Rules of origin and regional upstream competition

Kazuhiro Takauchi
Tomomichi Mizuno
Qing Hu

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Kazuhiro Takauchi*† Tomomichi Mizuno‡ Qing Hu§

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Abstract

To enjoy the preferential access of a free trade area (FTA), rules of origin (ROO) of the FTA defines how much to use regional contents. Hence, ROO defines the inter-firm transactions among upstream and downstream firms. We show asymmetric multiple equilibria in the downstream market "one firm meets ROO while the other does not" can appear for the effect of regional upstream competition. Importantly, our results, which correspond the real situation, maximizes consumer and total surpluses in the final-good importer. Hence, if the practitioner in the country concerned promoting utilization of the FTA, it may backfire.

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

JEL classification: F12; F13; L13; D43

*Corresponding author: Kazuhiro Takauchi, Faculty of Business and Commerce, Kansai University, 3-3-35 Yamate-cho, Suita, Osaka 564-8680, Japan. E-mail: kazh.takauch@gmail.com; Tel.: +81-6-6368-1817; Fax: +81-6-6339-7704.

†Research Fellow, Graduate School of Economics, Kobe University, 2-1 Rokkodai-cho, Nada-ku, Kobe-City, Hyogo 657-8501, Japan.

‡Graduate School of Economics, Kobe University, 2-1 Rokkodai-cho, Nada-ku, Kobe-City, Hyogo 657-8501, Japan. E-mail: mizuno@econ.kobe-u.ac.jp.

§Faculty of Business and Commerce, Kansai University, 3-3-35 Yamate-cho, Suita, Osaka 564-8680, Japan. E-mail: huqing549@gmail.com.

1 Introduction

Free Trade Area/Agreement (FTA) is now 405 cases in force,[1] and, with the spread of FTAs, a certain system has come to attract attention of researchers: Rules of origin (ROO).[2] This is because, if FTA has no ROO, because the third party of outside the FTA can conduct *circumvention export*, the benefit of the FTA vanishes. ROO is a system which judges the origin of goods, it prevents circumvention export. Hence, ROO is an essential system to FTAs. When final-good producers, i.e., downstream firms, use a certain amount of inputs produced within the FTA, they can meet the ROO.[3] If so, downstream firms enjoy duty free access. Furthermore, If downstream firms do not meet ROO, they must pay the external tariff of the supply destination (the member country of the FTA). Figure 1 illustrates downstream firms' duty free access.

In an FTA with ROO, if a firm enters in the regional upstream market, the input price falls due to an enhancement of competition. Because a fall in the regional input price lowers the cost of local procurement, it strengthens incentives for downstream firms to meet ROO. Hence, a competition in the regional upstream market can decide the action of downstream firms whether to meet ROO or do not. If downstream firms meet ROO, because they must use the regional inputs more than before to the response to ROO requirements, the transactions among downstream firms and the reginal upstream firms becomes active. That is, ROO is the institution that defines the *interfirm transaction*, and then, it especially regulates the vertical

[1]There are 405 FTAs in force worldwide (as of August 2025). See, for example, the following website https://www.jetro.go.jp/biznews/2025/04/cd0827bb342311aa.html

[2]Without ROO, the third party outside an FTA briefly ships its product to the member country of the FTA that has the lowest external tariff rate among them, and ships the product from there to another members. This action is so called **circumvention export**, and hence, the benefits of the FTA outflows. ROO can prevent the third parties from circumvention exporting, and therefore, ROO is indispensable regulation to FTAs.

[3]ROO at least can be defined in four types criteria: (i) Domestic content, defined in terms of value added or in physical content; (ii) change in tariff heading; (iii) specified process that mus be performed within the area; (iv) product has been substantially transformed (Krishna, 2006; Krishna and Krueger, 1995).

interfirm transaction.

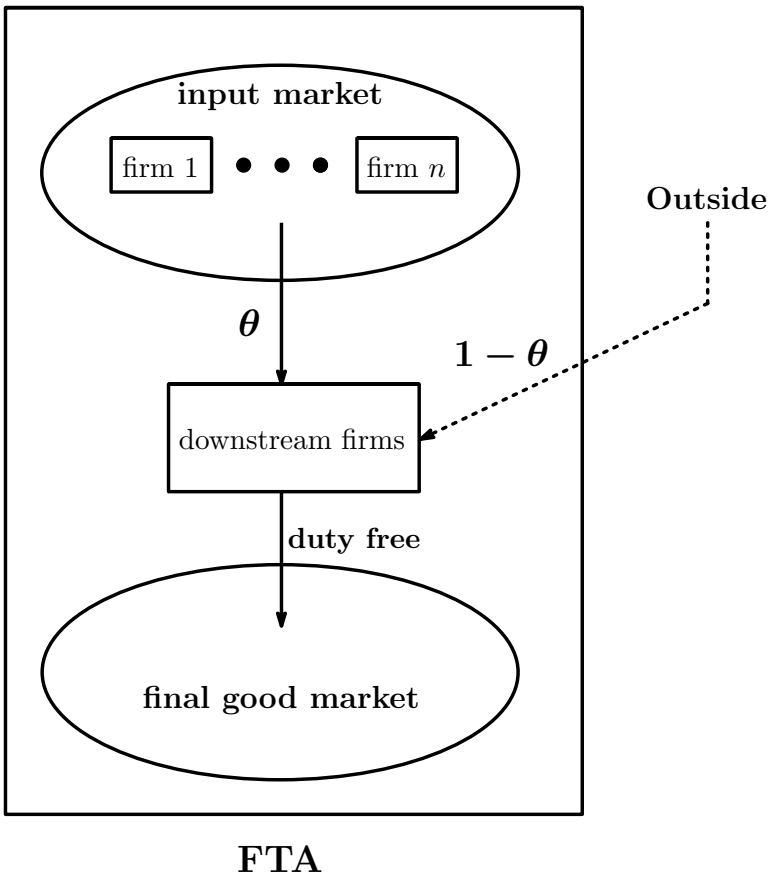

Figure 1: The case in which downstream firms comply with ROO

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

We first show that in a symmetric two downstream firms, asymmetry multiple equilibria "one meets ROO while another does not" appears. We build a model in which engaging in a quantity competition two downstream firms decide whether to meet ROO or do not, subsequently, many regional upstream firms engage in a price competition and they set their prices. If both downstream firms meet ROO, the input demand is maximized, and then, upstream firms know it, and hence, they set the highest input price. The downstream firm has an incentive to choose the non-compliance when the external tariff is intermediate level. This is because, if a downstream firm deviates only myself from the situation that all firms meet ROO, since the highest input price discontinuously falls, it can remain its rival's cost high. Conversely, suppose that

both firms choose noncompliance and the external tariff is intermediate level. The downstream firm knows that if only myself to meet ROO, upstream firms set higher input price. However, upstream firms know that unless downstream firm does not meet ROO, the input demand never occur. Hence, upstream firms do not dramatically raise their prices if a downstream firm meets ROO. For this reason, the downstream firm has an incentive to deviate from the situation that both downstream firms choose non-compliance.

We also show that in the major final-good importer inside the FTA, consumer surplus and total surplus can be maximized in the mixed regime (i.e., one downstream firm meets ROO and the other does not). When the external tariff is intermediate size, the total output is maximized in the mixed regime. Then, because the final-good price becomes the lowest, the mixed regimes consumer surplus is larger than those of other regimes. If the external tariff is intermediate size, the total surpluses in the all-compliers regime (i.e., all downstream firms meet ROO) and no-complier regime (i.e., neither downstream firms do not meet ROO) do not become largest becase consumer surplus or tariff revenue are relatively small. In this case, the mixed regime is the best among other regimes.

Our main contribution was showing that for a major final-good importer within an FTA, conditions for the "current situation to be optimal". Some empirical studies report that FTA utilization rate, i.e., ROO compliance rate, is by no means 100% (e.g., Anson et al., 2005; Hayakawa et al., 2023).[4] Consequently, we can consider that "one downstream firm meets ROO, and the other does not" corresponds to the current situation. Our results provide not only a new insight into the context of studies of FTA with ROO but also those call attention to the practitioner who is planning to promote the utilization of FTA. As long as the *current situation* is the optimum for the major final-good importer within an FTA (e.g., US in NAFTA), for example,

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

if the practitioner in the country concerned raises the external tariff, as the regime change can occur, it hurts consumers, and then, reduces welfare. Thus, if practitioner unconditionally tries to raise the FTA utilization rate could backfire.

This study is related to two main strands **(a)** and **(b)** of studies on FTA with ROO. The studies in **(a)** emphasize a role of protecting device of ROO (e.g., Krishna, 2006, 2015; Krishna and Kruger, 1995; Krueger, 1993; Takauchi, 2010; Tsirekidze, 2021).[5] The studies in **(b)** is on the relation of ROO and firm behavior (e.g., Cherkashin et al., 2015; Demidova and Krishna, 2008; Head et al., 2024; Ju and Krishna, 2005; Takauchi, 2014).[6] The beginning of attention being paid to ROO dates back to at least Kruger's (1993) paper; it pointed out that using a numerical example, NAFTA's ROO is a "hidden protectionism". Krishna and Krueger (1995) compare the effects of two types of ROOs that comprising cost-based and price-based definitions. Krishna (2006) shows that a rise in the production cost by introducing ROO. Based on Krishna (2006) and Krishna and Krueger (1995), Krishna (2015) consider the effects of ROOs under a framework of general equilibrium. Takauchi (2010) focuses on the interaction among ROO and other trade policies. Tsirekidze (2021) considers an endogenous formation of FTA and the effects of ROO.

[5]Moreover, the following works also emphasize ROO as the protecting device. Chang and Xiao (2013) focus on an optimal tariff under physical content requirements. Duttagupta and Panagariya (2007) focus on the effects of lobbying actions. 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 on the continuous production cost. RosellÓn (2000) considers a long-run effect of ROO.

[6]In addition, the following works also study the relation ROO and firms' action. Ju and Krishna (2002) examine on the effects of the conditional policy without FTA. Local content requirements (LCRs) are a similar policy to ROO such that it defines the criterion of using domestic inputs in the final-goods. Krishna and Itoh (1988) and Lahiri and Ono (1998, 2003) consider the effects of LCRs on firm behavior. Mizuno and Takauchi (2018) emphasizes ROO compliance cost and a production cost fluctuation due to meeting ROO. Mukunoki and Okoshi (2021) focuses on the effect of value-added criterion. Ornelas and Turner (2024) consider the bargaining problem with supplier. Incorporating oligopoly into input markets, Chung and Perroni (2025) consider the effect of ROO requirements in 1989 Canada-US FTA on the input markets.

Demidova and Krishna (2008) incorporate ROO into Melitz (2003)-type firm heterogeneity model and consider the effect of a fixed cost of ROO. Cherkashin et al. (2015) consider that by constructing a Melitz-type partial equilibrium framework, the effects of ROO. Head et al. (2024) consider that sourcing strategy of continuous cost firms, and they find that regional content share is an inverted-U shaped for ROO requirements. Ju and Krishna (2005) and Takauchi (2014) show that by using different models, a rise in input-price due to complying with ROO gives rise to "some firms meet ROO and the others do not".

These previous literature employs different setting each other and provides suggestive and interesting results. On one hand, our study uses different market structure and different competition mode from the previous literatures, so our study substantially differs from those literatures. Hence, our study complements the analysis of the previous literature.

The remainder of the paper proceeds as follows. Section 2 offers a baseline model. In Section 3, we analyses the model detail. Section 4 presents welfare analysis of the main final-good importer within FTA. Section 5 concludes.

2 Model

We consider an FTA consisting of two countries. For the sake of the simplest analysis, we focus on the vertical relationship in only one country and we call this country the final-good importer.[7] In the final-good importer within the FTA, there is an upstream market offering inputs to a downstream market. Specifically, in the upstream market, $n\,(\geq 2)$ firms (i.e., input suppliers) exist and they engage in Dastidar (1995)-type homogenous price competition and sell at an input price $w > 0$. In the downstream market, there are two firms, firm 1 and firm 2 located in the final-good importer, producing homogeneous final goods to the final good market (the final-good importer) and competing in quantities. To produce one unit of the final good, the

[7]We focus on the final-good importer which occupies the largest share of the final good market in the FTA.

downstream firms use one unit of the input from the upstream market. However, outside of the FTA, there is also an upstream market, which is assumed to be a perfectly competitive market and thus the input price w_0 is normalized to zero. All the input produced in the upstream markets within and outside the FTA are homogenous. Note that $w > w_0 = 0$, the upstream market within the FTA is less efficient than the one outside of the FTA. Hence, the downstream firms can choose to purchase the inputs from the upstream firms either within or outside of the FTA. Throughout the analysis, we do not matter that these downstream firms are inside or the outside firms of the FTA.

In our model, FTA has ROO, allowing downstream firm $i\,(i = 1, 2)$ to enjoy duty free access when they supply their products to the final good market within the area, only when they use at least $\theta\,(0 < \theta \leq 1)$ ratio of the input produced within the FTA. θ is the local procurement ratio inside the FTA. In another word, to enjoy a preferential duty, i.e., duty free in our model, the downstream firms must meet ROO requirement, that is, using at least θ ratio of the FTA input (input from the final-good importer). Figure 1 illustrates the situation where the downstream firms meet ROO. Specifically, the downstream firms use θ ratio of the inputs from the upstream market within the FTA, and $1-\theta$ ratio of those from the perfectly competitive market outside of the FTA. In such situation, the downstream firms meet ROO requirements and enjoy duty free access, i.e., paying only 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 ROO requirements.[8] The main reason is that the essence of ROO requirements can be considered by

[8] Although the number is not so much, in practise the physical-content definition is used. According to Krishna (2006), one example of physical-content definition is that in the cigarette industry in Australia. Beghin et al. (1997) also indicate that in USA, tobacco industry was similar too. Besides, going by James and Umemoto (2000), physical-content is also adopted to textile or apparel items in NAFTA. Another typical example is found in US-South Korea free trade agreement. Domestic content rules are defined in many industries: "... Specific Rules of Origin for Textile or Apparel Goods. Specific domestic content rules for other products such as chemicals, electronics, medical devices, and automobiles are found in Annex 6-A (Specific Rules of Origin)." (Jones and Platzer, 2011, p.5, footnote 9.)

"at least use the FTA inputs responded to the requirements". In addition, by using physical-content definition, it is possible to simplify the unnecessary complexities of analysis.[9]

Therefore, there are two options for the downstream firms: compliance and non-compliance with ROO. Specifically, when the downstream firm complies with ROO, they enjoy duty free access, while it is needed to pay the input price w. We denote the compliance unit cost for downstream firm i is $c = \theta w + (1-\theta)w_0$. Hence, in ROO compliance case, the unit cost of firm i is θw with our assumption that $w_0 = 0$. By contrast, when the downstream firm does not comply with ROO, they use the cheaper outside input ($w_0 = 0$) but must pay the final-good importer's external tariff $t > 0$ per unit, which is the unit cost of firm i in ROO noncompliance case.

In the downstream market, 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 ROO compliance case, while it is $\Pi_i = (p-t)q_i$ in ROO noncompliance case. We allow the downstream firms to choose to comply with ROO or not. Hence, we have four regimes as follows. Both downstream firms comply with ROO: CC; both downstream firms do not comply with ROO: NN; downstream firm 1 complies (does not comply) and firm 2 does not comply (complies): CN (NC).

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 there is no tariff on the input.[10] The upstream firms engage in Dastidar (1995)-type homogenous price competition.[11] We assume that each

[9]Many studies use physical-content definition of ROO, for example, see Anson et al. (2005), Chang and Xiao (2013), James and Umemoto (2000), Ju and Krishna (2002), Krishna (2006, 2015), RosellÓn (2000), Takauchi (2010, 2011, 2014), and Tsirekidze (2021).

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

[11]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

upstream firm l offers its own 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 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 to the upstream firms within the FTA. Because downstream firm i buys input from the upstream firm offering the lowest price, the 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; the input demand is $q_l = 0$ if upstream firm l does not offer the lowest price w_{low}. The cost function of upstream firms is a quadratic form and it is $(k/2)\, q_l^2$, where $k > 0$ denotes the production efficiency. The profit of upstream firm l is

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

The timing of the game is as follows. In the first stage, each downstream firm independently and simultaneously decides whether to comply with ROO or not. In the second stage, each upstream firm decides its input price. In the third stage, downstream firms compete in Cournot fashion in the final-good market within the FTA.[12] Since the Nash equilibrium is not unique in the second stage where 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

(2020, 2024), Takauchi and Mizuno (2022), and Yano and Komatsubara (2018).

[12]Meeting ROO requires ROO-compliers to firstly choose the use a certain ratio of FTA input. This is because, in order to meet the requirements of ROO, downstream firms need to change some input suppliers outside the FTA to the input suppliers inside the FTA. Because the transaction with input suppliers often is accompanied by a long-term contract, it is difficult to immediately change the business partners for the downstream firms. Moreover, a change in the inputs used does not always uneasy. To substitute the existing parts to new parts implies that a change in the current production technic. This is similar to the "technology choice" since it is difficult to flexibly change the decision once made. Hence, it is reasonable that whether to choose to comply with ROO is set in the first stage of the game. In contrast, the quantity of production can be flexibly changed, so it is set on the third stage of the game.

concept.[13] We solve the game by 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 the current real situations relates to our results, pursuing the implications of policy.

***NN* regime:** In this regime, downstream firms use the outside cheaper inputs and they face the external tariff t, so the first-order condition (FOC) for the 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 $q_i = (a - t)/3$.

***CN* and *NC* regimes:** Because downstream firms are symmetric players, we only present the analysis of NC regime (firm 1 does not comply and firm 2 complies with ROO). In the third stage, the FOCs for firm 1 and firm 2 are $a - 2q_1 - q_2 - t = 0$ and $a - q_1 - 2q_2 - w\theta = 0$, respectively. The outputs of 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 upstream firm and the input demand θq_2, the input prices, that is, the lower price $\underline{w}$, the upper price $\overline{w}$, and the collusive price w_{col}, are as follows.

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

***CC* regime:** All downstream firms meet ROO and they use 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 final-good

[13] The "payoff-dominance refinement" is not only often used in various cases but also it is supported by results of the experiment. See, for example, Harsanyi and Selten (1988) and the experiment by Rankin (2000). In practice, this approach is same as Cabon-Dhersin and Drouhin (2014) and Mizuno and Takauchi (2020).

$q_i = (a - w\theta)/3$.

In the second stage, from the profit of upstream firms and the input demand $(q_1 + q_2)\theta$, upstream firms decide their price. The lower price $\underline{w}^{CC}$, the upper price $\overline{w}^{CC}$, and the 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 these terms, we obtain Lemma 1.

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

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

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

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

The equilibrium profits of downstream firms are given by

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

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, we have:

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

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

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

(ii) If $t/a \leq \Delta^C$*, 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 $t/a \geq \Delta^N$*, 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 needed to specially pay an attention to Part (i) of Lemma 2, $\Delta^C > \Delta^N$, which can be explained as follows. First, In CC regime, the demand for input is the largest, so 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 noncompliance will lower the input price for the rival, which helps the rival thus is not pursued. Comparatively, there is no such helping-rival effect when the rival chooses noncompliance and change happens from compliance to noncompliance. Hence, in another word, 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 noncompliance, downstream firms can deviate from the situation that the payment for the input is the highest. This can bring 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 to the level of ROO requirement (θ), since the downstream firms are shut out from the market

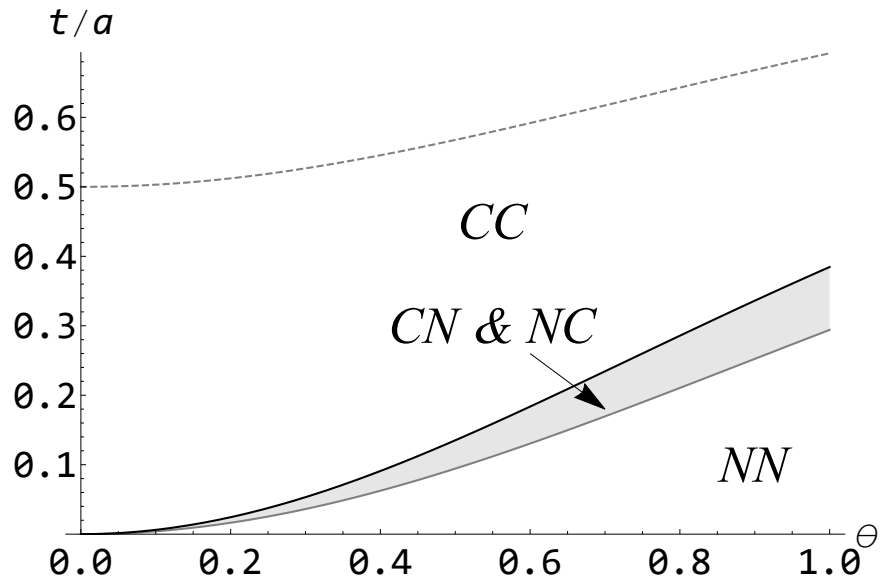

Figure 2: SPNE in $(\theta, t/a)$-space: Note $n = 4$ and $k = 2$.

unless they meet ROO, complying ROO becomes the dominant strategy. Oppositely, suppose that the external tariff is too low compared with the level of ROO requirement. By meeting ROO, each downstream firm uses a lower ratio of the FTA input (a lower θ), bringing more benefits. Since the upstream firms set their input prices after observing the action of downstream firms, the upstream firms set higher input prices to extract the benefit of downstream firms when they meet the ROO.[14] Because this opportunistic behavior by 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, an asymmetry multiple equilibria (i.e., $CN\&NC$) appears (See Figure 2). The logic behind the result is as follows. First, if all downstream firms meet ROO, the 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 not meeting ROO. Then, when one down-

[14]The opportunistic behaviour by upstream agents is studied by Takauchi and Mizuno (2019) in detail. See Takauchi and Mizuno (2019).

stream firm meets ROO, the input price discontinuously rises due to an occurrence of θq_i input demand. However, if upstream firms set higher input prices than the external tariff rate, because strategic substitute works in the final-good market, ROO-complier is shut out from the market. This means that the input demand shrinks, and then, the upstream benefit becomes small. Since upstream firms know fully it, they set an input price that is not relatively higher than the rate of external tariff. Thus, if only one downstream firm meets ROO, that ROO-complier does not suffer disadvantage of costs. Hence, if the rival chooses 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 a real world, some firms meet ROO but the others do not, so $CN\&NC$ represents the current real situation. An increase in n means that the market power of the upstream firms weakens, and, hence, the degree of a jumps up and/or down of the input price becomes small that is corresponding to the number of ROO-compliers. Hence, even if each downstream firm deviates from the regimes NN and CC, the effect of jumps up and/or down input price weakens. This means that a deviation benefit from each regime becomes smaller. Therefore, 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 is less-efficient, that is, k is large enough (or $(n/(1+n))^2 < (k^2\theta^4)/24$), since "$\Delta^C > \Delta^N$" and "$|\partial\Delta^C/\partial n| < |\partial\Delta^N/\partial n|$", the area of $CN\&NC$ expands as n increases. Hence, upstream tougher competition makes the current situations 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 that the degree of decline in the threshold Δ^C due

to an 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.

We next consider the consumer welfare. We find that *current real situation*, i.e., $CN\&NC$ regime, can become the best regime for consumers. The equilibrium outputs of downstream firms give the following consumer surplus in each regime.

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

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* $CN\&NC$ *regime is the largest among all other regimes. That is,* $CS^{NC} > \max\{CS^{NN}, CS^{CC}\}$.

Proposition 3 can be explained from the view of rival's cost. In oligopoly, an increase of the cost of rival firm increases its own outputs. When the external tariff rate t is an intermediate size, because NC regime can appear, let us consider NC 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. At the same time, since firm 2 complies with ROO, it receives the rival's cost t. That is, when t is an intermediate size, the firm 2's output becomes relatively large due to receiving its rival's cost. Because the output of ROO non-complier becomes not much smaller and the output of ROO-complier becomes relatively large, the total outputs in NC regime can be the largest among all other regimes.

4 Welfare of the major final-good importer

This section examines the welfare of the final-good importer within the FTA. To simplify the analysis, let us consider that all downstream firms exist in this country. Then, the total surplus of the final-good importer[15] is defined by

$$TS^r \equiv CS^r + \Pi_1^r + \Pi_2^r + \sum_{l=1}^{n} \pi_l^r + TR^r. \tag{6}$$

Here, note that under 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, so we compare total surpluses in these three regimes. Figures 3 and 4 illustrate the welfare (total surplus) ranking in $(\theta, t/a)$-space. The differences in Figures 3 and 4 are discussed later on (Proposition 5).

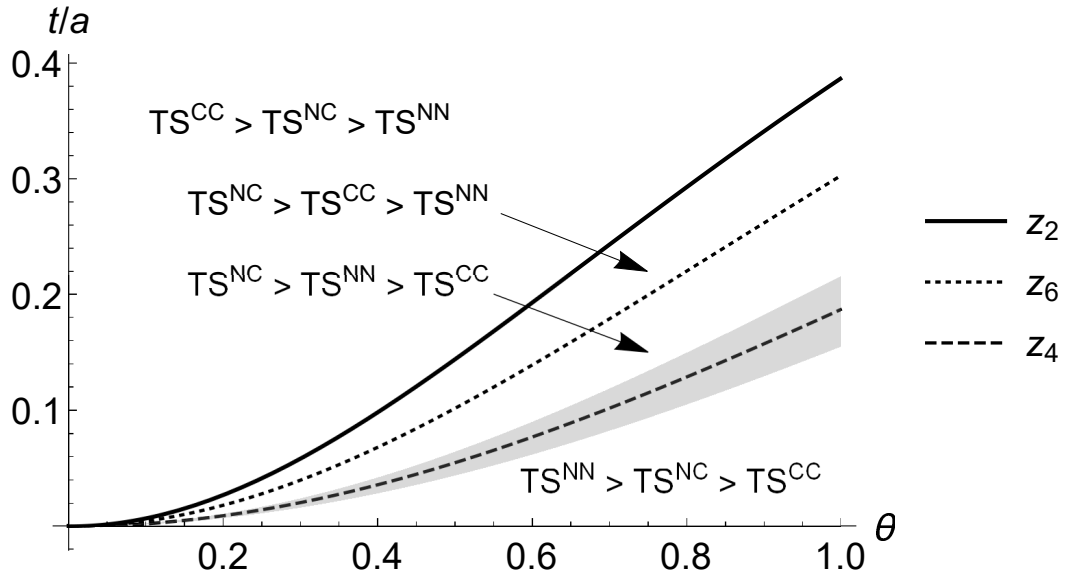

Figure 3: Welfare ranking: $\boldsymbol{n = 10}$ and $\boldsymbol{k = 1}$.

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

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

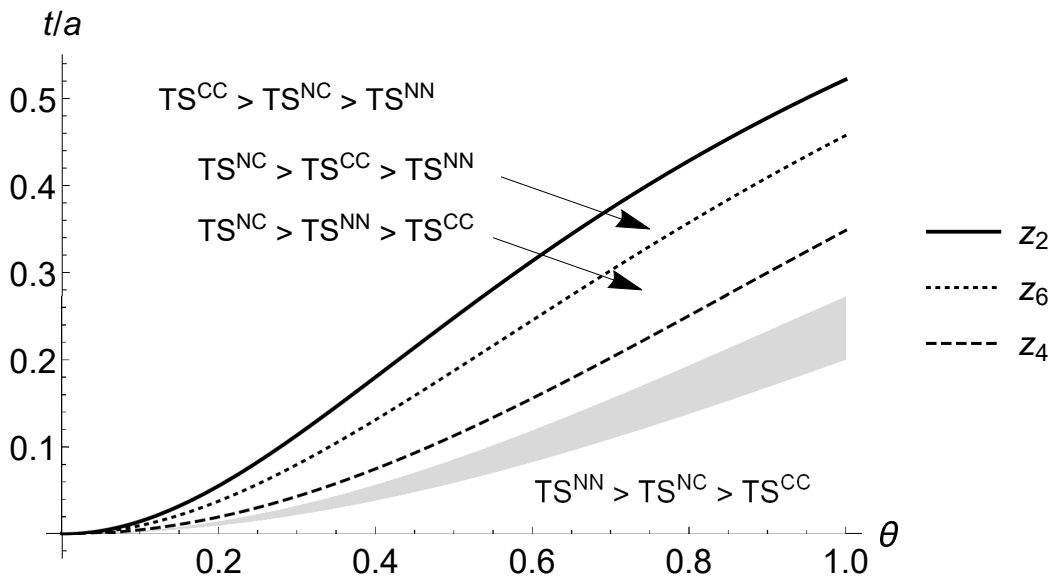

Figure 4: Welfare ranking: $\boldsymbol{n = 2}$ and $\boldsymbol{k = 1}$.

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

When the external tariff, i.e., t/a, is small, NN is the best regime. Contrast to this, CC is the best regime when t/a is large enough. When t/a is intermediate, NC is the best regime. This point is similar to the ranking in the consumer surplus. (See Proposition 3.)

Comparing equilibrium total surplus in the three regimes, we establish Proposition 4.

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

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

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

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

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

We first explain the logic behind the result and then consider the economic implication. Suppose that downstream firms do not meet ROO when the external tariff, t/a, is high. Then, because their costs become high and productions are strained, their profits fall. That is, inefficiency of final-good production becomes large and the final-good production becomes inactive,

so NN is the worst among all other regimes when t/a is high. By contrast, if downstream firms meet ROO, their production costs become relatively low. Of course, the tariff revenue vanishes. However, since the input demand becomes the biggest, the profits of upstream firms become the highest. Hence, CC is the best among all other regimes when t/a is high. In NC, the input demand is half compared to CC. The tariff revenue is also half compared to NN. In addition, because the less-productivity of 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 among all other regimes. There are two reasons. One is that the cost difference between ROO-complier and non-complier is relatively small. Hence, the inefficiency of final-good production is of modest size, so consumer surplus is not much smaller. The other is that both tariff revenue and input demand occur. Because t/a is not much smaller, the tariff revenue is also not much smaller. At the same time, the upstream firms gain a positive profit. Moreover, since 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, it reverses.

Although small t/a brings small tariff revenue, the inefficiency of non-compliance of ROO becomes small. Hence, NN is the best among all other regimes. By contrast, in CC, the final-good production becomes inactive due to the cost of complying with ROO becomes bigger. This not just makes consumer surplus smaller but also makes the profit of upstream firms smaller due to a reduction of input demand. Hence, CC is the worst. From these, NC is intermediate.

Figures 3 and 4 have a significant implication. This is because, we can find that *upstream efficiency* determines the nature of equilibrium. Here, let us define that upstream efficiency can be measured by the number of upstream firms n. Namely, few n means that the upstream market is relatively inefficient. Oppositely, 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 $CN\&NC$ regime. In this case, the area of $CN\&NC$ overlaps 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 the region in which TS^{NC} is the best among all other regimes. Hence, we can say that the current situation, i.e., $CN\&NC$, may bring the best regime for the final-good importer if the upstream market is efficient. Therefore, if the upstream market is efficient, because the current situation can be the best regime for the final-good importer within the FTA, to promote 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 competitive enough, the current real situation, that is, asymmetry multiple equilibria, can maximize social surplus of the final-good importer. Formaly,* $\Delta_N < z_4 < \Delta_C < z_2$ *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, and hence, the input demand rises through an increase in the final-good production due to a cost reduction. In CC regime, the number of ROO-compliers is twice compared to that in the NC regime. Hence, TS^{CC} becomes more larger compared to TS^{NC}. This implies that to make $TS^{CC} = TS^{NC}$, since t/a must become more larger and θ must become more smaller, 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, a similar reason as the upward movement of z_2, z_4 curve tends to move upward as n increases.

5 Conclusion

We examine the role of ROO in a vertical structure in an FTA. ROO is a system which decides the origin of (final) goods. To satisfy ROO, it is general to need firms to use more intermediate products (inputs) produced within the area. Hence, ROO defines the business among firms, especially those in vertical relationships. To simplify our analysis, we assume a two-country

FTA and the input market outside of the FTA is perfectly competitive. Then, we analyze the effects of ROO by considering an oligopolistic upstream market and a duopolistic downstream market exist in the final-good importer in the FTA.

The degree of the upstream competition in the final-good importer affects input prices, 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, i.e., one firm meets ROO and the other one dost not (CN and NC). This result corresponds to the *current real situation*. More importantly, we find that in the asymmetric multiple equilibria, which is in line with the current real situation, consumer and total surpluses in the final-good importer in the FTA are maximized. This result shows important policy implications. Practitioners seeking to increase the FTA utilization rate (the number of firms meeting ROO, i.e., CC) may end up harming the FTA's member countries. Therefore, it requires special attention for policy makers facing the FTA utilization promoting policies. This provides new insights into the context of FTA and ROO.

To analyze the effects of ROO, in a vertical structure, we build up a very simple model. There are many topics for future discussion. For instance, it is worthwhile to assume that there exists an upstream market outside of the FTA, which is same the one in the FTA, i.e., oligopolistic firms engaging in homogenous price competition. In this case, the upstream firms outside of the FTA may lower the input price and induce the downstream firms in the FTA to buy from the suppliers outside of the FTA. This may result in weaker incentive for the downstream firms in the FTA to meet ROO. This topic is an extension to discuss the effects of ROO facing the upstream competition within and outside the FTA. However, it is beyond the scope of our study, so we leave it for future research.

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Appendices

A1. Total surplus

$$TS^{NN} = \frac{2(a-t)(2a+t)}{9},$$

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

$$TS^{CC} = \frac{2a^2n^2(\theta^2k+2)}{[\theta^2k(n+1)+3n]^2}.$$

A2. Proofs

This section contains all proofs that are omitted in 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) $w_{col}^{NC} - \overline{w}^{NC} = \frac{3n(a+t)\left[3n-k\theta^2(n-1)\right]}{4\theta(\theta^2k+3n)(\theta^2k+\theta^2kn+3n)}$ and $w_{col}^{CC} - \overline{w}^{CC} = \frac{3an\left[3n-k\theta^2(n-1)\right]}{2\theta(\theta^2k+3n)(\theta^2k+\theta^2kn+3n)}$. These imply Lemma 1. □

Proof of Lemma 2. (i) A 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, we have

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

(ii) A 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 $t_1 > t_2$, there are areas in $(\theta, t/a)$-space such that $CS^{NC} > CS^{NN}$ and $CS^{NC} > CS^{CC}$. In fact, $t_1 - t_2 = \frac{4a\theta^2kn(1+n)}{(\theta^2k+\theta^2kn+2n)(\theta^2k+\theta^2kn+6n)} > 0$. □

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

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

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

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

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

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

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

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

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

A simple algebra yields $z_2 > z_6 > z_4$. Hence, from these, 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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