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Export Product Quality, Optimal Import Tariffs and Firms' Strategic Choice of Vertical Structure*

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Abstract Using the export rivalry model based exclusive dealer channel, we examine the endogenous determination of firms' vertical structure when optimal import tariffs are implemented by the importing country. In addition, we analyze the welfare effects of trade liberalization when firms' vertical structures are endogenous. We show that, despite being heterogeneous firms, a symmetric vertical structure appears between firms under discriminatory tariffs, but an asymmetric vertical structure under uniform tariffs, with only one firm choosing vertical separation. Moving toward free trade is not always beneficial to all exporters. For the exporting country of low-quality products, the transition from discriminatory tariffs to free trade can be rather detrimental, depending on the equilibrium vertical structure in the discriminatory tariffs and the quality gap between products.

Keywords Quality gap, strategic vertical structure, two-part tariffs, optimal import tariffs.

JEL Classification F12, F13, L13.

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1. INTRODUCTION

An important issue addressed in the literature on vertical relations is whether manufacturers will sell their products through independent retailers (vertical separation) or become retailers of their own products. It typically is argued that vertical integration gives advantages by facilitating the coordination of the activities and interests of agents involved in the production and distribution of products inside the firm. On the other hand, in an oligopolistic market environment, vertical separation may be advantageous strategically for the manufacturers[1], provided that the franchise fees can be used to extract the retailers' surplus. Despite this trade-off between vertical control and strategic separation, in the industrialized world, many consumer goods are delivered to consumers through independent retailers.

However, what should not be overlooked is that today, numerous firms are competing in the global market in a diverse vertical structure. Examples of industries characterized by vertical separation include assembly industries such as aircraft, cars, computers, and so on. Automobile industry procures major parts and assembles used to build their cars through OEMs or vertical supply networks, which occupy about 70 percent of the values of a vehicle. On the other hand, there are many industry and firm-level examples of vertical integration. Oil industry is the case. Multinational oil companies such as ExxonMobile, Royal Dutch Shell and BP have adopted a vertically integrated structure, meaning that they have engaged in from drilling and extracting crude oil, transporting it around the world, refining it into petroleum products, to distributing the fuel to company-owned retail stations, for sales to consumers (Lee *et al.*, 2020). Even within the same industry, there are firm-level examples where different vertical structures are found depending on the firm. In the electronic devices industry, Samsung pursues like many other Asian producers, such as NEC Corporation or SONY Corporation, vertical integration strategy in the sense that it controls much of its value chain. Although Samsung relies on vertical integration as its competitive advantage, Apple, the biggest rival in the market, still purchases billions of dollars' worth of components from the outside upstream manufacturers. And what is important is that trade friction is particularly frequent in these

[1]Focusing on the strategic advantages of delegation or vertical separation, many previous studies have been conducted in the following areas: strategic delegation of decision-making to managers within the firm (see, e.g., Vickers, 1985; Fershtman and Judd, 1987; Sklivas, 1987; Xu and Lee, 2023), vertical relationships between upstream manufacturers and retailers (e.g., see Bonanno and Vickers, 1988; Coughlan and Wernerfelt, 1989; Gal-Or, 1990; Li and Shuai, 2016), and bargaining between parties (e.g., see Jones, 1989; Christiansen, 2013).

industries.

In fact, it has been pointed out in the empirical studies that the intensity of global competition including trade policies can have a significant effect on firms' vertical structures. The international competition can affect productivity via firms' organization choices such as their vertical integration intensity (Acemoglu *et al.*, 2010; Alfaro *et al.*, 2016; Aghion *et al.*, 2006; Conconi *et al.*, 2012; McLaren, 2000; Stiebale and Vencappa, 2022). For example, using the firm-level data of Worldbase data set, Alfaro *et al.*, (2016) showed that trade policy provides a source of exogenous price variation and that higher tariffs lead to higher prices and, therefore, to more vertical integration. In this context, some theoretical studies have examined how trade policies affect firms' incentives for vertical separation (or integration) in an international oligopoly context and vice versa (Das, 1997; Ziss, 1997; Lee and Wong, 2005; Wang *et al.*, 2009; Wei, 2010; Lee and Choi, 2023; Zhang and Lee, 2023).

These studies contribute to the literature by providing an in-depth understanding of the relationship between trade policies and firms' decision on vertical structure, especially when firms compete in an oligopolistic market and governments implement strategic trade policies. But the following two points are overlooked in the analysis. First, although the above studies focus on the interaction between firms' strategic behavior regarding their vertical organizational-structure and governments' trade policies, they do not, except for Ziss (1997), Jansen (2003) and Lee and Choi (2023), take the endogenous determination of the vertical market structure into consideration. Second, the above studies fail to consider the role of endogeneity of firms' vertical structure and institutional differences related to trade in the welfare analysis of trade liberalization. This is because the above mentioned studies primarily focus on identifying the interrelationship between firms' strategic incentive with respect to managerial delegation and trade policies. Furthermore, in a series of studies which analyze the country's preferences for tariff system and the welfare effects of trade liberalization (i.g., Gatsios, 1990; Hashimzade *et al.*, 2011; Liao and Wong, 2006; Din *et al.*, 2016), the underlying assumption is that firms' vertical structure is fixed one.

Given the above discussion and, focusing on vertical product differentiation, this study analyzes the influences of importing countries' trade policies on the determination of vertical structure of exporting firms in a trade duopoly context. In addition, we analyze the welfare effects of trade liberalization when firms' vertical structure is endogenous. To this end, we construct an export rivalry model based on exclusive dealer channel, where two exporting firms each located in two different countries sell their quality-differentiated products to the third country

market, and try to answer the following questions on vertical market structure: (i) if vertical structure is endogenously determined by firms' strategical consideration in the presence of optimal import tariffs by the domestic country, what will be the industry's vertical structure at equilibrium; and (ii) how the move from optimal import tariffs toward free trade in the importing country affects the social welfare of trading countries?

The study here is close to Lee and Choi (2023) in that it deals with the endogenous determination of vertical structure of asymmetric firms. However, it differs significantly in the following two aspects. First, regarding firm asymmetry, Lee and Choi (2023) assumes marginal cost differential between firms, while this paper assumes asymmetry due to the vertical product discrimination, i.e., quality gap between products. This difference regarding the source of firm asymmetry leads to the differences in the strategy of exporters on choosing their vertical structure, especially when the importing country adopts uniform tariff regime. Consequently, the endogenously determined firms' vertical structure in this study is somewhat different from that in Lee and Choi (2023), especially when uniform tariff regime is adopted by the importing country. Second, this study examines the welfare effects of trade liberalization by considering the endogeneity of the firm's vertical structure, which was ignored in Lee and Choi (2023). In this context, this study serves as a companion paper to Lee and Choi (2023).

The present paper presents the following findings. First, our model explains the existence of diverse types of firms' vertical structure in the international oligopoly market by the interaction between tariff system, the quality gap between products, and the strategic behavior of exporting firms with respect to their vertical structure. Even without considering the gains of vertical integration, such as facilitating coordination in the production process, our model suggests that the trade policies of importing country affect the strategic behavior of exporters, resulting in diverse types of vertical structure. This finding is consistent with empirical research showing that the intensity of global competition, including trade policy, has a significant impact on firms' vertical organization choices. Second, we show that, while discriminatory tariffs result in a symmetric vertical structure across firms despite the heterogeneity of the firms, uniform tariffs result in an asymmetric vertical structure, with vertical separation for high-quality exporter and integration for low-quality exporter. This is because, in tariff discrimination, the quality gap is fully reflected into the import tariffs applied to the respective country, thereby eliminating the effect of the interaction between the quality gap and marginal production costs on firm's profits. In this case,

both firms have the same strategy on choosing their vertical structure, leading to symmetric vertical structure at equilibrium. Third, we show that moving toward to free trade is not always beneficial to all exporters when discriminatory tariffs were implemented. For the country exporting low-quality products, the transition from discriminatory tariffs to free trade can be rather detrimental, as long as the quality gap is sufficiently small and firms' vertical structure remains unchanged. However, in any case, trade liberalization reduces the welfare of importing country and increases the global welfare.

The remainder of the paper is organized as follows. Section 2 outlines our simple export-rivalry model of quality-differentiated products. Section 3 and 4 examine the market equilibrium for each firms' vertical structure in the discriminatory tariffs, and then analyze the firms' choosing of vertical structure. Section 5 investigates the welfare implication of the transition from optimal discriminatory tariffs to the free trade. In Section 6, we examine the case of uniform tariffs. Section 7 provides concluding remarks.

2. THE MODEL

We consider a game played between two foreign manufacturers, firm H and firm L, each of which is located in a different foreign country, and the government of the home country, M. Each foreign firm produces a quality-differentiated product intended to sell in the home market. For simplicity, we assume that there is no producer of this product in country M and there is no consumption of this product in foreign countries. The output of firm i, the one in country i, is denoted by q_i for $i = \{H, L\}$.

Here, we focus on the manufacturers' strategic incentives to vertically integrate or separate. To incorporate this, we assume that each manufacturer decides whether to sell its product directly in country M (i.e., vertical integration) or to sell it to consumers via a retailer (i.e., vertical separation). In the latter case, we allow for a two-part tariff contract[2] , which consists of a per-unit wholesale

[2]Note that, in this paper, we implicitly assume that the contract terms between the manufacturer and the retailer under the vertical separation are observable (common knowledge) to the rival firm of the competing vertical channel. However, in reality, contract terms may not be observed by rival firms under certain circumstances. A substantial body of the literature on unobservable and private contracts among suppliers and retailers has been developed (see e.g., O'Brien and Shaffer, 1992; McAfee and Schwartz, 1994; Hart and Tirole, 1990; Segal, 1999; Montez, 2015; Li and Liu, 2021), and they have found that certain established results regarding observable supply chain contracts do not always apply when those contracts become unobservable to the firms of competing vertical chain. The present study focuses on the relationship between importing country's strategic trade policies and exporting firms' decision on their vertical structure. To avoid the

price, w_i, and a fixed fee, V_i, between the manufacturer and the retailer. Consider firm H and firm L compete with each other for a population of consumers who differ in their willingness to pay for product quality. The product quality of firm i is denoted by s_i, and the per-unit production cost of both manufacturers is assumed to be c, regardless of the quality level. Without loss of generality, we normalize s_L to be 1 and assume that $s_H \equiv s > s_L (\equiv 1)$. In other words, with the same marginal production cost c, firm H produces high-quality products while firm L low-quality ones, and the quality gap between the two products is given by $s-1 (>0)$. We assume throughout the paper that the quality level of products is exogenously given.

A consumer's willingness to pay for quality is parameterized by a valuation β that is uniformly distributed over the interval $[0,1]$. The utility of consumers when buying firm i's product at price p_i is defined as follows: $U = \beta s_i - p_i$. We further assume that each consumer purchases at most one product and one unit of the product. Given the firms' product prices, each consumer maximizes utility by choosing either to buy one of the products or not to buy. Consumers are partitioned by two marginal consumers, β_{HL} and β_{L0}: Those with valuations in the range of $[\beta_{HL}, 1]$ buy the high-quality product; those in $[\beta_{L0}, \beta_{HL}]$ buy the low-quality one; and those in $[0, \beta_{L0}]$ buy neither. The two marginal consumers are respectively specified as $\beta_{HL} = \frac{p_H - p_L}{s-1}$ and $\beta_{L0} = p_L$. From $q_H = 1 - \beta_{HL}$ and $q_L = 1 - \beta_{HL} - \beta_{L0}$, the direct demand functions for high-quality and low-quality products are then specified as follows:

$$q_H = D_H(p_H, p_L) = 1 + \frac{p_L - p_H}{s-1} \quad \text{and} \quad q_L = D_L(p_H, p_L) = \frac{p_H - s p_L}{s-1}. \qquad (1)$$

We assume that the government of country M levies specific-tariffs t_i on the imports from country i, where the tariffs t_H and t_L are allowed to differ. The social welfare of country M, W, is defined as the sum of consumers' surplus and the tariff revenue, that is,

$$W = \int_{\beta_{HL}}^{1} (\beta s - p_H) d\beta + \int_{\beta_{L0}}^{\beta_{HL}} (\beta - p_L) d\beta + \sum_{i=H,L} t_i q_i.$$

The global welfare, G, is defined as the sum of welfare levels of the three countries, i.e., $G = W + \sum \Pi_i$, where Π_i represents the profit of firm i. The profit function of each firm can be specified as follows. Given a two-part tariff contract, (w_i, V_i), the vertically separated upstream manufacturer and downstream

complexity that arises from assuming contract unobservability, as with most existing studies, we assume that retailers' contract terms are always known in the market.

retailer receive the following profits, respectively:

$$\begin{cases} \text{Upstream manufacturer:} & \Pi_i(\mathbf{p}; w_i; V_i) = (w_i - c)q_i + V_i, \\ \text{Downstream retaler:} & Z_i(\mathbf{p}; \lambda_i; V_i) = (p_i - \lambda_i)q_i - V_i, \end{cases}$$

and the vertically integrated firm receives the following profits:

$$\text{vertically integrated firm } \Pi_i(\mathbf{p}; \lambda_i) = (p_i - \lambda_i)q_i,$$

where $\mathbf{p} = (p_H, p_L)$ and λ_i, the retailer's effective marginal cost including trade cost, varies depending on whether it is vertically integrated or separated. That is, $\lambda_i = c + t_i$ if firm i is vertically integrated, whereas $\lambda_i = w_i + t_i$ if the firm is vertically separated.

We analyze the following four-stage game. In stage one, each firm chooses its distribution channel; i.e., whether to sell directly to consumers by operating their own retail store (vertical integration) or to hire an independent exclusive retailer (vertical separation). In stage two, given the vertical structure determined in the first stage, the government of country M implements optimal tariffs based on either discriminatory tariffs or uniform ones. In stage three, if upstream manufacturer i chooses vertical separation in the first stage of the game, then it offers two-part tariff contracts to its own retailer. In the last stage, each manufacturer (or retailer) sets the price in the market (Bertrand competition). We solve the subgame perfect Nash equilibrium (SPNE) through backward induction[3].

Finally, we assume the following sufficient condition, which requires that the marginal production cost of firm be sufficiently small to ensure a positive output.

Assumption 1. $c < \tilde{c} \equiv \frac{1}{4s-1}$.

3. MARKET EQUILIBRIUM UNDER FIRMS' VERTICAL STRUCTURE

Depending on the manufacturers' decision at stage 1, there are four possible vertical structures: both upstream firms choosing vertical integration (IV), both choosing vertical separation (SV), firm H choosing vertical integration while firm L choosing vertical separation (IS), and firm H choosing vertical separation

[3]The timing that manufacturers' decisions on vertical structure precede the government's tariff policy highlights the notion that changing a firm's vertical organization-structure is a costly process and potentially has a longer time horizon than setting the import tariffs (See Yi *et al.*, 2016).

while firm L choosing vertical integration (SI). Before examining the subgame perfect Nash equilibrium for each possible organization structure, we first solve the last stage of the game following the backward induction method.

Since firms engage in Bertrand competition, the maximization problem of each retailer can be written as $\max_{p_i}(p_i - \lambda_i)q_i$, where q_i is given in (1). By solving the system of the two reaction functions, we obtain the equilibrium prices and quantities at this stage of the game as follows:

$$\begin{aligned} p_H(\lambda_H, \lambda_L) &= \frac{s[2(s-1) + 2\lambda_H + \lambda_L]}{4s-1}, \\ p_L(\lambda_L, \lambda_H) &= \frac{(s-1) + 2s\lambda_L + \lambda_H}{4s-1}, \end{aligned} \tag{2}$$

$$\begin{aligned} q_H(\lambda_H, \lambda_L) &= \frac{2s(1-s) - (2s-1)\lambda_H + s\lambda_L}{(4s-1)(s-1)}, \\ q_L(\lambda_H, \lambda_L) &= \frac{s[(s-1) + \lambda_H - (2s-1)\lambda_L]}{4s-1}, \end{aligned} \tag{3}$$

where $\lambda_i = c + t_i$ if firm i is vertically integrated, whereas $\lambda_i = w_i + t_i$ if it is separated. Following the backward induction method, we first solve four types of sub-games in a duopoly model – two symmetric vertical structures and two asymmetric vertical structures – and then examine the endogenous determination of vertical structure.

Symmetric vertical structures We first look at the case where both firms are vertically separated (i.e., SV regime). The equilibrium prices and quantities at the last stage of the game are given in (2) and (3) by replacing λ_i (for $i \in \{H, L\}$) with $w_i + t_i$. Apparently, p_i is the function of $\mathbf{w} = (w_H, w_L)$ and $\mathbf{t} = (t_H, t_L)$, and $\frac{\partial p_i}{\partial w_i} > 0$ and $\frac{\partial p_i}{\partial w_{-i}} > 0$, where "$-i$" represents the other firm. The latter, $\frac{\partial p_{-i}}{\partial w_i} > 0$, implies that if independent upstream manufacturer i raises its wholesale price, then it will also increase the retail price of its rival's products (the "cross effect" of the wholesale price).

In stage 3, upstream manufacturer determines its two part tariff contract (w_i, V_i). Because fixed fees are set to fully extract the retailer's anticipated profits, i.e., $V_i = (p_i - \lambda_i)q_i$, the maximization problem of each upstream manufacturer is reduced to $\max_{p_i} \Pi_i \equiv (p_i(\mathbf{w}, \mathbf{t}) - \lambda_i)q_i(\mathbf{w}, \mathbf{t})$, where p_i and q_i are given by (2) and (3) with replacement $\lambda_i = w_i + t_i$. Applying the envelope theorem gives:

$$\frac{\partial \pi_i}{\partial w_i} = \underbrace{(w_i - c)\overbrace{\frac{\partial D_i}{\partial p_i}}^{-}\overbrace{\frac{\partial p_i}{\partial w_i}}^{+}}_{\text{proift loss due to demand contradiction } (-)} + \underbrace{(p - c - t_i)\overbrace{\frac{\partial D_i}{\partial p_{-i}}}^{+}\overbrace{\frac{\partial p_{-i}}{\partial w_i}}^{+}}_{\text{Rent-shifting effects } (+)}. \quad (4)$$

The first term on the right-hand side (RHS) of (4) represents the profit loss of independent upstream manufacturer accruing from the decrease in derived demand while the second term represents the rent-shifting gain from the rival firm to own firm caused by the cross effect of the wholesale price (i.e., $\frac{\partial p_{-i}}{\partial w_i} > 0$). The sign of (4) is ambiguous, but the following two points are noteworthy. First, given the import tariffs, choosing vertical separation is the best response of firm i. Evaluating (4) at a position where wholesale price equals marginal cost, we have

$$\left.\frac{\partial \pi_i(\mathbf{w};t)}{\partial w_i}\right|_{w_i=c} = (p - c - t_i)\frac{\partial D_i}{\partial p_{-i}}\frac{\partial p_{-i}}{\partial w_i} > 0,$$

implying that, given the import tariffs, manufacturer i's best response to the rival's vertical separation decision is setting wholesale price above its per-unit cost (i.e., $w_i > c$), namely choosing vertical separation[4]. Second, we obtain

$$\frac{\partial^2 \Pi_i}{\partial t_i \partial w_i} = \left(\frac{\partial p_i}{\partial t_i} - 1\right)\frac{\partial D_i}{\partial p_{-i}}\frac{\partial p_{-i}}{\partial w_i} < 0 \text{ and } \frac{\partial^2 \Pi_i}{\partial t_{-i} \partial w_i} = \frac{\partial p_i}{\partial t_{-i}}\frac{\partial D_i}{\partial p_{-i}}\frac{\partial p_{-i}}{\partial w_i} > 0.$$

An increase in t_i, by worsening the terms of trade of country i (i.e., $\frac{\partial p_i}{\partial t_i} - 1 < 0$), reduces the scale of rent-shift gain of firm i's vertical separation, which in turn reduces the magnitude of rent-shift gain of firm i's vertical separation, which in turn reduces its motivation toward vertical separation. However, an increase in t_{-i} increases the motivation to vertical separation for firm i because it improves the terms of trade of country i (i.e., $\frac{\partial p_i}{\partial t_{-i}} > 0$).

Solving $\frac{\partial \Pi_i}{\partial w_i} = 0$ gives firm i's best response function of wholesale price $\psi_i(w_{-i}, \mathbf{t})$ as follows:

$$w_H = \psi_H(w_L; \mathbf{t}) = c - \frac{c + t_H}{4s} + \frac{2(s-1) + w_L + t_L}{4(2s-1)}, \quad (5)$$

[4]The strategic effect of vertical separation is explained as follows. An increase in w_i from its marginal cost (i.e., choosing vertical separation) leads to a price increase by the rival firm in the retail market (the cross effect of the wholesale price), which in turn shifts profits from the rival firm to its own retailer.

$$w_L = \psi_L(w_H;\mathbf{t}) = c - \frac{c+t_L}{4s} + \frac{s-1+w_H+t_H}{4s(2s-1)}. \tag{6}$$

In (5) and (6), the wholesale prices are strategic complements because they mutually reinforce one another (i.e., $\frac{\partial \psi_{-i}}{\partial w_i} > 0$).

Figure 1 depicts $\psi_i(w_{-i};\mathbf{t})$ for $i \in \{H,L\}$ in the (w_H, w_L) space. Both schedules are positively sloped, with schedule ψ_H being steeper than ψ_L to ensure stability of the equilibrium. An intersecting point between the two schedules, point S, gives the equilibrium values of the two wholesale prices in the SV regime, w_H^{SV} and w_L^{SV}. Using w_i^{SV} for $i \in \{H,L\}$, we obtain firms' output, profits and social welfare at this stage as follows

$$w_H^{SV}(\mathbf{t}) = c + \frac{(s-1)(4s-2c-1) - (4s-3)t_H + (2s-1)t_L}{1-12s+16s^2}, \tag{7}$$

$$w_L^{SV}(\mathbf{t}) = c + \frac{(s-1)(2s+c-4cs) - s(4s-3)t_L + (2s-1)t_H}{s(1-12s+16s^2)}, \tag{8}$$

$$q_H^{SV}(\mathbf{t}) = \frac{2(s-1)[(s-1)(4s-2c-1) - (4s-3)t_H + (2s-1)t_L]}{(s-1)(1-12s+16s^2)}, \tag{9}$$

$$q_L^{SV}(\mathbf{t}) = \frac{2(s-1)[(s-1)(2s+c-4cs) - s(4s-3)t_L + (2s-1)t_H]}{(s-1)(1-12s+16s^2)}, \tag{10}$$

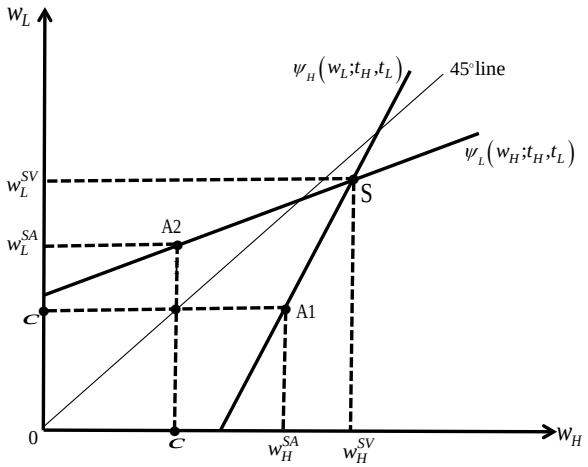

Figure 1: THE DETERMINATION OF WHOLESALE PRICES. Points S, A1 and A2 represent the equilibrium wholesale prices in the SV, SI and IS regimes, respectively.

$$\Pi_H^{SV}(\mathbf{t}) = \frac{2s(s-1)}{2(s-1)}[q_H^{SV}(\mathbf{t})]^2 \quad \text{and} \quad \Pi_L^{SV}(\mathbf{t}) = \frac{2s(s-1)}{2(s-1)}[q_L^{SV}(\mathbf{t})]^2, \tag{11}$$

$$W^{SV}(\mathbf{t}) = q_H^{SV}(\mathbf{t})q_L^{SV}(\mathbf{t}) + \frac{(q_H^{SV}(\mathbf{t}))^2 + s(q_L^{SV}(\mathbf{t}))^2}{2} + \sum_{i=H,L} t_i q_i^{SV}(\mathbf{t}), \tag{12}$$

$$G^{SV}(\mathbf{t}) = W^{SV}(\mathbf{t}) + \sum_{i=H,L} \Pi_i^{SV}(\mathbf{t}). \tag{13}$$

Lemma 1. *(i) Given the firms' vertical structure, an increase in t_i reduces the motivation for vertical separation of firm i but increases the motivation for vertical separation of the other firm (i.e., $\frac{\partial w_i^{SV}}{\partial t_i} < 0$ and $\frac{\partial w_i^{SV}}{\partial t_{-i}} > 0$). (ii) $w_H^{SV} > w_L^{SV}$ with $t_H = t_L$.*

Note that the magnitude of the wholesale price above the marginal production cost indicates the magnitude of the firm's motivation for vertical separation. Considering this, part (i) of Lemma 1 implies that an increase in t_i reduces the motivation for vertical separation of firm i ($\frac{\partial w_i^{SV}}{\partial t_i} < 0$) but increases that of the other firm ($\frac{\partial w_{-i}^{SV}}{\partial t_i} > 0$). Part (ii), $w_H^{SV} > w_L^{SV}$ with $t_H = t_L$[5], implies that firm H (exporter of high-quality products) has a greater incentive to vertical separation than firm L (exporter of high-quality products) if other conditions are the same.

In stage 2, the importing country sets t_H and t_L at its welfare maximizing level, that is,

$$\max_{t_H,t_L} W^{SV}(\mathbf{t}) (\equiv CS^{SV}(\mathbf{t}) + \sum_{i=H,L} t_i q_i^{SV}(\mathbf{t})).$$

Differentiating $W^{SV}(\mathbf{t})$ with respect to t_i gives

$$\frac{\partial W^R}{\partial t_i} = \Big(1 - \frac{\partial p_i^R}{\partial t_i}\Big) q_i^R - \frac{\partial p_{-i}^R}{\partial t_i} q_{-i}^R + \Big(t_i \frac{\partial q_i^R}{\partial t_i} + t_{-i} \frac{\partial q_{-i}^R}{\partial t_i}\Big), \tag{14}$$

where $i = H, L; R \in \{SV, IV, SI, IS\}$.

The first term on the RHS represents gains from terms of trade improvement for the import of good i, the second term consumer surplus loss due to the price increase of the other good, and the third term the effects of tax wedge of the two goods on the government revenue[6]. By solving the two first order conditions simultaneously, we can obtain the optimal import tariffs for this regime as follows

[5]In Figure 1, point S locates below the 45 degree line, implying $w_H^{SV} > w_L^{SV}$ with $t_H = t_L$.

[6]The tax-wedge effect equals the initial difference between the domestic and import prices times the change in imports.

(the subscript 'd' stands for discriminatory tariffs):

$$t_{H,d}^{SV} = \frac{2s(s-1)(6s-4c-1)}{1-28s+36s^2} \quad \text{and} \quad t_{L,d}^{SV} = \frac{2(2s-1)[4s-c(6s-1)]}{1-28s+36s^2}, \tag{15}$$

where

$$t_{H,d}^{SV} - t_{L,d}^{SV} = \frac{2(s-1)(6s^2+2cs-5s-c)}{1-28s+36s^2} > 0.$$

Using optimal import tariffs derived above, we can obtain the equilibrium market outcomes under the SV regime, vertical separation by both firms, as shown in Appendix A.1.

Next, we look at the case where both manufacturers are vertically integrated (IV regime). Since the stage of two-part tariff contracts is dropped, the case will be reduced to a three-stage game. With vertical separation by both manufacturers, the equilibrium prices and quantities in the last stage of the game are given in (2) and (3) by replacing $\lambda_i = c + t_i$. With these equilibrium outcomes at stage 4 and denoting the choice of vertical integration by both manufacturers with the superscript 'IV', we can obtain the home country's social welfare in terms of in terms of t_H and t_L:

$$W^{IV}(\mathbf{t}) = CS^{IV}(\mathbf{t}) + \sum_{i=H,L} t_i q_i^{IV}(\mathbf{t})).$$

In stage 2, the maximization problem of country M is $\max_{t_H,t_L} W^{IV}(\mathbf{t})$ with respect to t_i for $i \in \{H,L\}$ and applying the envelope theorem, we obtain (14) with $R = IV$. Solving $\frac{\partial W^{IV}}{\partial t_H} = \frac{\partial W^{IV}}{\partial t_L} = 0$ for $i \in \{H,L\}$ simultaneously, we obtain the optimal import tariffs in the IV regime as follows:

$$t_{H,d}^{IV} = \frac{(s-1)(3s-2c)}{9s-4} \quad \text{and} \quad t_{L,d}^{IV} = \frac{(s-1)(2-3c)}{9s-4}, \tag{16}$$

where

$$t_{H,d}^{IV} - t_{L,d}^{IV} = \frac{(s-1)(3s+c-2)}{9s-4} > 0.$$

Substituting $t_{H,d}^{IV}$ and $t_{L,d}^{IV}$ into the expressions for prices, quantities, firms' profits, and welfare, we obtain the equilibrium market outcomes under the vertical integration by both firms, as we show in Appendix A.1.

ASYMMETRIC VERTICAL STRUCTURES

We now solve the remaining two sub-games, asymmetric vertical structures. Consider the situation in which only firm H (resp. firm L) chooses vertical separation, regime SI (resp. regime IS). The prices and quantities at stage 4 of the game are given by (2) and (3) by replacing (λ_H, λ_L) with $(w_H + t_H, c + t_L)$ for SI regime, and by replacing with $(c + t_H, w_L + t_L)$ for IS regime. At stage 3, the wholesale prices are determined. Since the same procedure as in the *SV* regime is applied, the wholesale price in the SI (resp. IS) regime is obtained at point A1(resp. A2), the intersecting point between $\psi_H(\cdot)$ (resp. $(\psi_L(\cdot))$ and $w_L = c$(resp. $w_H = c$) in Figure 1. That is

$$\begin{cases} w_H^{SA}(\mathbf{t}) = c - \frac{c+t_H}{4s} + \frac{2(s-1)+c+t_L}{4s(2s-1)} & \text{for SI regime,} \\ w_L^{SA}(\mathbf{t}) = c - \frac{c+t_L}{4s} + \frac{(s-1)+c+t_H}{4s(2s-1)} & \text{for IS regime.} \end{cases} \tag{17}$$

where the second letter '*A*' in the superscript stands for asymmetric organizational structure between firms and the first letter '*S*' (resp. '*I*') represents vertical separation (resp. integration) of the firm indicated in the subscript[7].

Lemma 2. *Suppose that vertical structure is asymmetric between firm. It holds that (i)* $w_H^{SA}(\mathbf{t}) > w_L^{SA}(\mathbf{t})$ *if* $t_H = t_L$*, and (ii)* $\frac{\partial w_i^{SA}}{\partial t_i} < 0$ *and* $\frac{\partial w_i^{SA}}{\partial t_{-i}} > 0$.

Lemma 2 corresponds to Lemma 1. Even in an asymmetric vertical structure, the effects of import tariffs on the firm's motivation for vertical separation is similar to that in the symmetric vertical structure. Using the equilibrium wholesale prices given in (17), the equilibrium values of the market outcomes under the asymmetric organizational structure can be obtained. By solving the first order conditions of welfare maximization, we can obtain optimal import tariffs under each asymmetric regime as follows:

$$\begin{cases} t_{H,d}^{SA} = \frac{2(s-1)(3s-2c)}{18s-11} \text{ and } t_{L,d}^{IA} = \frac{(s-1)[4s-c(6s-1)]}{s(18s-11)} & \text{for SI regime,} \\ t_{H,d}^{IA} = \frac{(s-1)(6s-4c-1)}{18s-11} \text{ and } t_{L,d}^{SA} = \frac{2(2-3c)(s-1)}{18s-11} & \text{for IS regime.} \end{cases} \tag{18}$$

Substituting optimal tariffs given in (18), we can obtain the equilibrium market outcomes under the asymmetric vertical structure as shown in Appendix A.1.

[7]Therefore, w_H^{SA} represents the wholesale price that firm H charges its exclusive retailer when only firm H, the firm listed in subscript, is vertically separated. Note that $w_H^{IA} = w_L^{IA} = c$.

TARIFF RANKING ACROSS REGIMES

In our model, import tariffs set by the importing country is an important factor influencing exporters' motivation for vertical integration or separation (see Lemma 1 and 2). The magnitude of import tariffs does matter in determining firms' vertical organization. The following proposition is obtained with respect to the ranking of optimal tariffs.

Proposition 1. *Suppose that country M levies discriminatory import tariffs, given the firms' vertical structure. Then, the following inequalities hold:*

i) $t_{L,d} < t_{H,d}$ *for all types of vertical structure;*

ii) $\begin{cases} t_{H,d}^{IV} < t_{H,d}^{IA} < t_{H,d}^{SA} < t_{H,d}^{SV}, \\ t_{L,d}^{IV} < t_{L,d}^{SA} < t_{L,d}^{IA} < t_{L,d}^{SV}. \end{cases}$

Proof. The proof is easily obtained with simple calculations using (15), (16), and (18).

Part (i) of Proposition 1 represents that the tariff applied to the low-quality producer is lower than the tariff applied to the high-quality producer[8]. As pointed out by Hashimzade *et al.* (2011), the discriminatory tariff policy has the effects of partially equalizing the competitiveness of the two countries. Therefore, for the country producing low-quality products, discriminatory tariffs are more advantageous than uniform ones. In this context, tariff discrimination is inefficient from the viewpoint of resource allocation because it diverts production from the high-quality products country to a relatively low-quality products one.

Two types of inequalities, that is, (a) $t_{i,d}^{IA} < t_{i,d}^{SV}$ and $t_{i,d}^{IV} < t_{i,d}^{SA}$, and (b) $t_{i,d}^{SA} < t_{i,d}^{SV}$ and $t_{i,d}^{IV} < t_{i,d}^{IA}$ for $i \in \{H, D\}$, are observed in part (ii) of the Proposition 1. Case (a) states that given the vertical structure of the other firm, the importing country imposes higher tariffs on imports from vertically separated exporter than on imports from vertically integrated one.

It is well known in the strategic trade policy literature that importing country can raise its welfare by effectively extracting the rents earned by foreign exporters with market power through the imposition of import tariffs (rent-extraction

[8]The imposition of high tariffs on imports of high-quality products is explained as follows. The import tariff has rent-extracting effects from the foreign exporters under the oligopolistic market. As an initial state, let us assume that two exporting firms export products of different quality at the same unit cost of production under the uniform tariffs. In this situation, if the importing country slightly raises tariffs on high-quality imports and lowers tariffs on low-quality imports, then it can increase tariff revenue without causing changes in import volume and consumer surplus. Therefore, the importing country's welfare would be in such a way enhanced.

rationale of import tariffs). In our model, compared to vertical integration, vertical separation has the effect of expanding its market power as it results in higher retail prices in the market via the double marginalization. In this case, a small increase in the import tariff over what is levied for vertical integration increases the welfare of the importing country because it shifts profits from the foreign exporter to the importing country.

Case (b), $t_{i,d}^{SA} < t_{i,d}^{SV}$ and $t_{i,d}^{IV} < t_{i,d}^{IA}$, implies that firm i is subject to higher import tariffs when the rival exporter firm $j(i \neq j)$ is vertically separated than when it is integrated. This is straightforward considering that the vertical separation of the rival firm, compared to vertical integration, increases the retail price of firm i's products via the cross effects of the wholesale price, thereby increasing the monopoly power of firm i in the market.

4. ENDOGENOUS VERTICAL STRUCTURE UNDER TARIFF DISCRIMINATION

We now turn to the firms' choice of vertical structure in the first stage of the game. As mentioned earlier, import tariffs by country M is an important factor influencing exporters' motivation for vertical separation or integration (see Lemma 1 and 2). To highlight this, we first look at the case where the import tariff is exogenously given ($t_H = t_L = \hat{t}$) and set at the same level across the different types of organizational structure (the notation "$\wedge$" represents the market equilibrium under the exogenous tariff rates).

Table 1 summarizes the potential choice in this stage, with each firm facing two alternatives: a separation and an integration. In Table 1, $\Pi_i^R = \hat{\Pi}_i^R$ for $i \in \{H,L\}$ and $R \in \{SV,IV,SA,IA\}$, if import tariffs are exogenously given. The following Lemma is immediate.

Lemma 3 (Bonanno and Vickers, 1988): *Suppose that import tariffs are ex-*

firm $H \backslash$ firm L	Separation	Integration
Separation	Π_H^{SV}, Π_L^{SV}	Π_H^{SA}, Π_L^{IA}
Integration	Π_H^{IA}, Π_L^{SA}	Π_H^{IV}, Π_L^{IV}

Table 1: PAYOFF MATRIX Each firm has two options, i.e., vertical integration and vertical separation, and Π_i for $i \in \{H,L\}$ represents the profit of the upstream manufacturer i (resp. integrated firm i) in the case of vertical separation (resp. integration).

ogenously given at a symmetric level. In this case, choosing vertical separation is the dominant strategy for both firms, i.e., $\hat{\Pi}_i^{IA} < \hat{\Pi}_i^{SV}$ *and* $\hat{\Pi}_i^{IV} < \hat{\Pi}_i^{SA}$ *for* $i \in \{H, L\}$.

Proof: See Appendix III in the Supplement.

With a two-part tariff contract, choosing vertical separation, and hence charging its retailer a wholesale price higher than the per-unit manufacturing cost is in each manufacturer's interest because it gives rise to strategic rent-shifting from the rival firm.

However, if we allow for an optimal import tariff, the results in Lemma 3 no longer hold. To examine this, we look at firms' profit ranking among the different types of vertical structure. From the equilibrium outcome given in Appendix A.1, we have

$$\begin{cases} \Pi_i^{IV} < \Pi_i^{SV} < \Pi_i^{IA} < \Pi_i^{SV} & \text{if } s < s^* = 1.0428, \\ \Pi_i^{SA} < \Pi_i^{IV} < \Pi_i^{IA} < \Pi_i^{SV} & \text{if } s \in (s^*, s^{**}), \\ \Pi_i^{SA} < (\Pi_i^{IV}, \Pi_i^{SV}) < \Pi_i^{IA} & \text{if } s > s^{**} = 1.2588. \end{cases}$$

Above rankings provide the information on each firm's strategy for the choosing of its vertical structure. If $s < s^* = 1.0428$ (resp. $s > s^* = 1.2588$), then $\Pi_{i,d}^{IV} < \Pi_{i,d}^{SV}$ (resp. $\Pi_{i,d}^{IV} > \Pi_{i,d}^{SA}$) and $\Pi_{i,d}^{IA} < \Pi_{i,d}^{SV}$ (resp. $\Pi_{i,d}^{IA} > \Pi_{i,d}^{SV}$) hold, implying that vertical separation (resp. integration) is the dominant strategy for both firms. On the other hand, if $s \in (s^*, s^{**})$, then $\Pi_{i,d}^{IA} < \Pi_{i,d}^{SV}$ and $\Pi_{i,d}^{SA} < \Pi_{i,d}^{IV}$ hold, implying that each firm makes the same choice as its rival.

Proposition 2. *Suppose that the importing country implements optimal discriminatory tariffs on the imports of quality differentiated products. (i) If quality gap between products is sufficiently small (resp. large), i.e.,* $s < s^*$ *(resp.* $s > s^{**}$*), then both firms' vertical separation (resp. integration), SV (resp. IV) regime, emerges at equilibrium. On the other hand, if* $s \in (s^*, s^{**})$*, then either SV or IV emerges at equilibrium (multiple equilibria).*

Proposition 2 is similar to the results in Lee and Choi (2023) that introduces firm heterogeneity in terms of marginal production cost. This is because the quality gap in this study serves a similar role to the degree of product differentiation[9] in Lee and Choi (2023). The intuition behind Proposition 2 is as follows.

[9]The quality gap $s - 1$ has an inverse relationship with the degree of substitution between products. Therefore, the smaller s(the higher the degree of substitution), the larger the cross effect of wholesale price on retail price, resulting in the larger the strategic rent-shifting effect of vertical separation.

There are two opposing factors influencing the determination of exports' vertical structure: (1) strategic rent-shifting gain of vertical separation and (2) tariff reducing effect of vertical integration because vertical separation results in rent-shifting from the rival exporter due to the cross effect of the wholesale price in the market (see Lemma 3). As s is getting closer to 1 (a decrease in s), the larger is the rent-shifting effects of vertical separation. However, the government of country M levies different tariffs depending on the vertical structure of the foreign exporter. As in Proposition 1, the foreign exporter in vertical integration faces a lower import tariff than in the case of vertical separation (tariff reducing effects of vertical integration).

Consequently, if $s < s^*$ (resp. $s > s^{**}$), then the rent-shifting effects of vertical separation becomes relatively more (resp. less) important than the tariff reducing effects of vertical integration and both exporters tend to choose vertical separation (resp. integration). If s is moderate level ($s^* < s < s^{**}$), each exporter makes the same choice as its competitor, leading to the cases where exporters H and L are both vertically integrated or separated (i.e., multiple equilibria).

The following two points are noteworthy in Proposition 2. First, unlike Bonanno and Vickers (1988) where only SV regime appears at equilibrium, we show that either both firms' vertical integration or both firms' vertical separation does appear depending on the level of quality gap between products. This suggests that the findings of Bonanno and Vickers (1988) hold true only when the quality gap between products are sufficiently small as far as optimal discriminatory tariffs are implemented by the importing country. Second, asymmetric vertical structure where only one exporter chooses vertical separation does not appear as long as discriminatory tariffs are implemented. This is because, in tariff discrimination, the quality gap between products is fully reflected into the import tariffs applied to the respective country, thereby eliminating the effect of the interaction between the quality gap and marginal production costs on firm's profits. In this case, each firm has the same strategy on choosing its vertical structure (see Proposition 2), which leads to symmetric vertical structure at equilibrium.

5. WELFARE IMPLICATION OF TRADE LIBERALIZATION: DISCRIMINATORY TARIFFS

In this section, we analyze the impact of country M's transition from discriminatory tariffs to free trade on the welfare of exporting countries, importing countries, and the world. Since tariffs are imposed exogenously at the zero level, the equilibrium vertical structure of exporters in free trade is the SV regime

(see Lemma 3). Market equilibrium in free trade is obtained by substituting $t_H = t_L = 0$ into (7) to (13) (see Appendix A.1). On the other hand, when the importing country implements optimal discriminatory tariffs, different types of vertical structures, *SV* and *IV* regimes, appear in the equilibrium (Proposition 2). This suggests that it is necessary to consider changes in the vertical structure of firms in the welfare analysis of trade liberalization.

Corollary 1. *The transition from discriminatory tariffs to free trade includes the following two cases: (i) firms' vertical structure remains unchanged in the form of vertical separation (SV regime), and (ii) firms' vertical structure changes from vertical integration (IV regime) in the discriminatory tariffs to vertical separation (SV regime) in the free trade.*

In fact, empirical studies show that the intensity of competition in the international level, including trade policies, affects firms' vertical structure (Acemoglu et. al., 2010; Alfaro et. al., 2016; Conconi et. al., 2012). Now, we turn to the welfare effects of exogenous trade liberalization. By comparing the equilibrium welfare of each country under discriminatory tariffs and free trade, the following Lemma is obtained:

Proposition 3. *Free trade, as compared with optimal discriminatory tariffs, makes the exporter of high-quality products and the world better off and importing country worse off irrespective of whether firms' vertical structures in the discriminatory tariffs are vertically separated or integrated. That is,* $\Pi^{SV}_{H,d} < \Pi^{SV}_{H,FT}$, $\Pi^{IV}_{H,d} < \Pi^{SV}_{H,FT}$; $W^{SV}_{d} > W^{SV}_{FT}$, $W^{IV}_{d} > W^{SV}_{FT}$; *and* $G^{SV}_{d} < G^{SV}_{FT}$, $G^{IV}_{d} < G^{SV}_{FT}$.

Proof. See Appendix IV in the Supplement.

The above proposition suggests that the impact of the transition from discriminatory tariffs to free trade on the welfare change of each country is unrelated to the firms' vertical structure under the discriminatory tariffs, except for the country exporting low-quality products. The intuitive explanation is as follows. Exogenous trade liberalization increases the export volume of high-quality exporter by removing not only trade barriers but also the negative effects of discriminatory tariffs that partially equalize the quality gap between products. Since equilibrium profit is a positive function of its output, the trade liberalization increases the profit of high-quality exporter. Moreover, if the transition to free trade accompanies the change of firms' structure from vertical integration to separation, then the rent-shifting gains of vertical separation are added. For

the above reasons, the transition to free trade increases the profits of high-quality firms ($\Pi^{SV}_{H,d} < \Pi^{SV}_{H,FT}, \Pi^{IV}_{H,d} < \Pi^{SV}_{H,FT}$).

Note that tariff discrimination is inefficient because it diverts production from the country producing high-quality products to the country of low-quality products. Therefore, moving to free trade will be an overall gain in terms of global welfare because it not only enhances the market competition but also eliminates the negative trade-diverting impacts of discriminatory tariffs ($G^{SV}_d < G^{SV}_{FT}, G^{IV}_d < G^{SV}_{FT}$). On the other hand, the transition toward free trade harms the importing country since rent-extracting of import tariffs disappears irrespective of firms' vertical structure ($W^{SV}_d > W^{SV}_{FT}, W^{IV}_d > W^{SV}_{FT}$).

However, moving toward free trade is not always beneficial to all exporters. In particular, for the country exporting low-quality products, the transition to free trade could be rather be detrimental. The following Proposition is obtained by comparing equilibrium profits of firm L between optimal discriminatory tariffs and free trade.

Proposition 4. *Suppose that country M moves from discriminatory tariffs to free trade. (i) If firms' vertical structure remains unchanged, then there exists critical value*

$$\tilde{s} \equiv \frac{2 - 15c + \sqrt{8 - 56c + 57c^2}}{4(1 - 6c)},$$

such that for $s < \tilde{s}$, $\Pi^{SV}_{L,FT} < \Pi^{SV}_{L,d}$ and for $s > \tilde{s}$, $\Pi^{SV}_{L,FT} > \Pi^{SV}_{L,d}$ holds. (ii) If firms' vertical structure shifts from IV to SV regime with trade liberalization, then $\Pi^{SV}_{L,FT} > \Pi^{IV}_{L,d}$ holds.

Proof. See Appendix V in the Supplement.

Part (i) of above proposition suggests that, if firms' vertical structure remains unchanged with the shift to the free trade and the product quality gap is sufficiently small, then the profits of low-quality firms can rather decrease as a result of trade liberalization. Tariff discrimination, compared to uniform tariffs, favors low-quality exporter and damages high-quality exporter (equalizing of quality gap of discriminatory tariffs). Therefore, the move toward free trade from the discriminatory tariffs has two welfare effects for the exporting countries: (a) the export-enhancing effect by removing trade barrier, and (b) the redistributive effect that is beneficial to exporters of high-quality products and unfavorable to those of low-quality products. And in the case of latter (i.e., part (b)), the smaller s(i.e., the smaller the quality gap between products), the greater the effect.

The transition to free trade benefits the exporter of high-quality products as above two effects work positively. However, the profits of low-quality exporter may increase or decrease depending on their relative magnitude of two opposing effects above mentioned. If quality gap between products is sufficiently small (resp. large), then the effects of (b) dominate (resp. fall short of) the effect of (a), leading to $\Pi^{SV}_{L,FT} < \Pi^{SV}_{L,d}$ (resp. $\Pi^{SV}_{L,FT} > \Pi^{SV}_{L,d}$).

Part (ii) of Proposition 4 is the case where firms' vertical structure changes from vertical integration to separation with the transition to free trade. Compared to vertical integration, vertical separation has greater monopoly power due to double marginalization, which tends to increase the profits of both high-quality and low-quality exporters. Consequently, when trade liberalization accompanies changes in firms' vertical structure, the effect of strengthening market power caused by vertical separation is added to the effects mentioned above, increasing the net profits of low-quality goods exporter ($\Pi^{SV}_{L,FT} > \Pi^{IV}_{L,d}$).

6. THE CASE OF UNIFORM TARIFFS

The application of MFN, one of major principles in WTO, involves non-discrimination or symmetric treatment for all trading partners and is achieved by the prohibition on discriminatory tariffs. This Section analyzes the determination of vertical structure when uniform tariffs are implemented. Under the uniform tariffs, country M sets a single tariff t_u for the imports from both countries. Because the mathematical procedures are similar to those in discriminatory tariffs, we directly show the resulting market equilibriums in Appendix A.2.

Comparing uniform optimal tariffs among the different types of vertical structure, we can confirm the same pattern as for the discriminatory tariffs: those are (i) $t^{IV}_u < t^{SI}_u$, $t^{IS}_u < t^{SV}_u$, and (ii) $t^{IV}_u < t^{IS}_u$, $t^{SI}_u < t^{SV}_u$[10]. To examine firms' strategy for the choice of its vertical organizational structure, it is needed to look at the profit ranking among the different types of vertical structure. First we examine the strategy of firm H, exporter of high quality products, on choosing its vertical structure. The following Lemma is immediate from the equilibrium values of firm H's profits under the uniform tariffs:

Lemma 4: *Suppose that uniform tariffs are adopted by country M. (i) Choosing vertical separation is the dominant strategy for firm H for any* (s,c) *values in the*

[10]Part (i) implies that the optimal uniform tariffs on imports are higher when the foreign exporter is vertically separated then when it is vertically integrated. Part (ii) implies that the optimal level of the uniform tariff on imports from a foreign exporter is higher if the exporter's rival firm is vertically separated than if it is integrated

domain, i.e., $\Pi^{SV}_{H,u} > \Pi^{IA}_{H,u}$ *and* $\Pi^{SA}_{H,u} > \Pi^{IV}_{H,u}$. *(ii) Firm H's profit under the SV regime is greater than that under the IV regime, i.e.,* $\Pi^{SV}_{H,u} > \Pi^{IV}_{H,u}$.

Proof: See Appendix VI in the Supplement.

Lemma 4 implies that, for the high-quality products exporter, the gains from strategic rent shift of vertical separation exceed the loss due to the higher import tariffs faced in the case of choosing vertical separation.

To examine the strategy of the exporter of low-quality products (i.e., firm L), we introduce the notation $\Delta\Pi^{S|I}_{L,u}$ (resp. $\Delta\Pi^{S|S}_{L,u}$), which represents the change in firm L's profit due to the integration-to-separation shift in its vertical structure under the condition that the rival's organizational structure is vertically integrated (resp. separated). That is, $\Delta\Pi^{S|I}_{L,u} \equiv \Pi^{SA}_{L,u} - \Pi^{IV}_{L,u}$ and $\Delta\Pi^{S|S}_{L,u} \equiv \Pi^{SV}_{L,u} - \Pi^{IA}_{L,u}$. Since $\Delta\Pi^{S|I}_{L,u}$ and $\Delta\Pi^{S|S}_{L,u}$ are complicated polynomial functions of (s,c), we try to explain them graphically. Figure 2 displays $\Delta\Pi^{S|I}_{L,u} = 0$ and $\Delta\Pi^{S|S}_{L,u} = 0$ on the space of (s,c). The domain of (s,c) is divided into the three sub-regions by these two curves, regions A, B, and C. The profit ranking of firm L by region is given as follows:

$$\begin{cases} \Pi^{IV}_{L,u} < \Pi^{SA}_{L,u} < \Pi^{IA}_{L,u} < \Pi^{SV}_{L,u} & \text{if } (s,c) \text{ belongs region A,} \\ \Pi^{SA}_{L,u} < \Pi^{IV}_{L,u} < \Pi^{IA}_{L,u} < \Pi^{SV}_{L,u} & \text{if } (s,c) \text{ belongs region B,} \\ \Pi^{SA}_{L,u} < \Pi^{IV}_{L,u} < \Pi^{SV}_{L,u} < \Pi^{IA}_{L,u} & \text{if } (s,c) \text{ belongs region C.} \end{cases} \tag{19}$$

From (19), the following Lemma is immediate.

Lemma 5. *Suppose that uniform tariffs are adopted by country M. If* (s,c) *combination belongs to region A (resp. C) in Figure 2, choosing vertical separation (resp. integration) is the dominant strategy for firm L. Whereas if* (s,c) *belongs to region B, firm L just makes the same choice as firm H.*

Note that the smaller the quality gap, the greater the degree of substitution and thus the greater the strategic advantage of vertical separation. Therefore, for the exporter of low-quality products, if the quality gap s is sufficiently small for a given marginal cost (i.e., (s,c) belongs to region A), then choosing vertical separation is more profitable than choosing vertical integration because the gains of rent-shifting caused by vertical separation outweigh the disadvantage of facing higher import tariffs (i.e., $\Pi^{IA}_{L,u} < \Pi^{SV}_{L,u}$ and $\Pi^{IV}_{L,u} < \Pi^{SA}_{L,u}$). Conversely, if s is large enough for a given c (i.e., region C), then choosing vertical integration for the low-quality exporter gives more profits than choosing separation (i.e.,

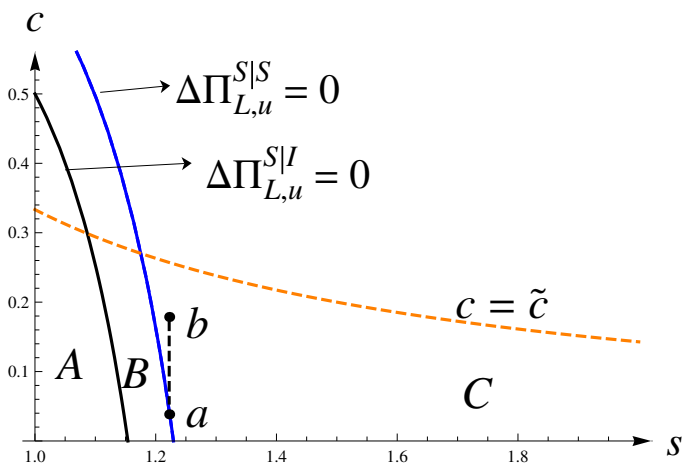

Figure 2: FIRMS' VERTICAL STRUCTURE UNDER UNIFORM TARIFFS. If (s,c) combination falls in regions A and B (resp. region C), the SV (or SI) regime appears in equilibrium. Therefore, the IV and IS regimes never appear in the uniform tariffs.

$\Pi^{IA}_{L,u} > \Pi^{SV}_{L,u}$ and $\Pi^{IV}_{L,u} > \Pi^{SA}_{L,u}$). On the other hand, if (s,c) combination belongs to region B, firm L's choice of its vertical organizational structure is affected by the choice of the rival firm H. In this region, firm H's vertical separation makes the market more monopolistic than its choosing of vertical integration, which also makes firm L's choice of vertical separation contribute to overall profit increase with higher rent-shifting gains and vice versa. From Lemmas 4 and 5, the following Proposition is immediate.

Proposition 5. *Suppose that uniform tariffs are adopted by country M. In Figure 2, (i) if (s,c) belongs to regions A and B, both firms' choosing vertical separation (i.e., SV regime) is the Nash equilibrium. If (s,c) belongs to region C, then vertical separation for firm H and integration for firm L (i.e., SI regime) is the Nash equilibrium. (ii) With SV regime at Nash equilibrium, each firm's individual interests coincide with the collective interests of two firms.*

Proof. Part (i) is straightforward from Lemmas 4 and 5. Part (ii) can be shown as follows. Both firms choose vertical separation in regions A and B (see Part (i)). From (19), the profit ranking of firm L by region, $\Pi^{IV}_{L,u} < \Pi^{SV}_{L,u}$ holds if (s,c)

belongs to regions A and B. In addition, $\Pi^{IV}_{H,u} < \Pi^{SV}_{H,u}$ holds from part (ii) of Lemma 4. Consequently, $\Pi^{IV}_{i,u} < \Pi^{SV}_{i,u}$ for $i \in \{H, L\}$.

The following points are noteworthy. First, unlike the case of discriminatory tariffs (Proposition 2), where only symmetric vertical structures appear at equilibrium, uniform tariffs results in an asymmetric vertical structure between the exporters, with vertical separation for the high-quality exporter and vertical integration for the low-quality exporter if the quality gap between products is large enough. This is because in the case of uniform tariffs, the firms' strategies on the choice of their vertical structure are different each other. For the exporter of high-quality products, choosing vertical separation is the dominant strategy[11]. However, the strategy of the low-quality exporter varies depending on the relative magnitude of (s,c). Given c, if the quality gap is sufficiently large (i.e., the degree of substitutability between products is low enough), then the rent-shift gain of vertical separation becomes relatively small, and the low-quality firm chooses vertical integration as a dominant strategy to enjoy lower imports tariffs.

Second, there is no case in which firms both choose vertical integration under uniform tariffs, which is in contrast the results in Lee and Choi (2023). This is related to whether firm asymmetry is due to the quality gap (present paper) or the marginal cost differential (Lee and Choi, 2023). In the former, high-quality producer chooses vertical separation as its dominant strategy irrespectively of the level of product quality gap, whereas in the latter, cost-efficient firm chooses different vertical structure as its strategy depending on the degree of product substituablity, that is, vertical integration for the lower level of product substituablity and vertical separation otherwise. This suggests that when firm asymmetry is based on the quality gap between the products, the rent-shifting gain that the high-quality exporter by choosing vertical separation exceeds the losses from increased tariff rates that results from giving up vertical integration.

Third, unlike in the discriminatory tariffs, marginal production cost of exporters has a substantial effect on the determination of firms' vertical structure. That is, the possibility of mixed vertical structure (IS regime) increases as c increases. This can be explained using Figure 2. Suppose that (s,c) combination

[11]Exporters of high-quality products under the uniform tariff are not disadvantaged by the equalizing effect that they would receive under discriminatory tariffs, resulting in a higher price-marginal cost margin compared to tariff discrimination. Accordingly, the high-quality exporter under the uniform tariff, as compared with tariff discrimination, gets the greater rent-shifting gain accrue from vertical separation, having a motivation to choose vertical separation irrespective of rival's vertical structure.

initially lies at point a (thus, $\Pi^{SV}_{L,u} = \Pi^{IA}_{L,u}$) and firms' vertical structure belongs to *SV* regime. Given s, an increase in c (moving from point a to point b) results in a decrease in the optimal level uniform tariffs, t^{SV}_u and t^{SI}_u. Since *SV* regime is less competitive than the *SI*, t^{SV}_u falls more than t^{SI}_u, i.e., $|\frac{\partial t^{SV}_u}{\partial c}| > |\frac{\partial t^{SI}_u}{\partial c}|$. Therefore, at point b, where only marginal cost is higher than at point a, $\Pi^{SV}_{L,u} < \Pi^{IA}_{L,u}$ is derived, leading to firm L's choosing of vertical integration. Third, part (ii) of Proposition 5 shows that even if an optimal uniform tariff is introduced, the results of Bonanno and Vickers (1988)[12] still hold if the quality gap between products is sufficiently small.

Now, as in the discriminatory tariffs, we examine the welfare effects of trade liberalization. Since two different types of vertical structure emerge in the uniform tariffs (see Proposition 5), the transition from uniform tariffs to free trade includes the cases where firms' vertical structure remains unchanged and the case which accompanies the changes in firms' vertical structure. The following Proposition is obtained regarding the welfare effects of the trade liberalization.

Proposition 6. *Country M's moving from optimal uniform tariffs to the free trade makes both exporting countries (country H and L) and the world better off and the home country worse off irrespective of firms' vertical structure in the uniform tariffs. That is,* $\Pi^{SV}_{H,u} < \Pi^{SV}_{H,FT}$, $\Pi^{SA}_{H,u} < \Pi^{SV}_{H,FT}$; $\Pi^{SV}_{L,u} < \Pi^{SV}_{L,FT}$, $\Pi^{IA}_{L,u} < \Pi^{SV}_{L,FT}$; $W^{SV}_u > W^{SV}_{FT}$, $W^{SI}_u > W^{SV}_{FT}$; and $G^{SV}_u < G^{SV}_{FT}$, $G^{SI}_u < G^{SV}_{FT}$.

Proof: See Appendix VII in the Supplement.

Proposition 6 confirms the standard results of trade liberalization assuming symmetric firms. An elimination of uniform tariffs implies a reduction in trade barriers for the exporting countries and a deterioration of terms of trade for the importing country. Therefore, compared to the case where the optimal import tariff is implemented, the profits of the two exporting firms will obviously increase and the welfare of the importing country will decrease under free trade as far as firms' vertical structure remains unchanged ($\Pi^{SV}_{H,u} < \Pi^{SV}_{H,FT}, \Pi^{SV}_{L,u} < \Pi^{SV}_{L,FT}$ and $W^{SV}_u > W^{SV}_{FT}$). In addition, the removal of trade barriers increases the production efficiency, thereby increasing the global welfare ($G^{SV}_u < G^{SV}_{FT}$).

We now consider the case where firms' vertical structure under the optimal import tariff differs from that under free trade. If, under the optimal uniform tariff, firm H is in the vertical separation and firm L in the integration, then the

[12]Bonanno and Vickers (1988) showed that vertical separation is profitable and of interest to manufacturers collectively, as well as individually, provided that final goods market is in Bertrand competition and franchise fees can be used to extract the retailers' surplus.

transition to free trade is accompanied by a shift in the organizational structure of L from vertical integration to vertical separation. Since vertical separation is more monopolistic than vertical integration due to the double marginalization, it makes firms' profits increase and consumer surplus decrease. This welfare effects resulting from the change in firm's vertical structure is added as an effect of implementing free trade, which obviously works in the direction of strengthening the existing welfare effects of trade liberalization ($\Pi^{SA}_{H,u} < \Pi^{SV}_{H,FT}$, $\Pi^{IA}_{L,u} < \Pi^{SV}_{L,FT}$, $W^{SI}_{u} > W^{SV}_{FT}$). Firm L's shift in its vertical organization-structure from integration to separation serves to lower the global welfare, if other things being equal. However, the increase in resource allocation efficiency caused by the removal of trade barriers increases global welfare, which outweighs the former effect, leading to $G^{SI}_{u} < G^{SV}_{FT}$.

7. CONCLUDING REMARKS

Using an exclusive dealer channel model in which firms each located in different countries export quality-differentiated products to a common market, we examined the endogenous determination of firms' vertical structure when importing country adopts either discriminatory or uniform optimal import tariffs. In addition, we analyzed the impact of trade liberalization on welfare when firms' vertical is endogenously determined. Our major findings are as follows.

First of all, we confirmed that importing country's tariff system (i.e., uniform tariffs or discriminatory ones) affects the vertical structure of firms in international oligopolistic market, and that the welfare effect of trade liberalization varies depending on the interaction between the tariff system and firms' vertical structure. When importing country adopts discriminatory tariffs, the quality gap between products exported by heterogeneous firms is fully reflected into the difference in tariffs levied on imported products. Therefore, in a discriminatory tariff system, firms that are heterogeneous in the quality of the products they produce adopt the same strategy in choosing their vertical structures, resulting in both firms having the same vertical structure.

However, under uniform tariffs, quality gap is not reflected into the tariff level, and thus heterogeneous firms adopt different strategies in their choice of vertical structure. Consequently, unlike the discriminatory tariffs, uniform tariffs results in an asymmetric vertical structure where high-quality exporter is vertically separated and low-quality exporter is vertically integrated as long as the quality gap between products is large enough. In the case of uniform tariffs, if quality gap is relatively small, vertical separation by both firms is the Nash

equilibrium. However, vertical integration by both firms does not appear in any case.

The welfare effect of trade liberalization also varies depending on the tariff system of the importing country prior to liberalization. When the importing country adopts uniform tariffs initially, trade liberalization benefits all exporting companies by having the positive effect of removing trade barriers. Importantly, moving toward free trade is not always beneficial to all exporters when discriminatory tariffs were implemented.

In particular, for the exporting country of low-quality products, the transition from discriminatory tariffs to free trade can be rather detrimental. If firms' vertical structure remains unchanged with the shift to the free trade and the product quality gap is sufficiently small, then the profits of low-quality firms may rather decrease as a result of exogenous trade liberalization. But if quality gap is large enough, the shift from discriminatory tariffs to the free trade makes both high-quality exporter and low-quality one better off and importing country worse off.

The conclusions of our paper depend largely on critical assumptions such as linear demand function, an exclusive dealing contract between the upstream manufacturer and retailer, a two-part tariff contract, and exogenously given quality level between products. In particular, as an extension of our study, we need to take into account relaxing the assumption of exclusive dealing contract between manufacturers and retailers. Today's retail market for most consumer goods is dominated by large retail chains, which usually carry multiple brands in most product categories. One way for extension, therefore, is to explicitly incorporate common retailers who sell competing multiple differentiated-products (i.e., brands), which would be left as future tasks.

A. APPENDIX

A.1. EQUILIBRIUM VALUES UNDER DISCRIMINATORY TARIFF

In this section, equilibrium values are presented under the discriminatory tariff. We first provide the equilibrium values under the symmetric vertical structure. The following is obtained under the regime of SV:

$$t_{H,d}^{SV} = \frac{2s(s-1)(6s-4c-1)}{36s^2-28s+1}, \quad t_{L,d}^{SV} = \frac{2(s-1)[4s-c(6s-1)]}{36s^2-28s+1},$$

$$q_{H,d}^{SV} = \frac{(2s-1)(8s-4c-1)}{1-28s+36s^2}, \quad q_{L,d}^{SV} = \frac{(2s-1)[4s-c(6s-1)]}{1-28s+36s^2},$$

$$w_{H,d}^{SV} = c + \frac{(6s-4c-1)(s-1)}{1-28s+36s^2}, \quad w_{L,d}^{SV} = c + \frac{(s-1)(c+4s-6cs)}{s(1-28s+36s^2)},$$

$$\Pi_{H,d}^{SV} = \frac{2s(s-1)}{2s-1}(q_{H,d}^{SV})^2, \quad \Pi_{L,d}^{SV} = \frac{2(s-1)}{2s-1}(q_{L,d}^{SV})^2,$$

$$W_d^{SV} = \frac{(2s-1)[3(1+2s)(1+2s)-2c(10s-1)]}{2(1-28s+36s^2)}, \quad \text{and}$$

$$G_d^{SV} = W_d^{SV} + \sum_{i=H,L} \Pi_{i,d}^{SV}.$$

The following is obtained under the regime of IV:

$$t_{H,d}^{IV} = \frac{(s-1)(3s-2c)}{9s-4}, \quad t_{L,d}^{IV} = \frac{(s-1)(2-3c)}{9s-4},$$

$$q_{H,d}^{IV} = \frac{3s-2c}{9s-4}, \quad q_{L,d}^{IV} = \frac{s(3c-2)}{9s-4},$$

$$\Pi_{H,d}^{IV} = (s-1)(q_{H,d}^{IV})^2, \quad \Pi_{L,d}^{IV} = \frac{s-1}{s}(q_{L,d}^{IV})^2,$$

$$W_d^{IV} = \frac{(c^2+s)(2+3s)-10cs}{2(9s-4)}, \quad \text{and}$$

$$G_d^{IV} = W_d^{IV} + \sum_{i=H,L} \Pi_{i,d}^{IV}.$$

We next provide the equilibrium values under the asymmetric vertical structure. The following is obtained under the regime of SA:

$$t_{H,d}^{SA} = \frac{2s(s-1)(3s-2c)}{18s-11}, \quad t_{L,d}^{IA} = \frac{(s-1)[4s+c-6cs]}{18s-11},$$

$$q_{H,d}^{SA} = \frac{(2s-1)(3s-2c)}{s(18s-11)}, \quad q_{L,d}^{IA} = \frac{c+4s-6cs}{18s-11},$$

$$w_{H,d}^{SA} = c + \frac{(3s-2c)(s-1)}{s(18s-11)},$$

$$\Pi_{H,d}^{SA} = \frac{2s(s-1)}{2s-1}(q_{H,d}^{SA})^2, \quad \Pi_{L,d}^{IA} = \frac{s-1}{s}(q_{L,d}^{IA})^2,$$

$$W_d^{SI} = \frac{s^2(1+6s)+c^2(3s+6s^2-2)-2c(10s-3)s}{2s(18s-11)}, \quad \text{and}$$

$$G_d^{SI} = W_d^{SI} + \Pi_{H,d}^{SA} + \Pi_{L,d}^{IA}.$$

The following is obtained under the regime of IA:

$$t_{H,d}^{IA} = \frac{(s-1)(6s-4c-1)}{18s-11}, \quad t_{L,d}^{SA} = \frac{2(s-1)(2-3c)}{18s-11},$$

$$q_{H,d}^{IA} = \frac{1+4c-6s}{18s-11)}, \quad q_{L,d}^{SA} = \frac{3c(2s-1)-2(2s-1)}{18s-11},$$

$$w_{L,d}^{IA} = c + \frac{(2-3c)(s-1)}{s(18s-11)},$$

$$\Pi_{H,d}^{IA} = (s-1)(q_{H,d}^{IA})^2, \quad \Pi_{L,d}^{SA} = \frac{2(s-1)}{2s-1}(q_{L,d}^{SA})^2,$$

$$W_d^{IS} = \frac{2c(10s-3)-2+3s(2s-1)+c^2(1+6s)}{2(18s-11)}, \quad \text{and}$$

$$G_d^{IS} = W_d^{IS} + \Pi_{L,d}^{SA} + \Pi_{H,d}^{IA}.$$

We finally provide the equilibrium values under the free trade condition.

$$q_{H,FT}^{SV} = \frac{(2s-1)(4s-2c-1)}{16s^2-12s+1}, \quad q_{H,FT}^{SV} = \frac{(2s-1)(2s+c-4cs}{16s^2-12s+1},$$

$$w_{H,FT}^{SV} = c + \frac{(s-1)(4s-2c-1)}{16s^2-12s+1}, \quad w_{L,FT}^{SV} = c + \frac{(s-1)(2s+c-4cs)}{16s^2-12s+1},$$

$$\Pi_{H,FT}^{SV} = \frac{2s(s-1)}{2s-1}(q_{H,FT}^{SV})^2, \quad \Pi_{L,FT}^{SV} = \frac{2(s-1)}{2s-1}(q_{L,FT}^{SV})^2,$$

$$W_{FT}^{SV} = \frac{(2s-1)^2[(16s^2+112s-3)(c^2+s)-2c(32s^2-8s+1)]}{2(16s^2-12s+1)^2}, \quad \text{and}$$

$$G_{FT}^{SV} = W_{FT}^{SV} + \sum_{i=H,L} \Pi_{i,FT}^{SV}.$$

A.2. EQUILIBRIUM VALUES UNDER UNIFORM TARIFF

In this section, equilibrium values are presented under the uniform tariff. We first provide the equilibrium values under the symmetric vertical structure. The following is obtained under the regime of IV:

$$t_u^{IV} = \frac{(s-1)[4s(1-c)-c]}{12s^2-s-2},$$

$$q_{H,u}^{IV} = \frac{6s^2-c(1+2s)}{12s^2-s-2}, \quad q_{L,u}^{IV} = \frac{s[2(1-c)+s(1-4c)]}{12s^2-s-2},$$

$$\Pi_{H,u}^{IV} = (s-1)(q_{H,u}^{IV})^2, \quad \Pi_{L,u}^{IV} = \frac{s-1}{s}(q_{L,u}^{IV})^2,$$

$$W_u^{IV} = \frac{3s^2(2+s) - 2cs(2+7s) + (c+2cs)^2}{2(12s^2 - s - 2)}, \quad \text{and}$$

$$G_u^{IV} = W_u^{IV} + \sum_{i=H,L} \Pi_{i,u}^{IV}.$$

The following is obtained under the regime of SV:

$$t_u^{SV} = \frac{2(s-1)[4(4s-1)s + c(4s-16s^2-1)]}{2s - 72s^2 + 96s^3 - 1},$$

$$q_{H,u}^{SV} = \frac{(2s-1)[(4s-1)(6s-1) - 2c(1+4s)]}{2s - 72s^2 + 96s^3 - 1},$$

$$q_{L,u}^{SV} = \frac{(2s-1)[2s(3+2s) + c(1-16s^2)]}{2s - 72s^2 + 96s^3 - 1},$$

$$w_{H,u}^{SV} = c + \frac{(s-1)[(4s-1)(6s-1) - 2c(1+4s)]}{2s - 72s^2 + 96s^3 - 1},$$

$$w_{L,u}^{SV} = c + \frac{(s-1)[2s(3+2s) + c(1-16s^2)]}{s(2s - 72s^2 + 96s^3 - 1)},$$

$$\Pi_{H,u}^{SV} = \frac{2s(s-1)}{2s-1}(q_{H,u}^{SV})^2, \quad \Pi_{L,u}^{SV} = \frac{2(s-1)}{2s-1}(q_{L,u}^{SV})^2,$$

$$W_u^{SV} = \frac{(2s-1)[(c+4cs)^2 - 2c(1-4s+28s^2) + s(3+2s)(6s-1)]}{2(2s - 72s^2 + 96s^3 - 1)}, \quad \text{and}$$

$$G_u^{SV} = W_u^{SV} + \sum_{i=H,L} \Pi_{i,u}^{SV}.$$

We next provide the equilibrium values under the asymmetric vertical structure. The following is obtained under the regime of SA:

$$t_u^{SA} = \frac{(s-1)[2(8s-3)s + c(1+4s-16s^2)]}{5 - 9s - 28s^2 + 48s^3},$$

$$q_{H,u}^{SA} = \frac{(2s-1)[s(12s^2 - 3s - 1) + c(1-s-4s^2)]}{s(5 - 9s - 28s^2 + 48s^3)},$$

$$q_{L,u}^{IA} = \frac{4s(2s + s^2 - 1) + c(5s - 16s^3 - 1)}{5 - 9s - 28s^2 + 48s^3},$$

$$w_{H,u}^{SA} = c + \frac{(s-1)[s(12s^2-3s-1)+c(1-s-4s^2)]}{s(5-9s-28s^2+48s^3)},$$

$$\Pi_{H,u}^{SA} = \frac{2s(s-1)}{2s-1}(q_{H,u}^{SA})^2, \quad \Pi_{L,u}^{IA} = \frac{s-1}{s}(q_{L,u}^{IA})^2,$$

$$W_u^{SI} = \frac{c^2(s+4s^2-1)^2+s^2(1-9s+12s^2+12s^3)-2cs(1-3s-10s^2+28s^3)}{2s(5-9s-28s^2+48s^3)},$$

$$G_u^{SI} = W_u^{SI} + \Pi_{L,u}^{IA} + \Pi_{H,u}^{SA}.$$

The following is obtained under the regime of IA:

$$t_u^{IA} = \frac{(s-1)[8s-3-2c(4s-1)]}{2(1-9s+12s^2)},$$

$$q_{H,u}^{IA} = \frac{1-2(2+c)s+6s^2}{1-9s+12s^2}, \quad q_{L,u}^{SA} = \frac{(2s-1)[1+(1-4c)s]}{2(1-9s+12s^2)},$$

$$w_{L,u}^{IA} = c + \frac{(s-1)(4cs-s-1)}{2s(1-9s+12s^2)},$$

$$\Pi_{H,u}^{IA} = (s-1)(q_{H,u}^{IA})^2, \quad \Pi_{L,u}^{SA} = \frac{2(s-1)}{2s-1}(q_{L,u}^{SA})^2,$$

$$W_u^{IS} = \frac{3-15s+16s^2+16c^2s^2+12s^3-4c(1-7s+14s^2)}{8(1-9s+12s^2)}, \quad \text{and}$$

$$G_u^{IS} = W_u^{IS} + \Pi_{H,u}^{IA} + \Pi_{L,u}^{SA}.$$

In the Supplement, we provide the proofs of Propositions 3, 4, 6, and Lemmas 3 and 4. The file is downloadable from the following link:

Link

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