Rules of origin and regional upstream competition

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Abstract

Rules of origin (ROO) in a free trade area (FTA) define the level of regional content required for firms to enjoy preferential access. Hence, ROO govern inter-firm transactions between upstream and downstream firms. We show that asymmetric multiple equilibria in the downstream market, where one firm meets ROO while the other does not, can emerge because of regional upstream competition. Importantly, our results, which correspond to the real situation, maximize consumer surplus for the final-good importer and the total welfare of the FTA. Therefore, if practitioners in member countries promote FTA utilization, such a policy may backfire.

Key words: Rules of origin; Inter-firm transactions; Upstream competition; FTA utilization

JEL classification: F12; F13; L13; D43

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1 Introduction

As of August 2025, 405 free trade areas/agreements (FTAs) are in force worldwide,[1] and as they have spread, a particular system has attracted researchers' attention: rules of origin (ROO).[2] This is because, without ROO, third parties outside the FTA can engage in *circumvention exports*, which causes the benefits of the FTA to vanish. ROO represent a system that determines the origin of goods and prevents circumvention exports. Hence, ROO are an essential component of FTAs. When final-good producers (i.e., downstream firms) use a certain amount of inputs produced within the FTA, they can meet the ROO requirements,[3] and hence enjoying duty-free access. Conversely, if downstream firms do not meet the ROO, they must pay the external tariff of the destination member country. Figure 1 illustrates downstream firms' duty-free access.

For an FTA with ROO, if a firm enters the regional upstream market, the input price falls because of increased competition. A lower regional input price reduces the cost of local procurement, which strengthens downstream firms' incentive to meet ROO. Hence, competition in the regional upstream market influences downstream firms' decision on whether to comply with (or meet) ROO. When downstream firms meet ROO, they must use more regional inputs to satisfy the requirements, which makes transactions between downstream and regional upstream firms more active. Thus, ROO represent an institution that defines the *interfirm transaction*, specifically regulating vertical relationships.

[1]See, for example, the following website https://www.jetro.go.jp/biznews/2025/04/cd0827bb342311aa.html

[2]Without ROO, a third party outside an FTA briefly ships its product to the member country of the FTA with the lowest external tariff rate and ships the product from there to other members. This action is referred to as **circumvention exporting**; hence, an outflow of the benefits of the FTA occurs. ROO can prevent third parties from circumvention exporting; therefore, ROO represent a regulation indispensable to FTAs.

[3]The fundamentals of ROO can be defined using four types of criteria: (i) domestic content, defined in terms of value added or physical content; (ii) change in tariff heading; (iii) a specified process that must be performed within the area; and (iv) a product having been substantially transformed (Krishna, 2006; Krishna and Krueger, 1995).

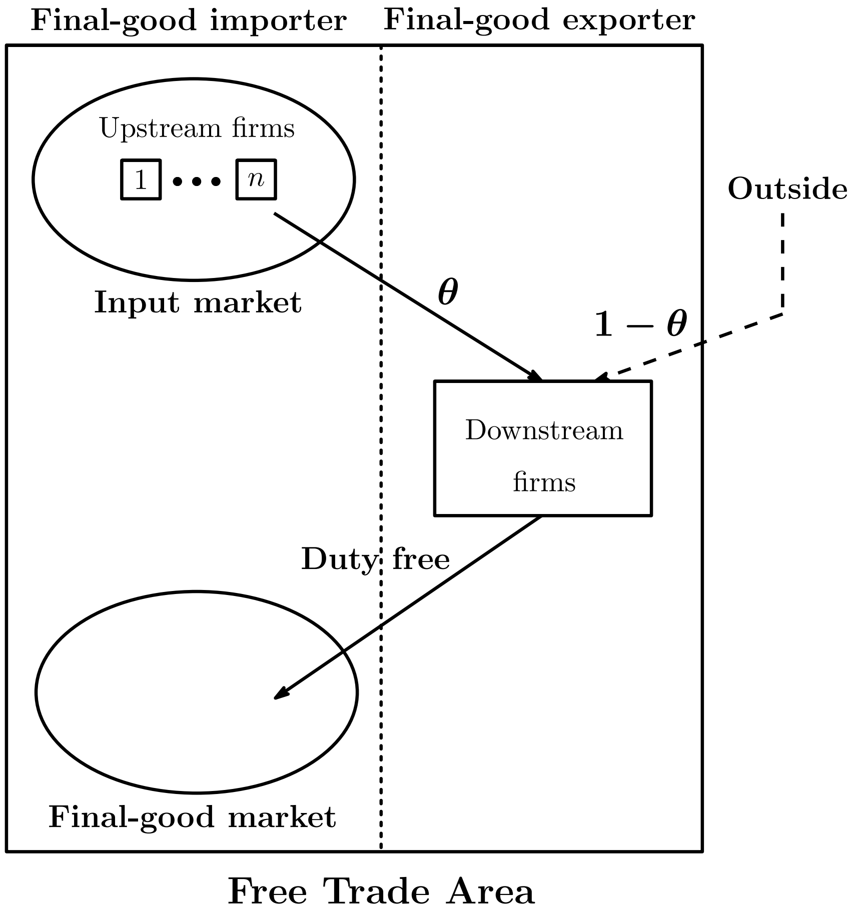

Figure 1: Case in which downstream firms comply with ROO

Note: The variable $\boldsymbol{\theta}$ is the FTA content rate.

First, we show that with two symmetric downstream firms, an asymmetric multiple equilibrium, where one firm meets ROO and the other does not, can arise. We build a model in which two downstream firms engaged in quantity competition first decide whether to comply with ROO. Subsequently, many regional upstream firms engage in price competition and set their prices. If both downstream firms comply, input demand is maximized; knowing this, upstream firms set the highest input price. A downstream firm has an incentive to choose non-compliance when the external tariff is at an intermediate level. This is because if a firm unilaterally deviates from full compliance, the high input price drops discontinuously, which allows it to maintain a cost advantage over its rival, whose costs remain high. Conversely, if both firms initially choose non-compliance, a firm considering unilateral compliance knows that upstream firms would set a higher price. However, upstream firms also recognize that input demand arises only if a downstream firm meets ROO. Thus, they will not raise prices dramatically if only one firm complies. This gives a downstream firm an incentive to deviate from mutual non-compliance.

We also show that consumer surplus for the final-good importer within the FTA can be maximized in the mixed regime (where one downstream firm meets ROO and the other does not). Furthermore, FTA welfare, defined as the sum of the total surpluses for all member countries, can also be maximized in this regime. When the external tariff is at an intermediate level, total output is highest in the mixed regime. As a result, the final-good price is lowest, which leads to a larger consumer surplus in the mixed regime than other regimes. At intermediate tariff levels, FTA welfare in both the all-complier regime (all downstream firms meet ROO) and the no-complier regime (neither downstream firm meets ROO) is not maximized because consumer surplus and tariff revenue are relatively small. In this case, the mixed regime yields the highest welfare among all regimes.

Our main contribution is to show the conditions under which the "current real situation is optimal" for the FTA as a whole. Empirical studies report that the FTA utilization rate (i.e., the ROO compliance rate) is far from 100% (e.g., Anson et al., 2005; Hayakawa et al., 2023).[4] Therefore, we can interpret the scenario in which "one downstream firm meets ROO and the other does not" as reflecting the current situation. Our results not only provide new insights for studies on FTAs with ROO but also serve as a caution to practitioners planning to promote FTA utilization. Provided the *current situation* is optimal for an FTA, policy changes, such as a member country raising its external tariff, could trigger a regime change that reduces FTA welfare. Thus, unconditionally attempting to raise the FTA utilization rate could backfire.

This study is related to two main strands, **(a)** and **(b)**, of the literature on ROO. The studies

[4] According to Anson et al. (2005), on average, approximately 64% of Mexican firms were meeting the ROO of NAFTA. Using firm-level data, Hayakawa et al. (2023) report that some firms use ROO, but others do not.

in **(a)** emphasize the role of ROO as a protecting device (e.g., Ju and Krishna, 2005; Krishna, 2006, 2015; Krishna and Krueger, 1995; Krueger, 1993; Takauchi, 2014; Tsirekidze, 2021).[5] The works in **(b)** focus on the role of ROO in the presence of Melitz (2003)-type firm heterogeneity (e.g., Cherkashin et al., 2015; Demidova et al., 2012; Demidova and Krishna, 2008; Head et al., 2024). Attention started to be paid to ROO at least as early as Krueger's (1993) paper, which indicates, using a numerical example, that NAFTA's ROO represent *hidden protectionism*. Krishna and Krueger (1995) compare the effects of two types of ROO comprising cost-based and price-based definitions. Krishna (2006) shows that the introduction of ROO raises production costs. Based on Krishna (2006) and Krishna and Krueger (1995), Krishna (2015) considers the effects of ROO under a general equilibrium framework. Using different models, Ju and Krishna (2005) and Takauchi (2014) show that a rise in the input price caused by complying with ROO leads to the following result: *some firms meet ROO and others do not*. Tsirekidze (2021) considers the endogenous formation of FTAs and the effects of ROO.

Demidova and Krishna (2008) incorporate ROO into the Melitz-type firm heterogeneity model and consider the effect of a fixed cost of ROO. Demidova et al. (2012) incorporate ROO into a Melitz-type framework of productivity differentials among firms and empirically examine the behavior of Bangladeshi garment exporters. By constructing a Melitz-style partial equilibrium framework, Cherkashin et al. (2015) consider the effects of ROO. Head et al. (2024)

[5]The following studies also emphasize ROO as a protecting device. Falvey and Reed (2002) provide a model in which producers account for value added. Takauchi (2011) considers cost-reducing R&D rivalry. Rodriguez (2001) considers continuous production cost. Rosellón (2000) considers the long-run effect of ROO. Additionally, the following studies consider the relation between ROO and firms' actions. Local content requirements (LCRs) are a policy similar to ROO in that they define the criterion for using domestic inputs in final goods. Krishna and Itoh (1988) and Lahiri and Ono (1998, 2003) consider the effects of LCRs on firm behavior. Mizuno and Takauchi (2018) emphasize the ROO compliance cost and the production cost fluctuation caused by meeting ROO. Mukunoki and Okoshi (2021) focus on the effect of the value-added criterion. Ornelas and Turner (2024) consider the bargaining problem with a supplier. Incorporating oligopoly into the upstream sector, Chung and Perroni (2025) empirically analyze the effect of ROO in the 1989 Canada–US FTA.

consider the sourcing strategy of firms with continuous costs and find that the regional content share is an inverted U-shaped function of the ROO requirements.

This paper substantially differs from previous studies in the following points. Although there are double Cournot models in group **(a)**, they tend to overlook upstream price competition. When upstream firms compete in price, because this has a different effect on the input price compared to the case where they compete in quantities, the behavior of downstream final goods firms faces a different effect. Thus, this can induce different results from the existing works. The research in group **(b)** is based on horizontal monopolistic competition, and hence, it does not place much emphasis on strategic interaction among firms. By contrast, we consider symmetric firms and show that asymmetric equilibrium arises even when the final goods producers are symmetric. This is a crucial difference from their Melitz-style research. Hence, our study complements the previous analyses.

The remainder of this paper is structured as follows: In Section 2, we present a baseline model. In Section 3, we analyze the model in detail. In Section 4, we perform welfare analysis of the main final-good importer within the FTA. Section 5 concludes the paper.

2 Model

We consider an FTA that consists of two countries (see Figure 1): one is a final-good importer and the other is a final-good exporter without a domestic final-good market.[6] For the final-good importer, an upstream market supplies inputs. Specifically, $n\,(\geq 2)$ upstream firms, that is, input suppliers, exist, and they engage in Dastidar (1995)-type homogenous price competition and sell at an input price $w > 0$. For the final-good exporter, there are two downstream

[6]That is, we mainly focus on the final-good importer that occupies the largest share of the final-good market in this FTA.

firms: firms 1 and 2.[7] They produce a homogeneous final good and export their products to the final-good importer, competing in quantities. To produce one unit of the final good, the downstream firms use one unit of the input from the upstream market of the final-good importer. Meanwhile, outside the FTA, there is also an upstream market, which is assumed to be a perfectly competitive market; thus, the input price w_O is normalized to zero. All inputs produced in the upstream markets within and outside the FTA are homogenous.

Note that if $w > w_O = 0$, the upstream market within the FTA is less efficient than that outside the FTA. Hence, the downstream firms can choose to purchase inputs from upstream firms either within or outside the FTA.

In our model, the FTA has ROO, which allows downstream firm i $(= 1, 2)$ to enjoy duty-free access when it supplies its products to the final-good market within the area, only when it uses at least the θ $(0 < \theta \leq 1)$ ratio of the input produced within the FTA; θ is the local procurement ratio inside the FTA. This means that to enjoy a preferential duty, which is duty free in our model, the downstream firms must meet the ROO requirement, that is, use at least the θ ratio of the FTA input. Figure 1 illustrates the situation in which the downstream firms meet ROO. Specifically, the downstream firms use the θ ratio of the inputs from the upstream market within the FTA and the $1 - \theta$ ratio of those from the perfectly competitive market outside the FTA. In such a situation, the downstream firms meet the ROO requirements and enjoy duty-free access, that is, they pay only for the consumption of inputs without any tariff. Following Krishna (2006, 2015) and Lahiri and Ono (1998, 2003), we use the FTA physical content definition as the ROO requirements.[8] In actual application, the following example is well known. NAFTA's ROO

[7]The equilibrium is the same even if one firm is in the final-good importing country and the other is in the final-good exporting country.

[8]Although the number is negligible, in practice, the physical-content definition is used. According to Krishna (2006), one example of the physical-content definition is from the cigarette industry in Australia. Beghin et al. (1997) also indicate that the tobacco industry in the US is similar.

adopt the "yarn principle" for textile products, meaning that fabrics made from yarn produced within the region are exempt from external tariffs (Fujii, 2018).[9] The main reason is that the essence of the ROO requirement can be considered as "at least use the FTA inputs responded to the requirements" (e.g., Krugman et al., 2022, p. 265). Furthermore, using the physical-content definition, it is possible to simplify the unnecessary complexities of analysis.[10]

Therefore, two options exist for the downstream firms: compliance or non-compliance with ROO. Specifically, when a downstream firm complies with ROO, it enjoys duty-free access, while it is necessary to pay the input price w. We denote the compliance unit cost for downstream firm i by $c = \theta w + (1-\theta)w_O$. Hence, in the ROO compliance case, the unit cost of firm i is θw with our assumption that $w_O = 0$. By contrast, when a downstream firm does not comply with ROO, it uses a cheaper outside input ($w_O = 0$), but must pay the final-good importer's external tariff $t > 0$ per unit, which is the unit cost of downstream firm i in the ROO non-compliance case.

For the final-good importer, the inverse demand function of the final good is $p = a - Q = a - (q_1 + q_2)$, where $a > 0$, p is the price of the final good, Q is the total sale, and q_i is the output of downstream firm i. Hence, based on the above explanations of the costs of the downstream firms, the profit of downstream firm i is $\Pi_i = (p - \theta w)q_i$ in the ROO compliance case, whereas it is $\Pi_i = (p - t)q_i$ in the ROO non-compliance case. We allow the downstream firms to choose to comply with ROO or not. Hence, we have four regimes: both downstream firms comply with ROO: CC; both downstream firms do not comply with ROO: NN; downstream firm 1 complies (does not comply), and downstream firm 2 does not comply (complies): CN (NC).

[9] Simillary, James and Umemoto (2000) report that physical content is adopted for textile and apparel items in NAFTA.

[10] In many studies, researchers use the physical-content definition of ROO, for example, see Anson et al. (2005), Chang and Xiao (2013), James and Umemoto (2000), Krishna (2006, 2015), Rosellón (2000), Takauchi (2010, 2011, 2014), and Tsirekidze (2021).

In the upstream market, to focus on the role of the final-good market within the FTA, we assume that there are no transportation costs and no tariff on the input.[11] Upstream firms engage in Dastidar (1995)-type homogenous price competition.[12] We assume that each upstream firm l offers its product at a price w_l. We define upstream firm l's demand as q_l. The aggregate input demand $Q^r(\theta)$ for $r = NC, CN,$ and CC depends on the number of ROO-compliers; thus, $Q^r(\theta)$ can be shown as follows: $Q^{NC}(\theta) = \theta q_2$, $Q^{CN}(\theta) = \theta q_1$, and $Q^{CC}(\theta) = \theta q_1 + \theta q_2$. Note that, in the case of NN, there is no demand on upstream firms within the FTA. Because downstream firm i buys input from the upstream firm that offers the lowest price, input demand for upstream firm l is $q_l = Q^r(\theta, w_{\text{low}})/n_{\text{low}}$ if upstream firm l offers the lowest price $w_l = w_{\text{low}}$, where n_{low} is the number of offering the lowest price; input demand is $q_l = 0$ if upstream firm l does not offer the lowest price w_{low}. The cost function of upstream firms has a quadratic form and is $(k/2)\, q_l^2$, where $k > 0$ denotes production efficiency. The profit of upstream firm l is

$$\pi_l \equiv w_l q_l - \frac{k}{2}\,(q_l)^2 \quad \text{for} \quad l \in \{1, \ldots, n\}.$$

The timing of the game is as follows: In the first stage, each downstream firm independently and simultaneously decides whether to comply with ROO. In the second stage, each upstream firm decides its input price. In the third stage, the downstream firms compete in Cournot

[11] This assumption does not alter our main results.

[12] We model upstream competition following Dastidar (1995), which involves homogeneous goods price competition. This framework is particularly appropriate for our analysis for two reasons. First, unlike the Bertrand paradox, which predicts marginal cost pricing, the Dastidar framework allows for equilibrium prices above the marginal cost, which is a realistic feature of many intermediate goods markets where firms hold some market power. Second, and more critically, this model naturally accommodates the possibility of multiple equilibria in input prices. This property is essential for capturing discontinuous shifts in the input prices that occur when the number of complying downstream firms changes, which is a central mechanism in our analysis. Dastidar (1995)-type price competition is a frequently used model; see, for example, Cabon-Dhersin and Drouhin (2014), Dastidar (2001), Delbono and Lambertini (2016a, b), Gori et al. (2014), Mizuno and Takauchi (2020, 2024), Takauchi and Mizuno (2022), and Yano and Komatsubara (2018).

fashion in the final-good market within the FTA.[13] Because the Nash equilibrium is not unique in the second stage where the input price is decided, we use the subgame perfect Nash equilibrium (SPNE) with payoff-dominance refinement for the input pricing decision stage as the equilibrium concept.[14] We solve the game using backward induction.

3 Results

In this section, we first analyze the regimes NN, $CN\&NC$, and CC. Then we find the SPNE in the first stage. More importantly, we examine the consumer and total surpluses, focusing on how current real situations relate to our results, thereby pursuing the implications of policy.

***NN* regime:** In this regime, the downstream firms use the outside cheaper inputs and they face the external tariff t; hence, the first-order condition (FOC) for profit maximization is $a - 2q_i - q_j - t = 0$ for $i \neq j$ and $i, j = 1, 2$. Hence, the output of downstream firm i is $q_i = (a - t)/3$.

[13] Meeting ROO requires compliant firms to first commit to using a certain ratio of FTA inputs. This is because the downstream firms must switch some input suppliers from outside to inside the FTA to meet the ROO requirements. Because transactions with input suppliers often involve long-term contracts, it is difficult for the downstream firms to change partners immediately. Moreover, changing inputs is not always easy. Substituting existing parts for new ones may require altering the current production technique. This resembles a "technology choice" because the decision is difficult to reverse once made. Hence, it is reasonable to model the compliance decision in the first stage of the game. By contrast, production quantities can be adjusted flexibly; hence, they are determined in the third stage.

[14] The second stage (input price competition) admits multiple Nash equilibria. We use the payoff-dominance refinement (Harsanyi and Selten, 1988) to select the equilibrium. This refinement selects the outcome where all upstream firms set the price $\overline{w}^r$, which is the highest price sustainable without being undermined by a slight unilateral price cut from a rival. This is a standard and plausible selection in such price-setting games because it assumes that firms can coordinate on the Pareto-dominant outcome for themselves. The "payoff-dominance refinement" is not only used often in various cases but also supported by the results of the experiment; see, for example, Harsanyi and Selten (1988) and the experiment by Rankin (2000). In practice, this approach is same as those of Cabon-Dhersin and Drouhin (2014) and Mizuno and Takauchi (2020).

***CN* and *NC* regimes:** Because the downstream firms are symmetric players, we only present the analysis of the NC regime (firm 1 does not comply and firm 2 complies with ROO). In the third stage, the FOCs for firms 1 and 2 are $a - 2q_1 - q_2 - t = 0$ and $a - q_1 - 2q_2 - w\theta = 0$, respectively. The outputs of the final good are $q_1 = (a - 2t + w\theta)/3$ and $q_2 = (a + t - 2w\theta)/3$.

In the second stage, from the profit of the upstream firm and input demand θq_2, the input prices, that is, the lower price $\underline{w}$, upper price $\overline{w}$, and collusive price w_{col}, are as follows:[15]

$$\left.\begin{aligned}
\underline{w}^{CN} &= \underline{w}^{NC} = \frac{k(a+t)\theta}{2(3n+k\theta^2)}, \\
\overline{w}^{CN} &= \overline{w}^{NC} = \frac{\theta k(n+1)(a+t)}{2[\theta^2 k + n(\theta^2 k + 3)]}, \\
w_{col}^{CN} &= w_{col}^{NC} = \frac{(a+t)(3n+2k\theta^2)}{4(3n+k\theta^2)\theta}.
\end{aligned}\right\} \tag{1}$$

***CC* regime:** All downstream firms meet the ROO and use the θ ratio of the FTA inputs. Hence, in the third stage, the FOC is $a - 2q_i - q_j - w\theta = 0$. This yields the following output of the final good: $q_i = (a - w\theta)/3$.

In the second stage, from the profit of upstream firms and input demand $(q_1+q_2)\theta$, upstream firms decide their price. The lower price $\underline{w}^{CC}$, upper price $\overline{w}^{CC}$, and collusive price w_{col}^{CC} are

$$\left.\begin{aligned}
&\underline{w}^{CC} = \frac{ak\theta}{3n+k\theta^2}; \quad \overline{w}^{CC} = \frac{a\theta k(n+1)}{\theta^2 k + n(\theta^2 k + 3)}, \\
&w_{col}^{CC} = \frac{a(3n+2k\theta^2)}{2\theta(3n+k\theta^2)}.
\end{aligned}\right\} \tag{2}$$

Comparing (1) with (2) and rearranging the terms, we obtain Lemma 1.

[15]Upstream firms engage in homogeneous price competition. For a given input price to constitute an equilibrium price, each upstream firm must satisfy the condition that it does not deviate from that price. The lower bound price, $\underline{w}$, is determined by the condition that a firm has no incentive to raise its price above the equilibrium level and thereby earn zero profit, while the upper bound price, $\overline{w}$, is determined by the condition that a firm has no incentive to slightly undercut the price and capture the entire demand. All input prices between this lower and upper bound constitute Nash equilibria. Since we employ the payoff-dominance criterion for equilibrium selection, we also derive the price that would prevail when upstream firms engage in collusion.

Lemma 1. *(i)* $\underline{w}^r < \overline{w}^r$ *for* $r = NC, CN, CC$.

(ii) $\overline{w}^r < w^r_{col}$ *for* $r = NC, CN, CC$ *iff* $k < \dfrac{3n}{(n-1)\theta^2} \equiv \overline{k}$.

Provided Lemma 1 holds, the input price becomes $w = \overline{w}^r$ for $r = NC, CN, CC$.

Now, we can find the SPNE of the game and consider the nature of equilibrium. Additionally, importantly, we also examine consumer welfare.

The equilibrium profits of the downstream firms are given by

$$\left.\begin{aligned}
\Pi_i^{NN} &= \frac{(a-t)^2}{9}; \quad \Pi_i^{CC} = \frac{a^2n^2}{[3n+(n+1)k\theta^2]^2},\\
\Pi_1^{NC} = \Pi_2^{CN} &= \frac{\left[(a-t)\left(2n+(n+1)k\theta^2\right)-2nt\right]^2}{4\left[3n+(n+1)k\theta^2\right]^2},\\
\Pi_1^{CN} = \Pi_2^{NC} &= \frac{(a+t)^2n^2}{[3n+(n+1)k\theta^2]^2}.
\end{aligned}\right\} \tag{3}$$

To ensure positive outcomes, we have Assumption 1.

Assumption 1. $\dfrac{t}{a} < \dfrac{k\theta^2 + n\left(2+k\theta^2\right)}{k\theta^2 + n\left(4+k\theta^2\right)}$.

We denote the values of t/a for which deviations from the regimes CC and NN are indifferent by Δ^C and Δ^N, respectively. More formally,

$$\left.\begin{aligned}
\frac{t}{a} &= \Delta^C \equiv \frac{k(1+n)\theta^2}{k\theta^2+n(4+k\theta^2)} \quad \text{s.t.} \;\; \Pi_1^{NC} - \Pi_1^{CC} = \Pi_2^{CN} - \Pi_2^{CC},\\
\frac{t}{a} &= \Delta^N \equiv \frac{k(1+n)\theta^2}{k\theta^2+n(6+k\theta^2)} \quad \text{s.t.} \;\; \Pi_1^{CN} - \Pi_1^{NN} = \Pi_2^{NC} - \Pi_2^{NN}.
\end{aligned}\right\} \tag{4}$$

From (3) and (4), we obtain Lemma 2.

Lemma 2. *(i)* $\Delta^C > \Delta^N > 0$.

(ii) If $t/a \le \Delta^C$, *downstream firm* i *chooses* N *when its rival chooses* C*; if* $t/a > \Delta^C$, *downstream firm* i *chooses* C *when its rival chooses* C.

(iii) If $t/a \ge \Delta^N$, *downstream firm* i *chooses* C *when its rival chooses* N*; if* $t/a < \Delta^N$, *downstream firm* i *chooses* N *when its rival chooses* N.

It is necessary to pay special attention to Part (i) of Lemma 2, $\Delta^C > \Delta^N$, which can be explained as follows: First, in the CC regime, the demand for input is the largest; hence, the input price is also the highest; that is,

$$\overline{w}^{CC} - \overline{w}^{NC} = \frac{k\theta(1+n)(a-t)}{2\left[3n + k\theta^2(1+n)\right]} > 0.$$

When the rival chooses compliance, the change from compliance to non-compliance lowers the input price for the rival, which helps the rival and thus is not pursued. Comparatively, there is no such helping-rival effect when the rival chooses non-compliance and the change from compliance to non-compliance occurs. Hence, it is more difficult to reach $\Pi^{CC} > \Pi^{NC}$ than $\Pi^{CN} > \Pi^{NN}$. Hence, the threshold value ranking is $\Delta^C > \Delta^N$. By choosing non-compliance, the downstream firms can deviate from the situation in which payment for the input is the highest. This can result in a larger benefit for the downstream firm.

We establish Proposition 1 from (4) and Lemma 2.

Proposition 1. *(i) If $t/a < \Delta^N$, NN appears.*
(ii) If $\Delta^N \leq t/a \leq \Delta^C$, CN and NC can appear.
(iii) If $t/a > \Delta^C$, CC appears.

Figure 2 illustrates Proposition 1. When the rate of the external tariff is too high compared with the level of ROO requirements (θ) because the downstream firms are shut out from the market unless they meet ROO, complying with ROO becomes the dominant strategy. Conversely, suppose that the external tariff is too low compared with the level of ROO requirements. By meeting ROO, each downstream firm uses a lower ratio of the FTA input (a lower θ), which results in more benefits. Because the upstream firms set their input prices after observing the action of the downstream firms, the upstream firms set higher input prices to extract the benefit of the downstream firms when they meet ROO.[16] Because this opportunistic behavior by

[16] Opportunistic behavior by upstream agents is studied by Takauchi and Mizuno (2019) in detail. See Takauchi

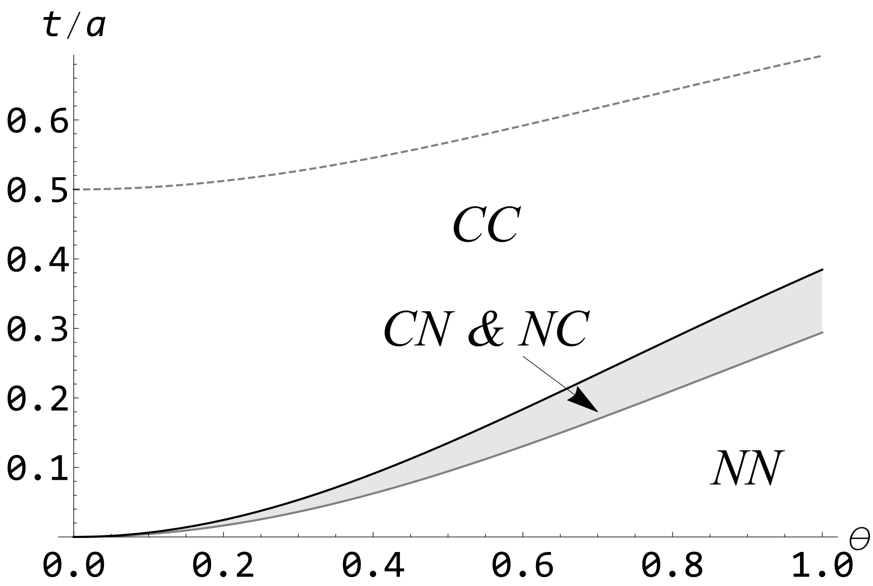

Figure 2: SPNE in $(\theta, t/a)$-space: Note that $n = 4$ and $k = 2$.

upstream firms increases input prices and this effect harms more than that of the rate of the external tariff, non-compliance with ROO becomes the dominant strategy.

If the external tariff rate is an intermediate size, asymmetric multiple equilibria (i.e., $CN\&NC$) appear (see Figure 2). The logic behind the result is as follows: First, if all downstream firms meet ROO, input demand becomes excessive and the input price discontinuously jumps up. Hence, if the rival meets ROO, the downstream firm does not meet ROO.

Next, let us consider that both downstream firms do not meet ROO. Then, when one downstream firm meets ROO, the input price discontinuously rises because of an occurrence of θq_i input demand. However, if upstream firms set higher input prices than the external tariff rate, because a strategic substitute works in the final-good market, the ROO-complier is shut out from the market. This means that input demand shrinks and then the upstream benefit becomes small. Because upstream firms know this fully, they set an input price that is not relatively higher than the rate of the external tariff. Thus, if only one downstream firm meets ROO, that ROO-complier does not suffer the disadvantage of costs. Hence, if the rival chooses

and Mizuno (2019).

non-compliance with ROO, the downstream firm has an incentive to choose compliance with ROO.

We further establish Proposition 2.

Proposition 2. *(i)* $\dfrac{\partial \Delta^C}{\partial n} < 0$ *and* $\dfrac{\partial \Delta^N}{\partial n} < 0$. *(ii)* $\left|\dfrac{\partial \Delta^C}{\partial n}\right| \gtreqless \left|\dfrac{\partial \Delta^N}{\partial n}\right|$ *iff* $\left(\dfrac{n}{1+n}\right)^2 \gtreqless \dfrac{k^2\theta^4}{24}$.

Proposition 2 presents the relationship between upstream competition (i.e., the number of upstream firms n) and the appearance of the area of $CN\&NC$. In the real world, some firms meet ROO, but others do not; hence, $CN\&NC$ represents the current real situation. An increase in n means that the market power of the upstream firms weakens; hence, the degree of a jump up and/or down of the input price becomes small; that is, it corresponds to the number of ROO-compliers. Hence, even if each downstream firm deviates from regimes NN and CC, the effect of jumps up and/or down of the input price weakens. This means that a deviation benefit from each regime becomes smaller. Therefore, the two thresholds Δ^C and Δ^N lower as n increases. (Part (i) of Proposition 2.)

Part (ii) indicates more significant matter. If the upstream firms are less efficient, that is, k is sufficiently large (or $(n/(1+n))^2 < (k^2\theta^4)/24$) because "$\Delta^C > \Delta^N$" and "$|\partial\Delta^C/\partial n| < |\partial\Delta^N/\partial n|$", the area of $CN\&NC$ expands as n increases. Hence, tougher competition upstream makes the current situation's ease of occurrence more possible.

The logic behind Part (ii) is as follows: When the upstream is less efficient, the effect of competition becomes limited. This leads to a degree of decline in the threshold Δ^C because the increase in n becomes small. This is because Δ^C depends on the decreasing effect of the input price when one downstream firm chooses N. If competition is weaker, the decreasing effect of the input price also weakens. Hence, in this case, an increase in n decreases the degree of decline in the threshold Δ^C. For this reason, $|\partial\Delta^C/\partial n| < |\partial\Delta^N/\partial n|$ holds.

Next, we consider consumer welfare. We find that the *current real situation*, that is, the $CN\&NC$ regime, can become the best regime for consumers. The equilibrium outputs of the downstream firms yield the following consumer surplus in each regime:

$$\left.\begin{aligned} CS^{CC} &= \frac{2a^2n^2}{[3n+k\theta^2(1+n)]^2}; \quad CS^{NN} = \frac{2}{9}(a-t)^2, \\ CS^{NC} &= \frac{[2an+(a-t)(2n+k\theta^2(1+n))]^2}{8[3n+k\theta^2(1+n)]^2}. \end{aligned}\right\} \tag{5}$$

The above (5) yields Proposition 3.

Proposition 3. *If* $\dfrac{k(1+n)\theta^2}{k\theta^2+n(6+k\theta^2)} = \Delta^N < \dfrac{t}{a} < \dfrac{k(1+n)\theta^2}{k\theta^2+n(2+k\theta^2)}$*, the consumer surplus of the final-good importer in the* $CN\&NC$ *regime is the largest among all other regimes; that is,* $CS^{NC} > \max\left\{CS^{NN}, CS^{CC}\right\}$.

Proposition 3 can be explained from the view of the rival's cost. In an oligopoly, an increase of the cost of the rival firm increases that firm's outputs. When the external tariff rate t is an intermediate size, because the NC regime can appear, let us consider this regime. In this case, firm 1 receives the rival's cost $w\theta$; thus, the decreasing effect of its own output through its paying cost t is alleviated. Hence, the output of firm 1 becomes not much smaller. Simultaneously, because firm 2 complies with ROO, it receives the rival's cost t; that is, when t is an intermediate size, firm 2's output becomes relatively large because it receives its rival's cost. Because the output of the ROO non-complier becomes not much smaller and the output of the ROO-complier becomes relatively large, the total outputs in the NC regime can be the largest among all other regimes.

4 FTA Welfare

In this section, we examine the welfare of the whole FTA. FTA welfare is the sum of the final-good importer's welfare and final-good exporter's welfare. Then, the total surplus (welfare) of the whole FTA[17] is defined as

$$TS^r \equiv \underbrace{CS^r + \sum_{l=1}^{n} \pi_l^r + TR^r}_{\text{Final-good importer's welfare}} + \Pi_1^r + \Pi_2^r. \tag{6}$$

Note that, in the case $r = CC$, $TR^{CC} = 0$. When $r = NC$, $TR^{NC} = tq_1$. When $r = CN$, $TR^{CN} = tq_2$. When $r = NN$, $TR^{NN} = t(q_1 + q_2)$.

The NN, NC, and CC regimes can occur in equilibrium, as we found above; hence, we compare the total surpluses in these three regimes. Figures 3 and 4 illustrate the welfare ranking in $(\theta, t/a)$-space. We discuss the differences in Figures 3 and 4 later (Proposition 5).

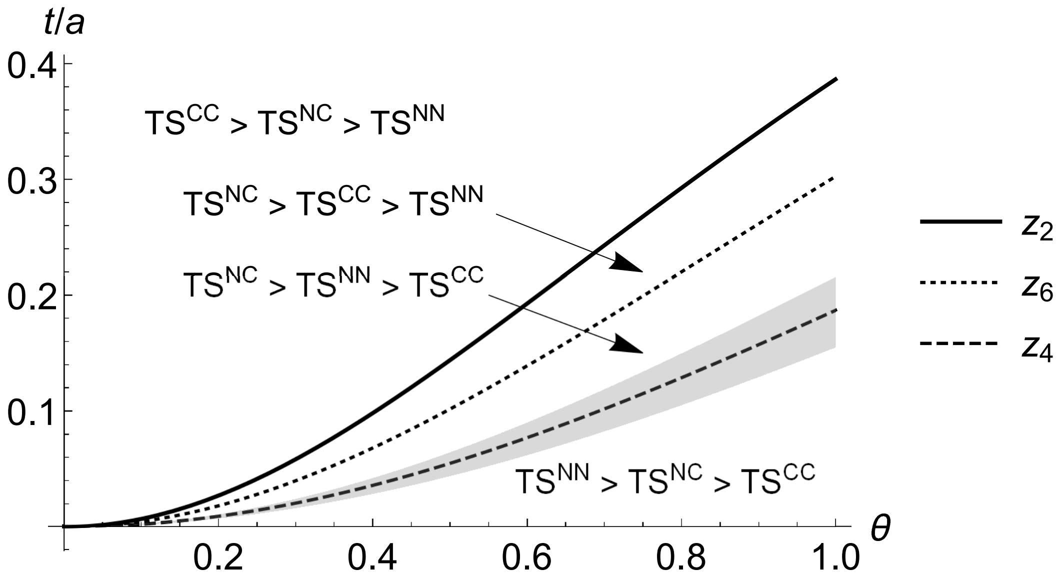

Figure 3: Welfare ranking: $\boldsymbol{n = 10}$ and $\boldsymbol{k = 1}$.

Note: The shadow area is the $CN\&NC$ regime.

When the external tariff, that is, t/a, is small, NN is the best regime. By contrast, CC is the best regime when t/a is sufficiently large. When t/a is intermediate, NC is the best regime. This point is similar to the ranking of the consumer surplus for the final-good importer (see Proposition 3.)

[17]The equilibrium total surpluses are illustrated in the appendix.

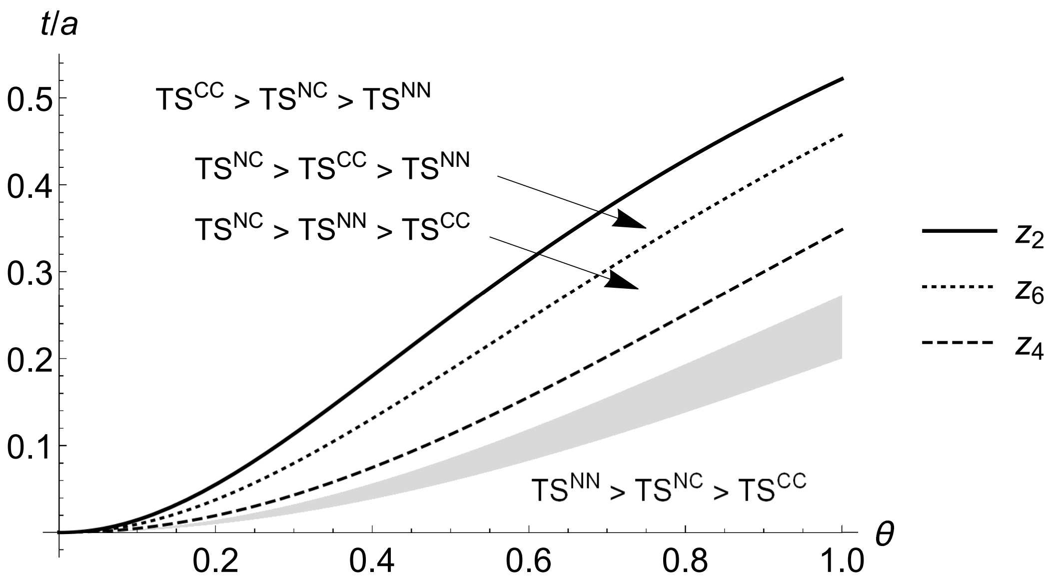

Figure 4: Welfare ranking: $\boldsymbol{n = 2}$ and $\boldsymbol{k = 1}$.

Note: The shadow area is the $CN\&NC$ regime.

Comparing equilibrium FTA welfare in the three regimes, we establish Proposition 4.

Proposition 4. *(i) If* $t/a < z_4$, $TS^{NN} > TS^{NC} > TS^{CC}$.

(ii) If $z_4 < t/a < z_6$, $TS^{NC} > TS^{NN} > TS^{CC}$.

(iii) If $z_6 < t/a < z_2$, $TS^{NC} > TS^{CC} > TS^{NN}$.

(iv) If $t/a > z_2$, $TS^{CC} > TS^{NC} > TS^{NN}$.

Here, z_2, z_4, *and* z_6 *are illustrated in the proof.*

First, we explain the logic behind the result and then consider the economic implication. Suppose that the downstream firms do not meet ROO when the external tariff, t/a, is high. Then, because their costs become high and production is strained, their profits fall; that is, the inefficiency of final-good production becomes large and final-good production becomes inactive. Hence, NN is the worst of all the regimes when t/a is high. By contrast, if the downstream firms meet ROO, their production costs become relatively low. Clearly, tariff revenue vanishes. However, because input demand becomes the largest, the profits of upstream firms become the highest. Hence, CC is the best of all the regimes when t/a is high. For NC, input demand is half compared with CC. Tariff revenue is also half compared with NN. Additionally, because the less-productivity of the final good is smaller than that of NN, NC is the middle among all other regimes.

When t/a is intermediate, NC is the best of all the regimes. There are two reasons. One is that the cost difference between the ROO-complier and non-complier is relatively small. Hence, the inefficiency of final-good production is a modest size. Thus, consumer surplus is not much smaller. The other reason is that both tariff revenue and input demand occur. Because t/a is not much smaller, tariff revenue is also not much smaller. Simultaneously, the upstream firms gain a positive profit. Moreover, because all items appear in the total surplus, NC is the best. Additionally, if t/a is relatively high, NN surpasses CC. If t/a is relatively low, this reverses.

Although small t/a results in small tariff revenue, the inefficiency of non-compliance with ROO becomes small. Hence, NN is the best of all the regimes. By contrast, for CC, final-good production becomes inactive because the cost of complying with ROO increases. This not only reduces consumer surplus but also reduces the profit of upstream firms because of a reduction of input demand. Hence, CC is the worst. From these results, NC is intermediate.

Figures 3 and 4 have a significant implication because we find that *upstream efficiency* determines the nature of equilibrium. Let upstream efficiency be measured by the number of upstream firms n; that is, few n means that the upstream market is relatively inefficient; conversely, if n is large, the upstream market is relatively efficient.

In Figure 3, for example, n is large ($n = 10$ and $k = 1$). The shadow area in the figure is the $CN\&NC$ regime. In this case, the area of $CN\&NC$ overlaps with the region in which TS^{NC} is the best among all other regimes. However, in Figure 4, n is small ($n = 2$ and $k = 1$). The area of $CN\&NC$ does not overlap with the region in which TS^{NC} is the best of all the regimes. Hence, we can say that the current real situation, that is, $CN\&NC$, may result in the best situation for the FTA if the upstream market is efficient. Therefore, if the upstream market is efficient, because the current situation can be the best regime for the FTA, the promotion of the FTA utilization policy may be a big mistake.

From (4) and Proposition 4, we establish Proposition 5.

Proposition 5. *When the upstream market within the FTA is sufficiently competitive, the current real situation, that is, asymmetric multiple equilibria, can maximize FTA welfare. Formally,* $\Delta_N < z_4 < \Delta_C < z_2$ *holds if* $n \geq 5$.

The intuition is as follows: z_2 is the threshold of $TS^{CC} = TS^{NC}$. Now, let us consider that n rises. Then, the input price lowers; hence, input demand rises through an increase in final-good production because of a cost reduction. In the CC regime, the number of ROO-compliers is twice that compared with the NC regime. Hence, TS^{CC} becomes larger compared with TS^{NC}. This implies that to make $TS^{CC} = TS^{NC}$, because t/a must become larger and θ must become smaller, the z_2 curve moves upward. z_4 is the threshold of $TS^{NC} = TS^{NN}$. A rise in n enlarges TS^{NC} more than TS^{NN}. Hence, for a similar to that for the upward movement of z_2, the z_4 curve tends to move upward as n increases.

5 Conclusion

In this paper, we examined the role of ROO in a vertical structure within an FTA. ROO are defined as a system that decides the origin of goods. To satisfy ROO, it is generally necessary for firms to use more intermediate products (inputs) produced within the area. Hence, ROO define business among firms, particularly those in vertical relationships. To simplify our analysis, we assumed a two-country FTA and a perfectly competitive input market outside the FTA. Then, we analyzed the effects of ROO by considering that an oligopolistic upstream market and a duopolistic downstream market exist for the final-good importer in the FTA.

The degree of upstream competition in the final-good importer affects input prices, and thus determines the behaviors of the downstream firms. When the level of external tariffs of the final-good importer is intermediate, asymmetric multiple equilibria arise in the downstream market, that is, one firm meets the ROO and the other does not (CN and NC). This result corresponds to the *current real situation*. More importantly, we find that under asymmetric multiple equilibria, which is in line with the current real situation, consumer surplus for the final-good importer and welfare in the FTA are maximized. This result indicates important policy implications. Practitioners seeking to increase the FTA utilization rate (the number of firms meeting ROO, i.e., CC) may end up harming consumers in the FTA's member countries and the FTA. Therefore, special attention is required for policy makers facing FTA utilization promoting policies. This provides new insights into the context of an FTA with ROO.

To analyze the effects of ROO, in a vertical structure, we built a simple model. There are many topics for future discussion. For instance, it is worthwhile to assume that there exists an upstream market outside the FTA, which is the same as that in the FTA, that is, oligopolistic firms engaging in homogenous price competition. In this case, upstream firms outside the FTA may lower the input price and induce downstream firms in the FTA to buy from suppliers outside the FTA. This may result in a weaker incentive for downstream firms in the FTA to meet ROO.[18] This topic is an extension to discuss the effects of ROO on upstream competition within and outside the FTA, which will be addressed in future research.

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[18]Furthermore, we can consider the interrelationship between ROO and other trade policies. Takauchi (2010) examines ROO and export subsidy race. However, in his model, the upstream sector is perfectly competitive.

ies on Economics and Finance. We thank Edanz (https://jp.edanz.com/ac) for editing a draft of this manuscript. All remaining errors are our own.

Appendices

A1. FTA welfare

$$
\begin{aligned}
TS^{NN} &= \frac{2(a-t)(2a+t)}{9},\\
TS^{NC} &= \frac{\left(\begin{array}{l} a^2[3\theta^4k^2(n{+}1)^2{+}4\theta^2kn(5n{+}4){+}32n^2] \\ -at[\theta^2k(2\theta^2k(n{+}1)^2{+}8n(n{+}2)){+}8n^2]{-}t^2[\theta^4k^2(n{+}1)^2{+}4\theta^2kn(n{+}2){+}4n^2] \end{array}\right)}{8[\theta^2k(n+1)+3n]^2},\\
TS^{CC} &= \frac{2a^2n^2(\theta^2k+2)}{[\theta^2k(n+1)+3n]^2}.
\end{aligned}
$$

A2. Proofs

This section contains all proofs that were omitted from the text.

Proof of Lemma 1. (i) $\overline{w}^{NC} - \underline{w}^{NC} = \frac{3\theta kn^2(a+t)}{2(\theta^2k+3n)(\theta^2k+n(\theta^2k+3))} > 0$, where $\overline{w}^{NC} = \overline{w}^{CN}$ and $\underline{w}^{NC} = \underline{w}^{CN}$; $\overline{w}^{CC} - \underline{w}^{CC} = \frac{3a\theta kn^2}{(\theta^2k+3n)(\theta^2k+\theta^2kn+3n)} > 0$. (ii) $w^{NC}_{col} - \overline{w}^{NC} = \frac{3n(a+t)\left[3n-k\theta^2(n-1)\right]}{4\theta(\theta^2k+3n)(\theta^2k+\theta^2kn+3n)}$ and $w^{CC}_{col} - \overline{w}^{CC} = \frac{3an\left[3n-k\theta^2(n-1)\right]}{2\theta(\theta^2k+3n)(\theta^2k+\theta^2kn+3n)}$. These imply Lemma 1. □

Proof of Lemma 2. (i) Simple algebra yields $\Delta^C - \Delta^N = \frac{2\theta^2kn(1+n)}{(4n+\theta^2k(1+n))(6n+\theta^2k(1+n))} > 0$. (ii) From (4) in the definition of Δ^C, the claim follows. (iii) From (4) in the definition of Δ^N, the claim follows. □

Proof of Proposition 2. (i) Differentiating Δ^C and Δ^N with respect to n,

$$
\frac{\partial \Delta^C}{\partial n} = -\frac{4\theta^2k}{\left[\theta^2k+n\left(\theta^2k+4\right)\right]^2} < 0; \quad \frac{\partial \Delta^N}{\partial n} = -\frac{6\theta^2k}{\left[\theta^2k+n\left(\theta^2k+6\right)\right]^2} < 0.
$$

(ii) Simple algebra yields

$$
\left|\frac{\partial \Delta^C}{\partial n}\right| - \left|\frac{\partial \Delta^N}{\partial n}\right| = \frac{2\theta^2k\left[24n^2-\theta^4k^2(1+n)^2\right]}{\left(\theta^2k+\theta^2kn+4n\right)^2\left(\theta^2k+\theta^2kn+6n\right)^2}.
$$

This implies Part (ii). □

Proof of Proposition 3. First, $CS^{NC} - CS^{CC}$ is a convex function with respect to t. Solving $CS^{NC} - CS^{CC} \geq 0$ for t, we obtain $t \leq t_1 = \frac{ak(1+n)\theta^2}{k\theta^2+n(2+k\theta^2)}$. Second, $CS^{NC} - CS^{NN}$ is a single-peaked function with respect to t. Solving $CS^{NC} - CS^{NN} \geq 0$ for t, we obtain $t \geq t_2 = \frac{ak(1+n)\theta^2}{k\theta^2+n(6+k\theta^2)}$. Hence, if $t_1 > t_2$, areas exist in $(\theta, t/a)$-space such that $CS^{NC} > CS^{NN}$ and $CS^{NC} > CS^{CC}$. In fact, $t_1 - t_2 = \frac{4a\theta^2 kn(1+n)}{(\theta^2 k+\theta^2 kn+2n)(\theta^2 k+\theta^2 kn+6n)} > 0$. □

Proof of Proposition 4. First, $TS^{CC} - TS^{NC} \geq 0$ if $z \geq z_2$. Note that

$$z_2 = \frac{-[\theta^4 k^2 + n^2(\theta^2 k + 2)^2 + 2\theta^2 kn(\theta^2 k + 4)] + 2\sqrt{A_1}}{\theta^4 k^2 + n^2(\theta^2 k + 2)^2 + 2\theta^2 kn(\theta^2 k + 4)}, \quad 1 > z_2 > 0 \;\; \forall \theta \in (0, 1],$$

where $A_1 \equiv \theta^8 k^4 + \theta^4 k^2 n^2(6\theta^4 k^2 + 34\theta^2 k + 53) + 2\theta^2 kn^3(2\theta^6 k^3 + 13\theta^4 k^2 + 25\theta^2 k + 16) + n^4(\theta^4 k^2 + 3\theta^2 k + 2)^2 + 2\theta^6 k^3 n(2\theta^2 k + 7) > 0$.

Second, $TS^{NN} - TS^{NC} \geq 0$ if $z \leq z_4$. Note that

$$z_4 = \frac{\theta^4 k^2 + n^2(\theta^4 k^2 - 12\theta^2 k - 36) + 2\theta^2 kn(\theta^2 k + 12) + 6\sqrt{A_2}}{7\theta^4 k^2 + n^2(7\theta^4 k^2 + 60\theta^2 k + 108) + 2\theta^2 kn(7\theta^2 k + 12)}, \quad 1 > z_4 > 0 \;\; \forall \theta \in (0, 1],$$

where $A_2 \equiv [\theta^2 k + n(\theta^2 k + 3)]^2[\theta^4 k^2 + n^2(\theta^2 k + 2)^2 + 2\theta^2 kn(\theta^2 k + 4)] > 0$.

Third, $TS^{NN} - TS^{CC} \geq 0$ if $z \leq z_6$. Note that

$$z_6 = \frac{-[n^2(\theta^2 k + 3)^2 + 2\theta^2 kn(\theta^2 k + 3) + \theta^4 k^2] + 3\sqrt{A_3}}{2[\theta^2 k + n(\theta^2 k + 3)]^2}, \quad 1 > z_6 > 0 \;\; \forall \theta \in (0, 1],$$

where $A_3 \equiv [\theta^2 k + n(\theta^2 k + 3)]^2[\theta^4 k^2 + 2\theta^2 kn(\theta^2 k + 3) + (\theta^2 kn + n)^2] > 0$.

Simple algebra yields $z_2 > z_6 > z_4$. Hence, from these results, Proposition 4 follows. □

Proof of Proposition 5. From (4) and the proof of Proposition 4, we obtain the following relation: $z_2 > z_4 > \Delta^C > \Delta^N$ if $n = 2, 3, 4$; $z_2 > \Delta^C > z_4 > \Delta^N$ if $n \geq 5$. This implies Proposition 5. □

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