c+\tau)^2}{16},\ \pi_{2FF} = \frac{(1-3c+\tau)^2}{16}.$$

Case (d') ($c \geq 1/3$ and $\tau < (3c-1)$): The profits of the firms are:

$$\pi_{MF} = \frac{(1-2\tau)^2}{9},\ \pi_{1FF} = \frac{(1+\tau)^2}{9}.$$

Type (IV): By symmetry, we only have to consider country H. There are potentially three firms: the merged inefficient domestic firm, the efficient domestic firm, the efficient foreign firm. The market structure in country H is equivalent to the basic one except the absence of the inefficient foreign firm. From Proposition 1, we have the following result.

Case (a) ($\tau \geq (1+c)/3$): The profits of the firms are:

$$\pi_{1HH} = \frac{(1+c)^2}{9},\ \pi_{MH} = \frac{(1-2c)^2}{9}.$$

Case (b) ($c < 1/3$ and $\tau < (1+c)/3$): The profits of the firms are:

$$\pi_{1HH} = \frac{(1+c+\tau)^2}{16},\ \pi_{MH} = \frac{(1-3c+\tau)^2}{16},\ \pi_{1FH} = \frac{(1+c-3\tau)^2}{16}.$$

Case (c) ($c \geq 1/3$ and $(3c-1) \leq \tau < (1+c)/3$): The profits of the firms are:

$$\pi_{1HH} = \frac{(1+c+\tau)^2}{16},\ \pi_{MH} = \frac{(1-3c+\tau)^2}{16},\ \pi_{1FH} = \frac{(1+c-3\tau)^2}{16}.$$

Case (d) ($c \geq 1/3$ and $\tau < (3c-1)$): The profits of the firms are:

$$\pi_{1HH} = \frac{(1+\tau)^2}{9},\ \pi_{1FH} = \frac{(1-2\tau)^2}{9}.$$

3.2 Profitability (incentive) and desirability (welfare) of a pairwise merger

We now compare *ex ante* and *ex post* profits of the firms. From the discussions in the previous section and the previous subsection, we can summarize the conditions of the exogenous parameters (c and τ) in the following tables.

Type (I): a cross-border merger of efficient firms (firms 1 and 1 in countries H and F merge).

Parameters		*ex ante*	*ex post*
c	τ	(Section 2.2)	(Section 3.1)
$\forall c \in (0, 1/2)$	$\tau \geq (1+c)/3$	(iv)	(a)
$c < 1/3$	$(1-2c)/3 \leq \tau < (1+c)/3$	(ii)	(a)
	$(1-3c)/3 \leq \tau < (1-2c)/3$	(ii)	(b)
	$\tau < (1-3c)/3$	(i)	(b)
$1/3 \leq c < 4/11$	$(1-2c)/3 \leq \tau < (1+c)/3$	(ii)	(a)
	$(3c-1) \leq \tau < (1-2c)/3$	(ii)	(b)
	$\tau < (3c-1)$	(iii)	(b)
$4/11 \leq c < 1/2$	$(3c-1) \leq \tau < (1+c)/3$	(ii)	(a)
	$(1-2c)/3 \leq \tau < (3c-1)$	(iii)	(a)
	$\tau < (1-2c)/3$	(iii)	(b)

Type (II): a cross-border merger of efficient and inefficient firms (firm 1 in country H and Firm 2 in country F merge).

Parameters		*ex ante*	*ex post*
c	τ	(Section 2.2)	(Section 3.1)
			(H,F)
$\forall c \in (0, 1/2)$	$\tau \geq (1+c)/3$	(iv)	(a,a')
$c < 1/3$	$(1-3c)/3 \leq \tau < (1+c)/3$	(ii)	(b,a')
	$\tau < (1-3c)/3$	(i)	(b,b')
$1/3 \leq c$	$(3c-1) \leq \tau < (1+c)/3$	(ii)	(c,a')
	$\tau < (3c-1)$	(iii)	(d,a')

Type (III): a domestic merger of efficient and inefficient firms (firms 1 and 2 in country H merge).

Parameters		*ex ante*	*ex post*
c	τ	(Section 2.2)	(Section 3.1)
			(H,F)
$c < 1/11$	$(1-3c)/2 \leq \tau < 1/2$	(iv)	(b,a')
	$(1+c)/3 \leq \tau < (1-3c)/2$	(iv)	(c,a')
	$(1-3c)/3 \leq \tau < (1+c)/3$	(ii)	(c,b')
	$\tau < (1-3c)/3$	(i)	(c,b')
$1/11 \leq c < 1/3$	$(1+c)/3 \leq \tau < 1/2$	(iv)	(b,a')
	$(1-3c)/2 \leq \tau < (1+c)/3$	(ii)	(b,b')
	$(1-3c)/3 \leq \tau < (1-3c)/2$	(ii)	(c,b')
	$\tau < (1-3c)/3$	(i)	(c,b')
$1/3 \leq c$	$(1+c)/3 \leq \tau < 1/2$	(iv)	(b,a')
	$(3c-1) \leq \tau < (1+c)/3$	(ii)	(b,c')
	$\tau < (3c-1)$	(iii)	(b,d')

Type (IV): a cross-border merger of inefficient firms (firms 2 and 2 in countries H and F merge).

Parameters		*ex ante*	*ex post*
c	τ	(Section 2.2)	(Section 3.1)
$\forall c \in (0, 1/2)$	$\tau \geq (1+c)/3$	(iv)	(a)
$c < 1/3$	$(1-3c)/3 \leq \tau < (1+c)/3$	(ii)	(b)
	$\tau < (1-3c)/3$	(i)	(b)
$1/3 \leq c$	$(3c-1) \leq \tau < (1+c)/3$	(ii)	(c)
	$\tau < (3c-1)$	(iii)	(d)

In each case, we have to check whether the merged firm's profit (*ex post* profit) is larger than the *ex ante* joint profits of firms involved in the merger. Since those calculations are simple but highly tedious, we summarize those calculations in four figures (Figures 1-a, b, c, and d).

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Figures 1-a, b, c, and d here

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The shaded areas of the left hand side figures represent the combinations of c and τ under which a merger is profitable. Furthermore, the shaded areas of the right hand side figures describe the the combinations of c and τ under which a merger is desirable from the viewpoint of social welfare. Here, we use the social surplus W as the criterion of welfare:

$$W = \frac{Q_H^2 + Q_F^2}{2} + \text{sum of firms' profits.} \tag{8}$$

Denoting the pre-merger and post-merger surpluses as W_t and W_m, respectively, a merger is desirable if and only if $W_m - W_t > 0$. Examining these figures, we have the following proposition.

Proposition 2 *When the trade cost is low and the cost difference is small, a merger is neither profitable nor desirable. Increases in trade cost are likely to make a cross-border merger profitable and desirable. Increases in the cost difference may make both cross-border and domestic mergers profitable and desirable.*

In our model, the following three factors affect merger profitability and desirability: (i) tariff jumping, (ii) technology spillover, and (iii) degree of competition. (i) is relevant to cross-border mergers and (ii) can make mergers between heterogeneous firms profitable and desirable. Moreover, any types of mergers changes the degree of competition, which affects the profitability and desirability of mergers. In the followings, we explore how these three factors affect profitability and desirability of a merger. Especially, we put emphasis on areas in which we observe discrepancies between profitability and desirability.

Before proceeding to each type of a merger, a few comments regarding overall tendencies are in order. First, a merger is neither profitable nor desirable at lower cost difference and lower trade cost, which is described in the lower left area of all these figures. Since firms are nearly homogeneous and there is little trade cost, non-profitability is explained by the well-known "Cournot merger paradox." Non-desirability comes from the reductions in the consumer surplus because a merger implies a decrease in the number of firms in the Cournot competition. Second, starting from the lower left area, increases in the trade cost and in the cost difference make a merger profitable and desirable, which is the results of tariff jumping and technology spillover, respectively. However, these effects work quite differently for different types of mergers. A larger trade cost does not make a domestic merger neither profitable nor desirable for the most part, whereas a merger is likely to become profitable and desirable under larger heterogeneity of firms except a merger of Type (I). In

this sense, a larger trade cost is in favor only of a cross-border merger whereas larger heterogeneity of firms increases both domestic and cross-border mergers.

We start from Type (I), which is described in Figure 1-a. In the lower right area of this figure, merger is profitable but undesirable. In this area, trade cost is low, and cost difference is large, which makes inefficient firms inactive in the absence of a merger. If a cross-border merger of efficient firms occurs, it becomes possible that inefficient firms earn positive profits and they become active. Then, although it's impossible for a merged firm to become a monopoly, it can still obtain a sufficient market share for a merger to be profitable because it competes with inefficient firms. Thus, in this area, although the tariff jumping effect is small, a cross-border merger of efficient firms reduces competition sufficiently for it to be profitable. However, because it makes inefficient firms active, losses in production inefficiency reduce welfare, making a cross-border merger of efficient firms profitable but undesirable. In the higher-left area, no firms exports in the absence of a merger and inefficient firms do not export in the presence of a merger. Hence, a merger does not alter the market structure, and it is indifferent to firms and to the welfare.

The results for Type (II) is described in Figure 1-b. In this case, profitability and desirability almost coincide: profitable mergers are always desirable and desirable mergers are almost profitable. In the higher-left area, again, no firms exports in the absence of a merger and inefficient firms do not export in the presence of a merger. Hence, a merger does not alter the market structure, and it is indifferent to firms and to the welfare.

Figure 1-c represents the case of Type (III). In the higher left area, we observe a discrepancy between profitability and desirability. When the cost difference is sufficiently small and firms are quite similar, social gains from a domestic merger via technology spillover is small and merger reduces intensity of competition, leading to the undesirability in the left area of this figure. On the other hand, in the higher left area, the trade cost is high and a domestic market is more isolated, yielding a higher incentive of a domestic merger. Thus, we observe discrepancy between profitability and desirability. In the lower-right area, inefficient firms are inactive both in the presence and in the absence of a domestic merger. Then, a domestic merger does not alter the market structure and hence it is neither profitable nor desirable.

Finally, Figure 1-d deals with Type (IV). In the lower-right area, a cross-border merger of inefficient firms is neither profitable nor desirable because of the small tariff jumping effect. In contrast, we can observe that it is not profitable but desirable in the lower-center area. In this area,

the market shares of inefficient firms shrink with a cross-border merger of inefficient firms, leading to the unprofitability. However, a merger of inefficient firms enables efficient firms to obtain larger shares, which lowers the price of manufactured goods in both domestic and foreign markets and raises the consumer surplus. Therefore, it is socially desirable. In the higher-left area, inefficient firms do not export their product in the absence of merger. In the right area, inefficient firms are inactive regardless of merger. Thus, in these areas, merger does not change the market structure and hence it is neither profitable nor desirable.

4 Analysis of mergers: merger waves

In this section, we explore the conditions under which we observe merger waves, that is, the conditions under which a pairwise merger is followed by another merger.

4.1 Profitability (incentive) and desirability (welfare) of the second pairwise merger

Before moving to the full analysis of merger waves, we need to examine whether there is incentive to merge for the remaining two firms given the pairwise merger described in the previous section. In doing so, we ignore the possibility of a merger of one firm and an already merged firm. We now mention four types of second pairwise mergers respectively: (I-2) firms 2 and 2 in countries H and F merge given that firms 1 and 1 in countries H and F merge, (II-2) firm 2 in country H and firm 1 in country F merge given that firm 1 in country H and firm 2 in country F merge, (III-2) firms 1 and 2 in country F merge given that firms 1 and 2 in country H merge, (IV-2) firms 1 and 1 in countries H and F merge given that firms 2 and 2 in countries H and F merge. In considering the incentive to merge, we again use the same criterion as that used in the previous section: gains from merger.

Type (I-2): By symmetry, we only have to consider country H. There are potentially two firms: the merged efficient domestic firm $M1$ and the merged inefficient domestic firm $M2$. There is only one case: both firms supply.

The profits of the firms are:

$$\pi_{M1H} = \frac{(1+c)^2}{9}, \ \pi_{M2H} = \frac{(1-2c)^2}{9}.$$

Type (II-2): By symmetry, we only have to consider country H. There are potentially two firms: the merged efficient domestic firms $MH1$ and $MH2$ (one of the firms becomes efficient because of spillover effects caused by the merger). There is only one case: both firms supply.
The profits of the firms are:

$$\pi_{MH1H} = \frac{1}{9},\ \pi_{MH2H} = \frac{1}{9}.$$

Type (III-2): In each country, there are potentially two firms: the merged efficient domestic firms MH and the merged efficient foreign firm MF. There is only one case: both firms supply.
In country H, the profits of the firms are:

$$\pi_{MHH} = \frac{(1+\tau)^2}{9},\ \pi_{MFH} = \frac{(1-2\tau)^2}{9}.$$

In country F, the profits of the firms are:

$$\pi_{MHH} = \frac{(1-2\tau)^2}{9},\ \pi_{MFH} = \frac{(1+\tau)^2}{9}.$$

Type (IV-2): By symmetry, we only have to consider country H. There are potentially two firms: the merged efficient domestic firm $M1$ and the merged inefficient domestic firm $MH2$. There is only one case: both firms supply.
The profits of the firms are:

$$\pi_{M1H} = \frac{(1+c)^2}{9},\ \pi_{M2H} = \frac{(1-2c)^2}{9}.$$

We now compare *ex ante* and *ex post* profits of the merged firms. We can use the conditions of the exogenous parameters (c and τ) in Section 3.2. In each case, we have to check whether the merged firm's profit (*ex post* profit) is larger than the *ex ante* joint profits of the merged firms. Since those calculations are simple but highly tedious, we summarize those calculations in four figures (Figures 2-a, b, c, and d).

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Figures 2-a, b, c, and d here

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4.2 Possibility of merger waves

Combining the results obtained thus far, we can explore the possibility of merger waves by analyzing a sequential merger game a la Nilssen and Sørgard [23]. More concretely, we provide a discussion of merger decisions made in sequence by disjoint groups of firms. In our model, there are two possible pairwise mergers that can take place in this industry.[9] We denote the two mergers that can potentially take place as M_1 and M_2, respectively. As discussed earlier, there are four types of sequential merger:

Type (I→I-2): M_1: Firms 1 and 1 in countries H and F, M_2: Firms 2 and 2 in countries H and F.

Type (II→II-2): M_1: Firm 1 in country H and firm 2 in country F, M_2: Firm 1 in country F and firm 2 in country H.

Type (III→III-2): M_1: Firms 1 and 2 in country H, M_2: Firms 1 and 2 in country F.

Type (IV→IV-2): M_1: Firms 2 and 2 in countries H and F, M_2: Firms 1 and 1 in countries H and F.

We now consider the following three-stage game. In this model, the industry is initially in the no-merger situation. There is an opportunity for the firms in M_1 to merge at stage one, and for the firms in M_2 to merge at stage two. Hence, M_1 is the first mover. The firms in M_2 observe whether or not M_1 has merged before they make their own merger decision. After merger decisions are made, the firms compete in the market.

In each type of merger, there are four situations that may occur $S \equiv \{s_0, s_1, s_2, s_3\}$.

Situation s_0: no merger takes place.

Situation s_1: the firms in M_1 merge while the firms in M_2 do not merge.

Situation s_2: the firms in M_2 merge while the firms in M_1 do not merge.

Situation s_3: both the firms in M_1 and the firms in M_2 merge.

Situation s_3 describes the merger waves.

The profit of entity τ in situation s is $\pi_\tau(s)$ and social surplus in situation s is $W(s)$, where

[9] Remind that we assumed that each merger consits of two firms and that we ignore a merger of one firm and an already merged firm.

$s \in S$ and $\tau \in \{1H, 2H, 1F, 2F, M_1, M_2\}$. We now define four labels Δ_i^1, Δ_i^2, Δ_i^3, and Δ_i^4 as follows:

$$\Delta_i^1 \equiv \pi_{Mi}(s_i) - \sum_{j \in M_i} \pi_j(s_0),\ i \in \{1,2\},$$

$$\Delta_i^2 \equiv \pi_{Mi}(s_3) - \sum_{j \in M_i} \pi_j(s_k),\ i,k \in \{1,2\},\ i \neq k,$$

$$\Delta_i^3 \equiv \pi_{Mi}(s_3) - \sum_{j \in M_i} \pi_j(s_0),\ i \in \{1,2\},$$

$$\Delta_i^4 \equiv \pi_{Mi}(s_i) - \sum_{j \in M_i} \pi_j(s_k),\ i \in \{1,2\},\ i \neq k.$$

If Δ_i^1 is positive, the merger of the firms in M_i increases their profits given that M_j does not merge. If Δ_i^2 is positive, the merger of the firms in M_i increases their profits given that M_j merges. If Δ_i^3 is positive, the sequential mergers increase the profits of the firms in M_i. If Δ_i^4 is positive, the firms in M_i prefers their own merger to the rival's merger.

We now denote four regimes, according to the signs of M_2's gains from merging, either alone (Δ_2^1) or after M_1 has merged (Δ_2^2):

$$\text{Regime 1 } (\Delta_2^1 \leq 0,\ \Delta_2^2 \leq 0): \begin{cases} \Delta_1^1 > 0 & s_1 \text{ appears,} \\ \Delta_1^1 \leq 0 & s_0 \text{ appears.} \end{cases}$$

$$\text{Regime 2 } (\Delta_2^1 > 0,\ \Delta_2^2 > 0): \begin{cases} \Delta_1^2 > 0 & s_3 \text{ appears,} \\ \Delta_1^2 \leq 0 & s_2 \text{ appears.} \end{cases}$$

$$\text{Regime 3 } (\Delta_2^1 \leq 0,\ \Delta_2^2 > 0): \begin{cases} \Delta_1^3 > 0 & s_3 \text{ appears,} \\ \Delta_1^3 \leq 0 & s_0 \text{ appears} \end{cases}$$

$$\text{Regime 4 } (\Delta_2^1 > 0,\ \Delta_2^2 \leq 0): \begin{cases} \Delta_1^4 > 0 & s_1 \text{ appears,} \\ \Delta_1^4 \leq 0 & s_2 \text{ appears.} \end{cases}$$

As mentioned in Nilssen and Sørgard [23](p.1689, Proposition 1), in regime r, M_1 should merge if and only if $\Delta_1^r > 0$, $r \in \{1,2,3,4\}$. In each regime, we check the sign of Δ_1^r and what situations appear under the exogenous parameters. Since those calculations are simple but highly tedious, we summarize those calculations in four figures (Figures 3-a, b, c, and d).

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Figures 3-a, b, c, and d here

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From these figures, we have the following proposition.

Proposition 3 *The large cost difference induces both domestic and cross-border merger waves that consist of mergers between heterogeneous firms. Cross-border merger waves that consist of mergers between firms of the same type are possible only when both the cost difference and trade cost are moderate.*

From Figure 3-b and Figure 3-c, it is noteworthy that a merger between heterogeneous firms always leads to merger waves. This result is very similar to that obtained in Salvo [29] (Proposition 1). However, quite different pictures emerge when we focus on mergers between firms of the same type. The first pairwise merger is unlikely to be followed by another merger when both the trade cost and cost difference are sufficiently large (See Figure 3-a, and Figure 3-d). This indicates that the possibility of merger waves depends on the type of firms involved in the lead-off merger.

5 Asymmetric countries

In this section, we examine the effects of asymmetry between countries on the profitability and desirability of mergers. Here, we restrict our attention only on a pairwise merger between two firms as in the case of myopic merger incentives described in Neary [24]. Consider n firms ($n > 2$) in each country. Among n firms, $\lambda_j n$ firms are efficient firms (type 1 firms) and $(1-\lambda_j)n$ firms are inefficient firms (type 2 firms), where $0 \leq \lambda_j \leq 1$. Note here that λ_j may differ between countries. Prices in a Cournot equilibrium when all firms engage in trade are given by

$$\begin{aligned} P_j &= 1 - Q_j \\ &= 1 - [\lambda_j n q_{1jj} + (1-\lambda_j) n q_{2jj} + \lambda_k n q_{1kj} + (1-\lambda_k) n q_{2kj}], \end{aligned}$$

and equilibrium outputs are determined by

$$\begin{aligned} q_{1jj} &= P_j \qquad \text{and} \qquad q_{1jk} = P_k - \tau, \\ q_{2jj} &= P_j - c \qquad \text{and} \qquad q_{2jk} = P_k - c - \tau. \end{aligned} \tag{9}$$

5.1 No trade cost case

As a benchmark analysis, we start with a case with no trade cost ($\tau = 0$), which enables us to abstract from examining trade patterns before/after mergers. In this case, it is indifferent for firms to sell their produced goods in both countries, and the conditions under which inefficient firms produce are given by

$$\lambda_H + \lambda_F < \Gamma \equiv \frac{1-c}{cn}.$$

Note here that it can be readily confirmed that the efficient firms always produce. Therefore, both types of firms produce if $\lambda_H + \lambda_F < \Gamma$. We assume this inequality to hold true throughout this subsection. As in Section 3, the merger incentive is examined by the profitability (7) of a merger that is defined as the difference between the profit of a firm after merger and the total profits of two firms before merger. The following proposition summarizes the merger in this case:[10]

Proposition 4 *There is no incentive of merger for two efficient firms, or for two inefficient firms. An efficient firm and an inefficient firm have incentive to merge if and only if $\lambda_H + \lambda_F > \Omega$.*

Here, Ω is defined as

$$\Omega \equiv \frac{4n(n-1) - 1 - c\left(12n^2 - 1\right)}{cn\left[4n(n-1) - 1\right]}.$$

Figure 4 describes the region in which a merger between heterogeneous firms is profitable. In the figure, the horizontal and vertical axes represent λ_H and λ_F, respectively.

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Figure 4 here

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First note that a merger between heterogeneous firms is profitable if there are a sufficiently large number of efficient firms in the economy as a whole. In this case, a merger implies a reduction in the number of inefficient firms, leading to a trade-off between increases in the price and reductions in the joint output of two merging firms compared to the pre-merger environment. When a lot of efficient firms are in the economy, the second effect becomes ignorable because the output of an inefficient firm in the pre-merger environment is sufficiently small. Second note that in the absence of trade

[10] See Appendix B for the proof of this proposition.

cost, a domestic merger has exactly the same impacts on the economy as a cross-border merger. Therefore, this case is very similar to that analyzed in Neary [24], in which all firms in one country have low costs and all firms in the other country have high costs. The focus of Neary [24] is on the merger impacts on the relationship between the degree of cost heterogeneity between countries and the specialization pattern of countries. In contrast, our focus here is on the relationship among merger, firm heterogeneity and the degree of asymmetry between countries. Finally, as the cost difference c becomes larger, Ω as well as Γ decrease. Therefore, if $\lambda_H + \lambda_F$ is sufficiently low and a merger between heterogeneous firms is unprofitable, successive increases in c will make the merger profitable. In this sense, larger heterogeneity leads to more mergers.

The assumption of no trade cost enables us to go one step further and we can examine when mergers described above is desirable from the welfare viewpoint even with asymmetric countries. Again, the criterion of welfare is the social surplus W that is given by (8). Denoting the pre-merger and post-merger surpluses as W_t and W_m, respectively, it is readily confirmed that

$$W_m - W_t = \frac{c^2 \left[3 + 8n\left(1+n\right)\right]}{4\left(1+2n\right)^2} \left(\lambda_H + \lambda_F - \Gamma\right)\left(\lambda_H + \lambda_F - \Phi\right),$$

where Φ is defined as

$$\Phi \equiv \frac{c\left[4n\left(8n^2+4n-1\right)-3\right] - 16n^3 + 8n + 3}{cn\left[8n\left(1+n\right)+3\right]}.$$

From this, we have the following proposition:

Proposition 5 *A merger between an efficient firm and an inefficient firm is desirable if and only if* $\lambda_H + \lambda_F < \Phi$.

Once we compare Φ with Γ and with Ω, we observe three possible cases, which are described in Figures 5-a, b, and c.[11]

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Figures 5-a, b, and c here

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[11] See Appendix C for details.

Figure 5-a represents the case of small cost difference c. In this case, Φ is small and the desirability of a merger requires that there are only few efficient firms in the economy. This is because small cost difference implies small gains from improving efficiency by a merger, which dominates the loss from decreasing number of firms only when efficient firms are scarce. As a result, profitable mergers are not desirable whereas desirable mergers are not profitable. As the cost difference gets larger, the effect of improving efficiency becomes larger and the region in which a merger is desirable also becomes larger, leading to Figure 5-b. Now a part of profitable mergers are desirable. When the cost difference is sufficiently large, as seen in Figure 5-c, all profitable mergers become desirable.

5.2 Positive trade cost case

We introduce the trade cost into the economy described in the previous section. In this section, we use a numerical example in examining how firm heterogeneity and trade costs affect the incentive of merger. We specify n as 5. Moreover, we focus on the case in which all firms engage in trade before and after mergers, which hold true if $c \leq 2/25$ and $\tau \leq 1/50$. Here, we present the case of small ($c = 1/25$), moderate ($c = 3/50$), and large ($c = 2/25$) cost difference. In each case, we consider a low ($\tau = 1/100$), moderate ($\tau = 3/200$), and high ($\tau = 1/50$) trade cost. Figures 6-a, b, and c show the incentive of a pairwise merger.

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Figures 6-a, b, and c here

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In the figures, again, the horizontal and vertical axes represent λ_H and λ_F, respectively. A pairwise merger is profitable for (λ_H, λ_F) in the shaded regions. Because a domestic merger between firms of the same type is never profitable, we examine Type (i): a cross-border merger between efficient firms (1 and 1), Type (II): that between low and inefficient firms (1 and 2), Type (III): a domestic merger between low and inefficient firms (1 and 2), and Type (IV): a cross-border merger between inefficient firms (2 and 2).

When the cost difference is small, any types of merger is not profitable (Figure 6-a). As the cost difference gets larger, some types of merger become profitable (Figures 6-b and c). In this sense, larger heterogeneity leads to higher incentives of mergers. Moreover, Figures 6-b and c show that a

high trade cost leads to higher incentive of cross-border mergers whereas it may lower incentives of domestic mergers. Among cross-border mergers, it is most likely that the one between heterogeneous firms is profitable. A merger between inefficient firms is less likely to be profitable but may be still profitable for a sufficiently high trade cost. A merger between efficient firms is the least profitable.

6 Concluding remarks

We investigated the role of firm heterogeneity in considering M&As in the international economy. We showed that larger firm heterogeneity leads to proliferation of both domestic and cross-border mergers and that whether or not the first pairwise merger leads to merger waves depends on the types of firms involved in it. Furthermore, we uncovered the conditions under which one can find discrepancy between profitability and desirability for a merger. Although we don't intend to claim that our arguments took all things regarding M&As into consideration, it would be safe to say that our analysis shed some light on the important features of M&As. Especially, given the important literature on firm heterogeneity in the field of international trade, our results would play an important role of working as a bridge between this trade literature and M&A literature.

Appendix A. Derivations of trade patterns

This appendix describes the formal derivations of trade patterns. Note first that any firm obtains positive profit from domestic sales whenever profit from export is positive. Note further that efficient firms obtains positive profit from domestic sales (from export) whenever inefficient firms obtain positive profit from domestic sales (from export). Note finally that the assumption $c < 1/2$ ensures that all firms earn positive profit under autarky. Then, possible cases are the followings: pattern (i): All firms supply goods in both countries. Pattern (ii): All firms supply goods in a domestic market but only efficient firms export. Pattern (iii): only efficient firms are active, and they supply goods in both countries. Pattern (iv): all firms supply goods in a domestic market but no firms export (autarky).

Pattern (i) is fully described in the main text and we obtain

$$r_{1jd} > 0, \forall \tau > 0 \qquad \text{and} \qquad r_{1jx} > 0 \Leftrightarrow \tau < \frac{1+2c}{3} \tag{A1}$$
$$r_{2jd} > 0 \Leftrightarrow \tau > \frac{3c-1}{2} \qquad \text{and} \qquad r_{2jx} > 0 \Leftrightarrow \tau < \frac{1-3c}{3}.$$

In pattern (ii), firms' profits in country j are given as

$$\pi_{1j} = P_j q_{1jj} + (P_k - \tau) q_{1jk},$$
$$\pi_{2j} = (P_j - c) q_{2jj},$$

and the total supply Q in country j is given by $Q_j = q_{1jj} + q_{2jj} + q_{1kj}$. Hence, the supply functions become

$$q_{1jj} = \frac{1+c+\tau}{4} \qquad \text{and} \qquad q_{1jk} = \frac{1+c-3\tau}{4},$$
$$q_{2jj} = \frac{1+c+\tau}{4}.$$

Substituting the above equations into (1), we obtain

$$r_{1jd} > 0, \forall \tau > 0 \qquad \text{and} \qquad r_{1jx} > 0 \Leftrightarrow \tau < \frac{1+c}{3}, \tag{A2}$$
$$r_{2jd} > 0 \Leftrightarrow \tau > 3c - 1.$$

Similarly. pattern (iii) yields

$$\pi_{1j} = P_j q_{1jj} + (P_k - \tau) q_{1jk}, \tag{A3}$$
$$q_{1jj} = \frac{1+\tau}{3} \qquad \text{and} \qquad q_{1jk} = \frac{1-2\tau}{3},$$
$$r_{1jd} > 0, \forall \tau > 0 \qquad \text{and} \qquad r_{1jx} > 0 \Leftrightarrow \tau < \frac{1}{2}.$$

Finally, in pattern (iv), we have

$$\pi_{1j} = P_j q_{1jj}, \tag{A4}$$
$$\pi_{2j} = (P_j - c) q_{2jj},$$
$$r_{1jd} > 0, \forall \tau > 0,$$
$$r_{2jd} > 0, \forall \tau > 0.$$

From (A1), we know that pattern (i) is possible for some positive trade cost τ only when $0 < c \leq 1/3$. Hence, we consider the case of $0 < c \leq 1/3$ and that of $1/3 < c < 1/2$ separately. We start from the case of $0 < c \leq 1/3$. In this case, both firms earn positive profit from export as well as domestic sales for τ smaller than $(1-3c)/3$, and thus pattern (i) appears. Note further that only pattern (i) happens when $0 < \tau < (1-3c)/3$ because each firm supplies goods whenever the price exceeds the cost of supply (See (3)). Put differently, when $0 < \tau < (1-3c)/3$, even inefficient firms can earn from export and other patterns (say, pattern (ii)) cannot be equilibrium. If τ becomes larger than $(1-3c)/3$, (A1) implies that inefficient firms cannot earn from export, and the economy is now in pattern (ii). Pattern (ii) holds true as long as $(1-3c)/3 \leq \tau < (1+c)/3$ (see (A2)). For $\tau = (1+c)/3$, export is not profitable even for efficient firms, and the economy is in the autarky (pattern (iv)) when $\tau > (1+c)/3$.

In the case large cost difference ($1/3 < c < 1/2$), it is convenient to start from pattern (ii), which is, from (A2), now possible when $0 < 3c - 1 < \tau < (1+c)/3$. For $\tau = 3c - 1$, even domestic sales are not profitable for inefficient firms and they stop producing goods, and pattern (iii) emerges. Because $3c - 1 < 1/2$, (A3) implies that pattern (iii) holds true when $0 < \tau \leq 3c - 1$. Meanwhile, when $\tau = (1+c)/3$, export is not profitable even for efficient firms, and the economy is in the autarky (pattern (iv)) when $\tau > (1+c)/3$.

Appendix B. Pairwise mergers under asymmetric countries with no trade cost

In this case, it is sufficient to consider the following three cases because we need not to distinguish between the domestic merger from a cross-border merger: (i) efficient firms merge, (ii) efficient and inefficient firms merge, and (iii) inefficient firms merge. Moreover, it is obvious that a merger between firms of the same type is not profitable, i.e., (i) and (iii) are not profitable for $\forall \lambda_j \in [0, 1]$ and $\forall n > 2$.

Therefore, it is sufficient to consider only (ii). When an efficient firm in H and an inefficient firm in F merge, the total outputs of H and F are given by

$$Q_H = q_{mH} + (\lambda_H n - 1)q_{1HH} + (1-\lambda_H)nq_{2HH} + \lambda_F n q_{1FH} + [(1-\lambda_F)n - 1]q_{2FH},$$

$$Q_F = q_{mF} + (\lambda_H n - 1)q_{1HF} + (1-\lambda_H)nq_{2HF} + \lambda_F n q_{1FF} + [(1-\lambda_F)n - 1]q_{2FF}.$$

The first order conditions for profit maximization become (9) with $\tau = 0$ and

$$q_{mj} = P_j.$$

The merger incentive In is now described by

$$In = \pi_m - \pi_{1H} - \pi_{2F}.$$

In this case, we observe that

$$\begin{aligned} &In > 0 \\ &\quad \Leftrightarrow \lambda_H + \lambda_F < \Gamma \qquad \text{and} \qquad \lambda_H + \lambda_F > \Omega, \end{aligned}$$

where

$$\Omega \equiv \frac{4n\,(n-1) - 1 - c\left(12n^2 - 1\right)}{cn\,[4n\,(n-1) - 1]}.$$

Note here that

$$\Gamma - \Omega = \frac{4 + 8n}{4n\,(n-1) - 1} > 0.$$

Because we assume that $\lambda_H + \lambda_F < \Gamma$, $In > 0$ if and only if $\lambda_H + \lambda_F > \Omega$.

Appendix C. Profitability and desirability of a pairwise merger

Note first that in this subsection, a merger is profitable if and only if $\lambda_H + \lambda_F > \Omega$, and it is desirable if and only if $\lambda_H + \lambda_F < \Phi$ because we consider only the case of $\lambda_H + \lambda_F < \Gamma$. Moreover, we already know that $\Gamma > \Omega$. Simple comparison yields

$$\Phi > \Omega \qquad \Leftrightarrow \qquad c > \frac{n[4n(n-1) - 1]}{8n^3 - 2n^2 + 1}$$

and

$$\Phi > \Gamma \qquad \Leftrightarrow \qquad c > \frac{2n}{1 + 4n}.$$

Therefore, when $c \leq n[4n(n-1) - 1]/(8n^3 - 2n^2 + 1)$, we have Figure 5-a. And when $n[4n(n-1) - 1]/(8n^3 - 2n^2 + 1) < c \leq 2n/(1+4n)$, we observe Figure 5-b. Finally, the case in which $c > 2n/(1+4n)$ leads to Figure 5-c.

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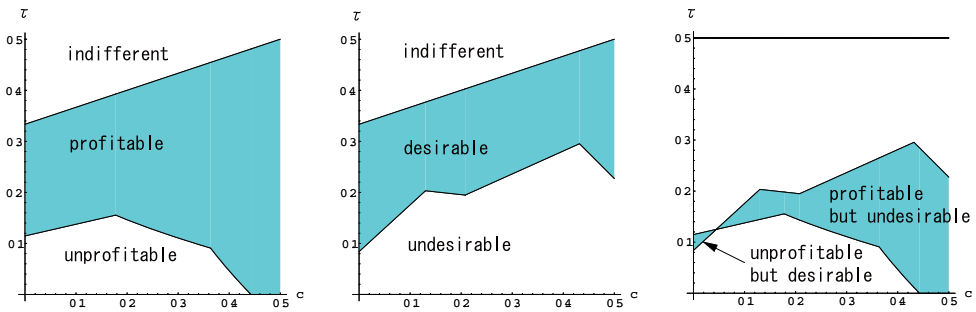
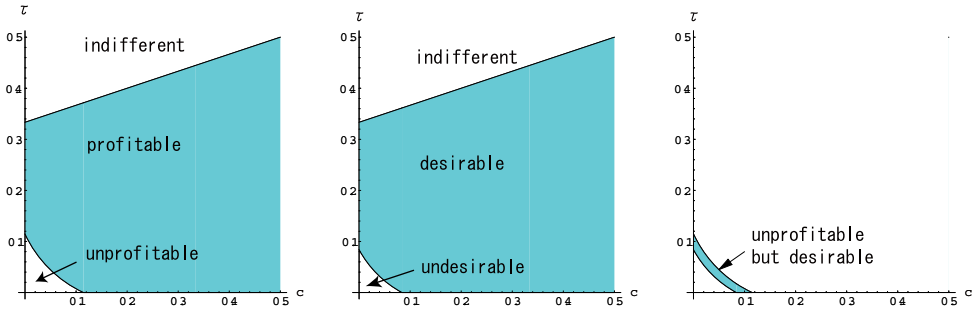


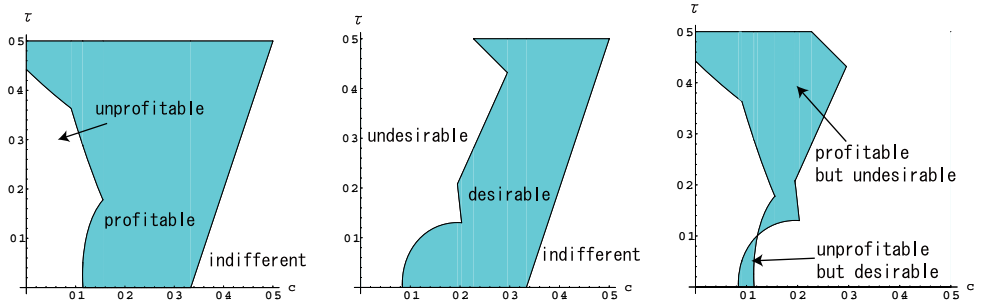
(profitability) (desirability) (discrepancy)

Figure 1-a: Profitability and desirability of a pairwise merger (Type (I): a cross-border merger of efficient firms (firms 1 in H and 1 in F)).



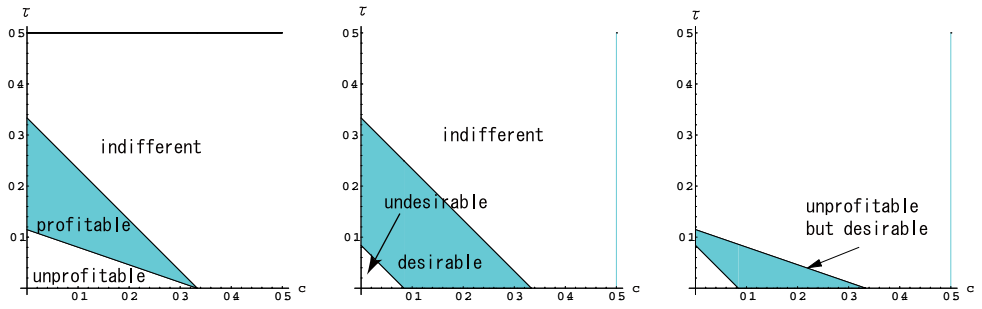
(profitability) (desirability) (discrepancy)

Figure 1-b: Profitability and desirability of a pairwise merger (Type (II): a cross-border merger of efficient and inefficient firms (firms 1 in H and 2 in F)).



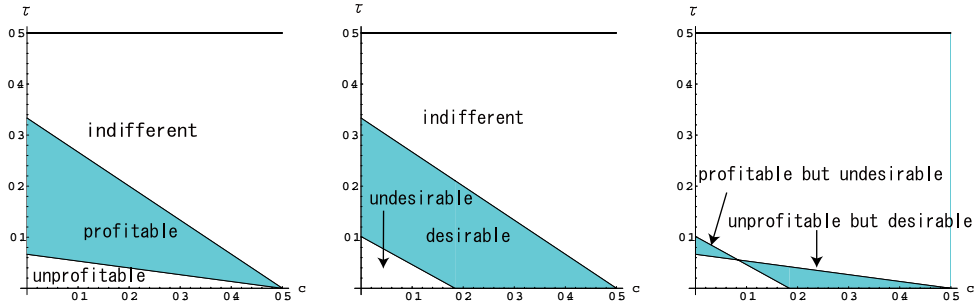
(profitability) (desirability) (discrepancy)

Figure 1-c: Profitability and desirability of a pairwise merger (Type (III): a domestic merger of efficient and inefficient firms (firms 1 and 2 in H)).



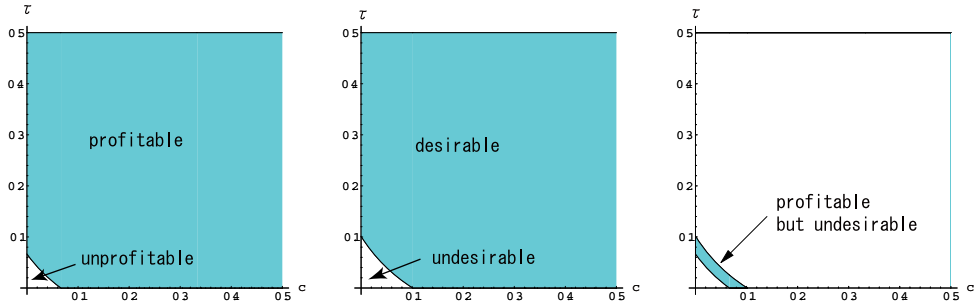
(profitability) (desirability) (discrepancy)

Figure 1-d: Profitability and desirability of a pairwise merger (Type (IV): a cross-border merger of inefficient firms (firms 2 in H and 2 in F)).



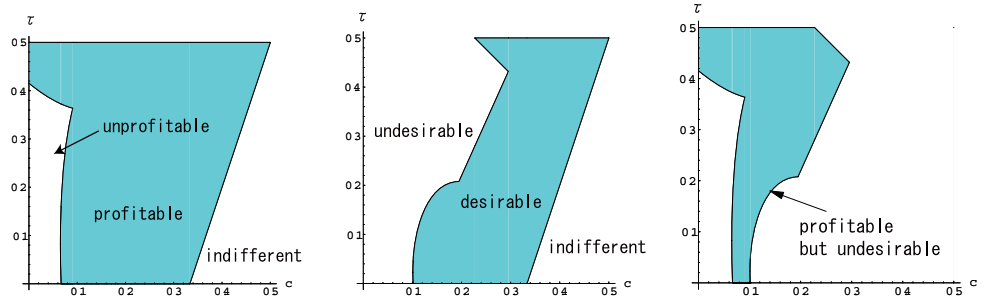
(profitability) (desirability) (discrepancy)

Figure 2-a: Profitability and desirability of the second pairwise merger (Type (I-2)).



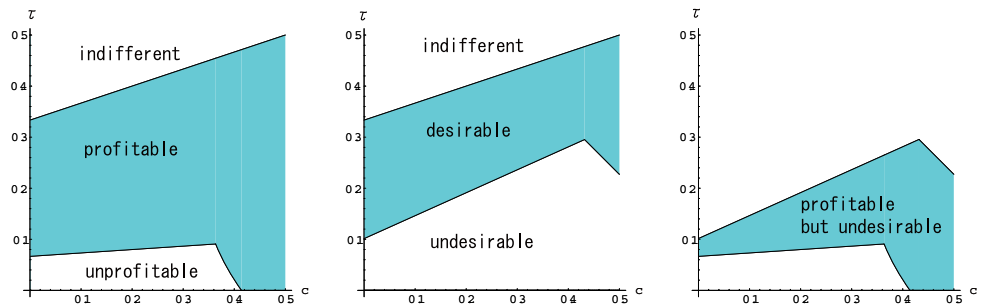
(profitability) (desirability) (discrepancy)

Figure 2-b: Profitability and desirability of the second pairwise merger (Type (II-2)).



(profitability) (desirability) (discrepancy)

Figure 2-c: Profitability and desirability of the second pairwise merger (Type (III-2)).



(profitability) (desirability) (discrepancy)

Figure 2-d: Profitability and desirability of the second pairwise merger (Type (IV-2)).

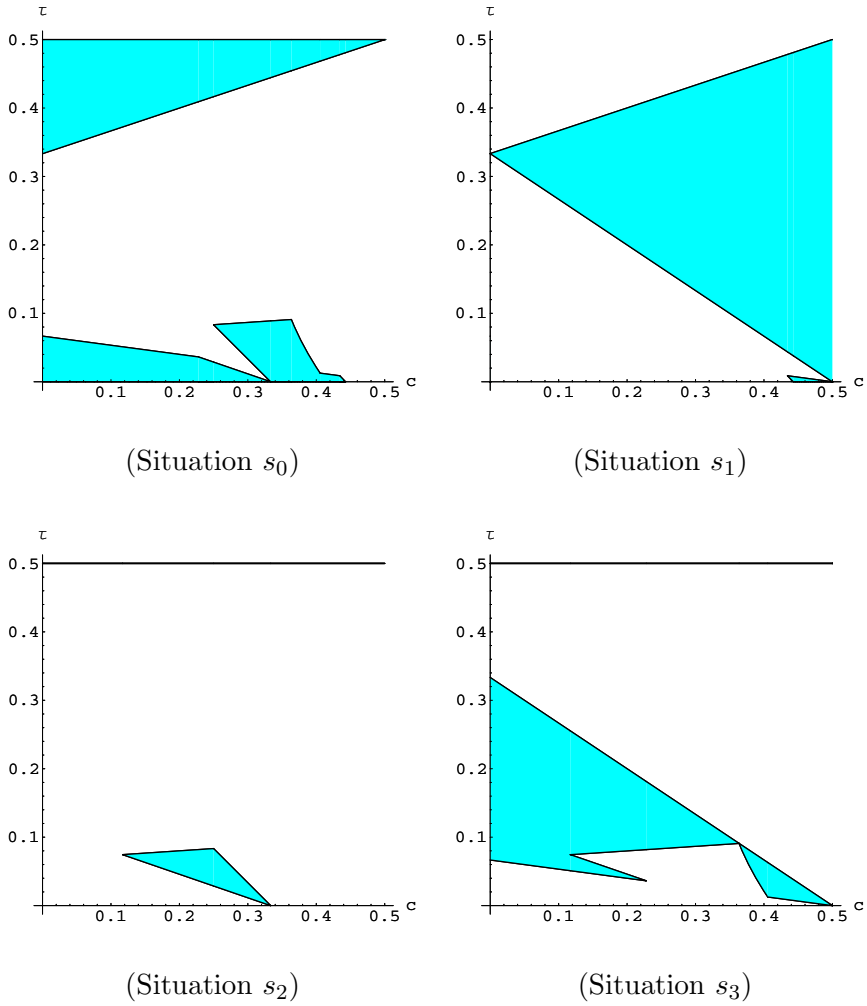
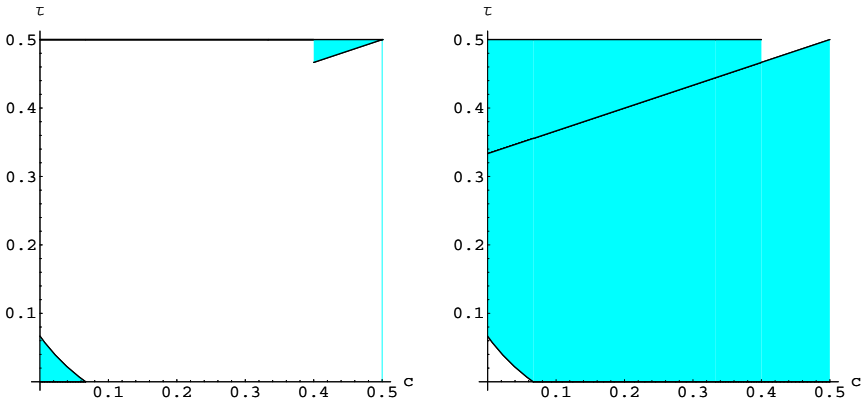
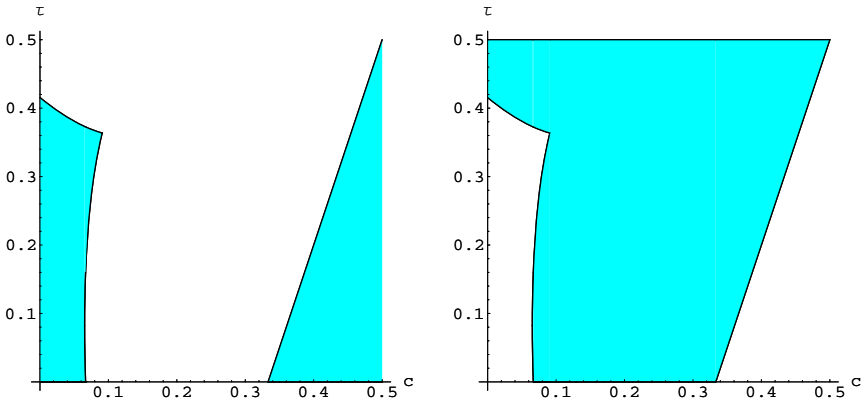


Figure 3-a: Sequential mergers (Type (I → I-2)).



(Situation s_0) (Situation s_3)

Figure 3-b: Sequential mergers (Type (II → II-2)).



(Situation s_0) (Situation s_3)

Figure 3-c: Sequential mergers (Type (III → III-2)).

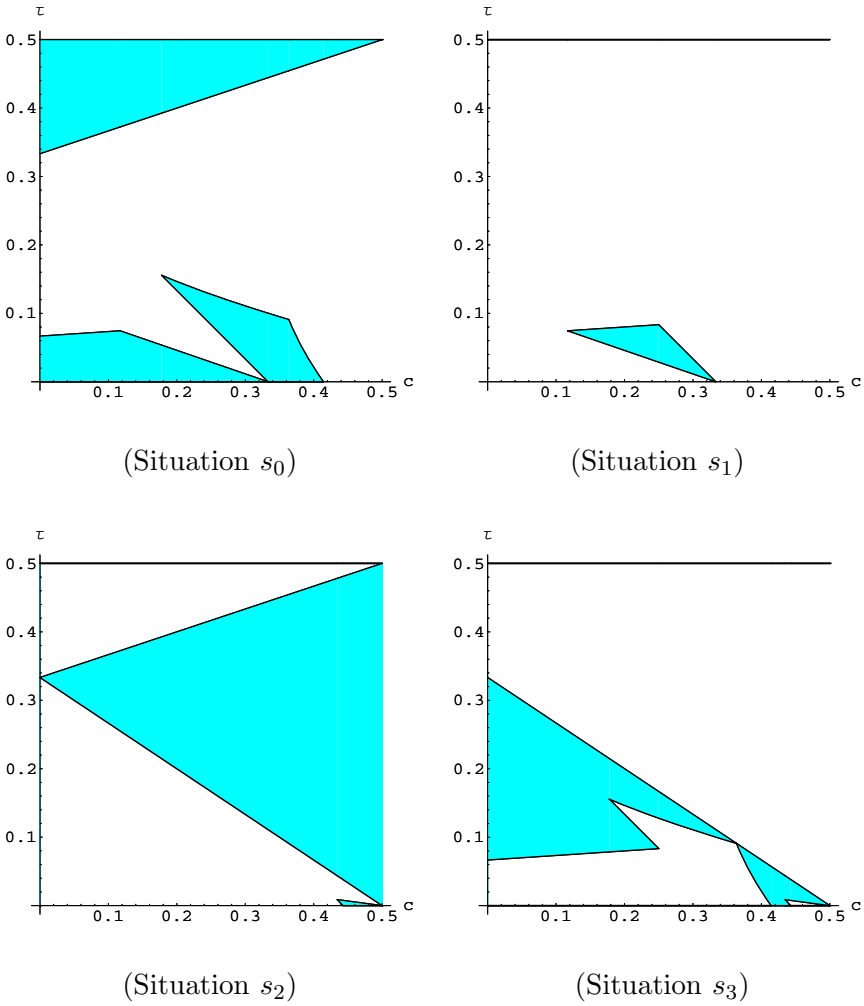


Figure 3-d: Sequential mergers (Type (IV → IV-2)).

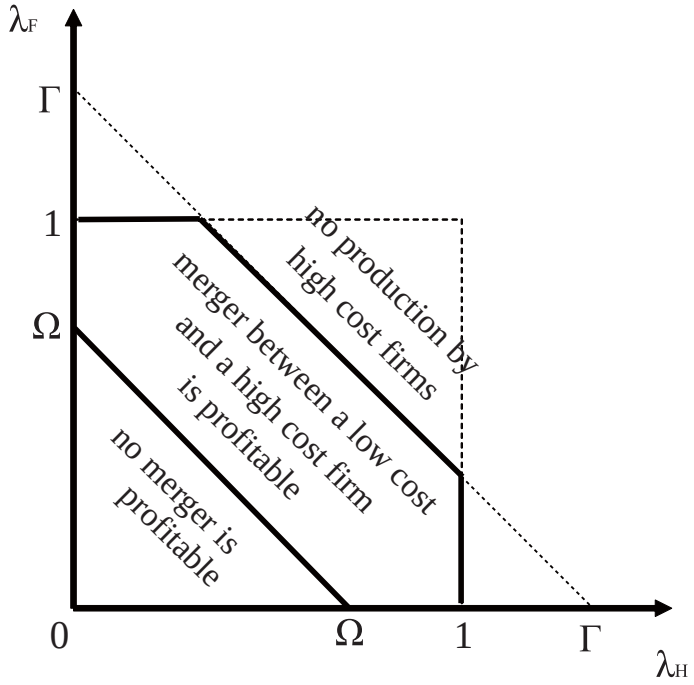


Figure 4: Merger incentive under country asymmetery with no trade cost.

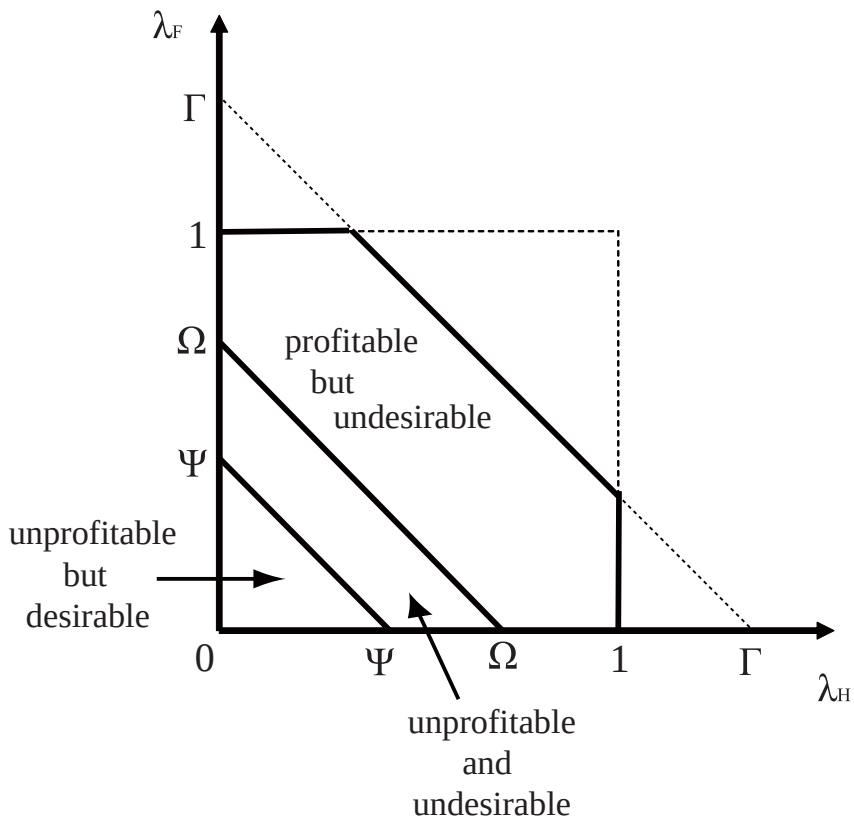


Figure 5-a: Profitability and desirability: The case of small cost difference ($c \leq n[4n(n-1)-1]/(8n^3-2n^2+1)$).

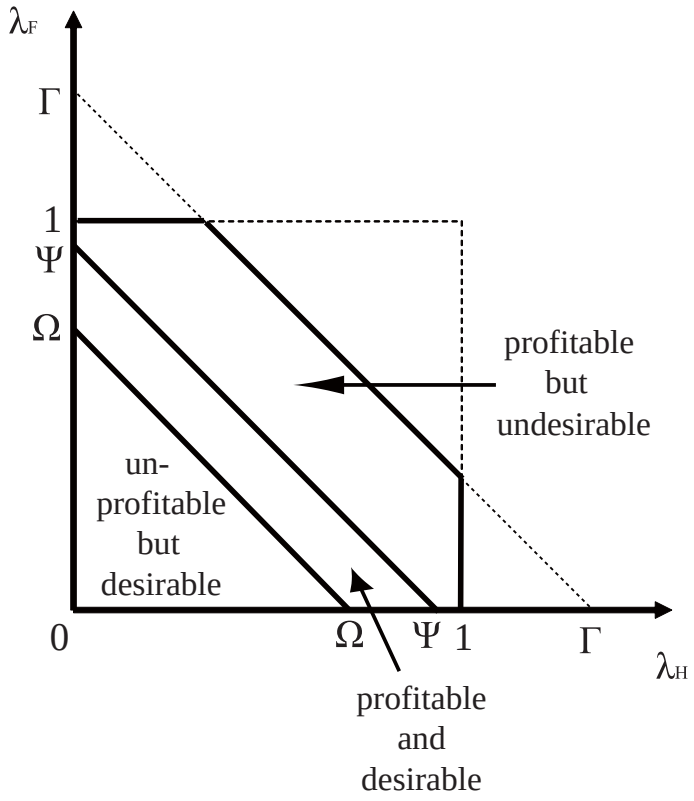


Figure 5-b: Profitability and desirability: The case of moderate cost difference $(n[4n(n-1)-1]/(8n^3-2n^2+1) < c \leq 2n/(1+4n))$.

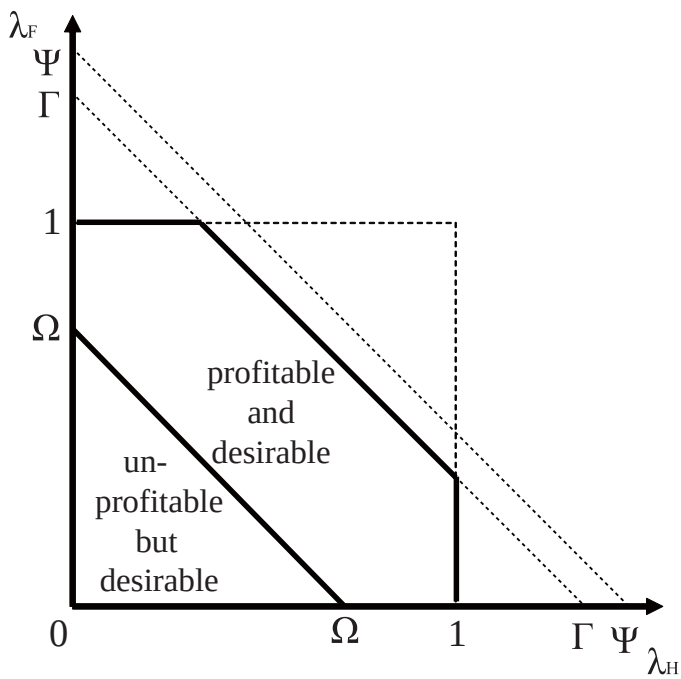


Figure 5-c: Profitability and desirability: The case of large cost difference ($c > 2n/(1+4n)$).

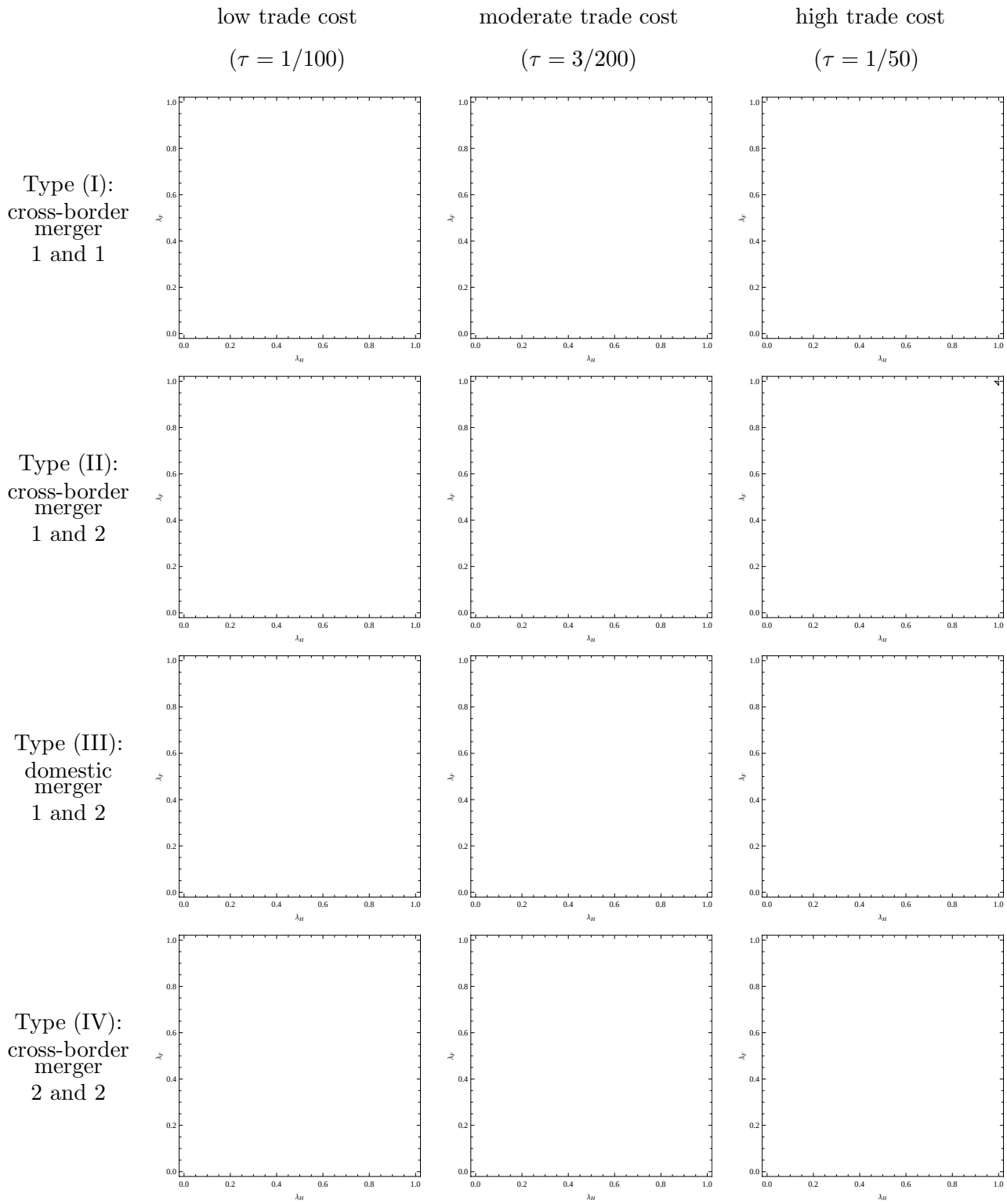


Figure 6-a: Merger incentive under country asymmetery with trade cost: The case of small cost difference ($c = 1/25$).

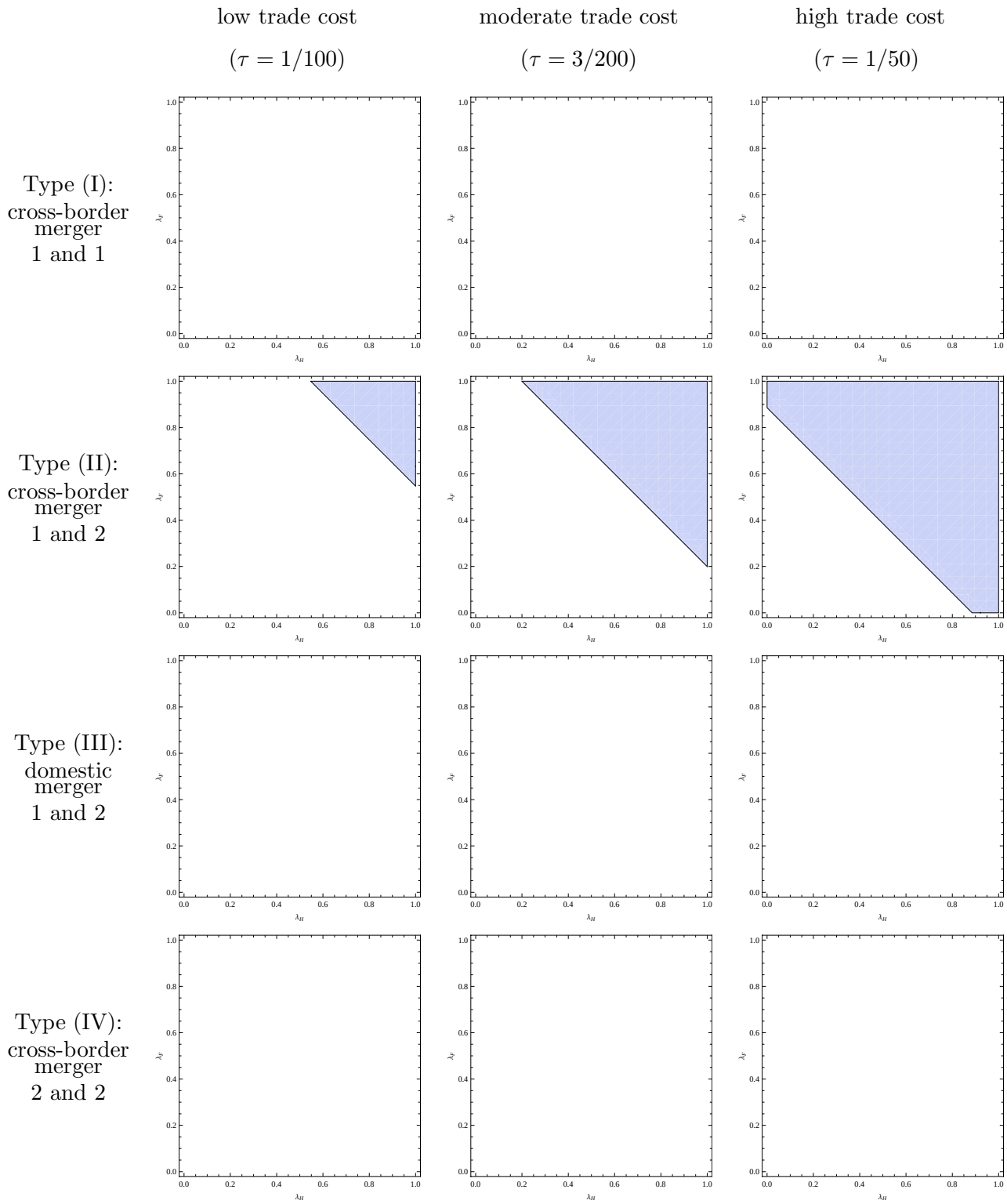


Figure 6-b: Merger incentive under country asymmetery with trade cost: The case of moderate cost difference ($c = 3/50$).

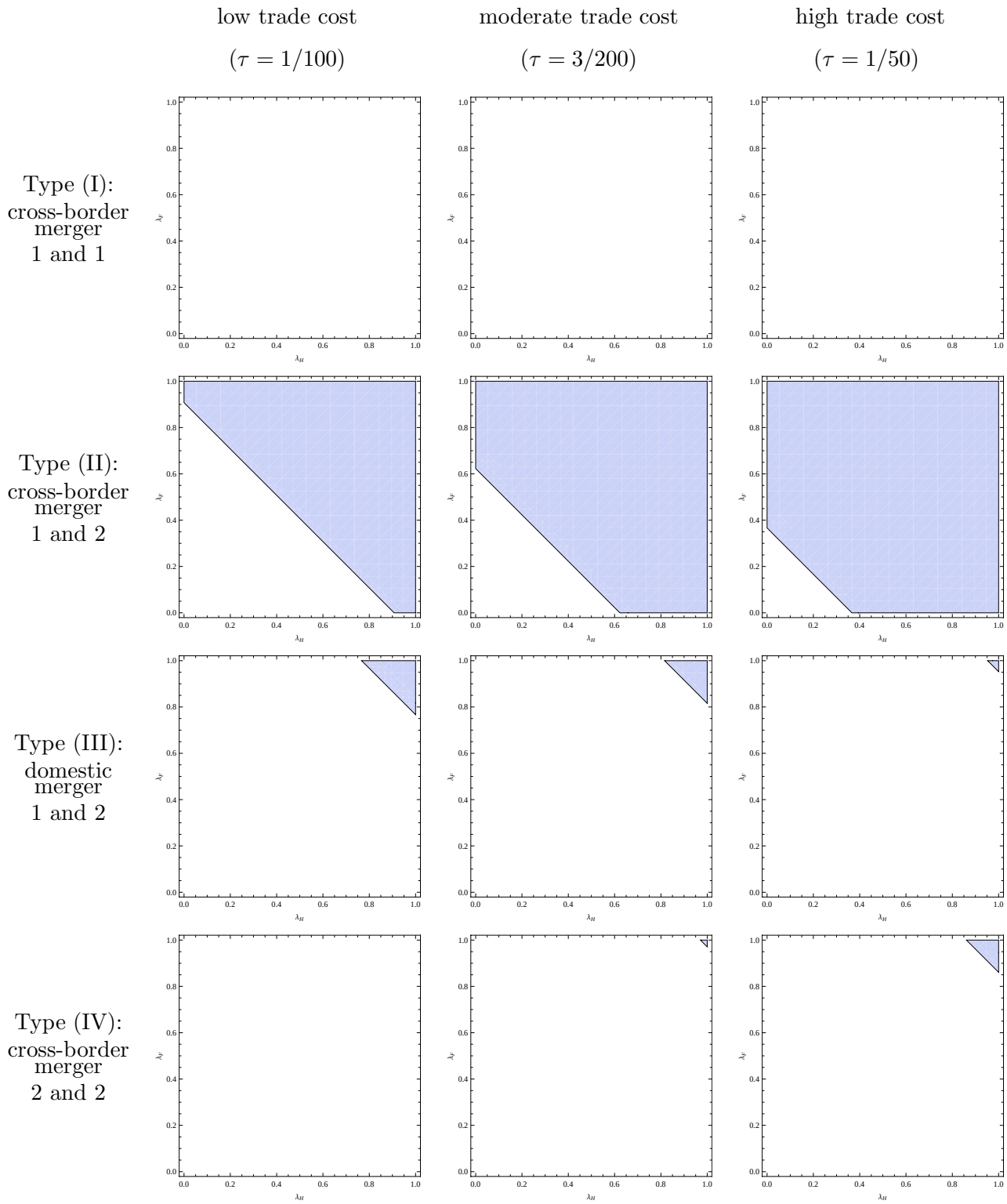


Figure 6-c: Merger incentive under country asymmetery with trade cost: The case of large cost difference ($c = 2/25$).