Optimal Tariffs, Increasing Marginal Costs and Endogenous Delegation: Uniform vs. Discriminatory Tariffs

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Abstract

We examine the superiority of the uniform versus discriminatory tariffs in global welfare by taking into account the asymmetric increasing marginal costs between exporters and endogenous delegation problem. First, depending on the degree of product differentiation under Bertrand competition, discriminatory tariffs give rise to delegation or no delegation in equilibrium, while uniform tariffs result in diverse delegation types; delegation, no delegation, and asymmetric. Second, given each delegation equilibrium, the discriminatory tariffs can always achieve Pareto superiority from the perspectives of consumers surplus, social and global welfare, regardless of both the degree of product differentiation and difference cost between the efficient and inefficient exporters. This results from that the inefficient (efficient) exporter is handicapped (subsidized) under alternative tariff regimes. Third, the inefficient exporter always prefers the uniform tariffs to the discriminatory tariffs while the efficient exporter's preference for tariff regime varies for any degree of product differentiation.

JEL Classification: F12, F13, L13.
Keywords: Increasing marginal cost, Uniform and discriminatory tariffs, Delegation.

1 Introduction

The most favored nation (MFN) clause is so important that it is the first article of the General Agreement on Tariffs and Trade (GATT) that governs trade in goods. The MFN clause has played an important role in bringing about multilateral trade liberalization. There are numerous papers that study the superiority of a uniform tariff regime, i.e. MFN, as compared with a tariff discrimination regime. For decades, governments have used tariffs on imports to protect special industries and exert political influence over foreign competitors. However, in a globalized world, the effects of such tariffs have become more difficult to measure. Most of the existing literature supports the view that MFN is preferred to tariff discrimination in global welfare. Although the assumption of constant marginal costs is frequently used when analyzing the efficiency of uniform or discriminatory tariffs, we should bear in mind that it restricts the analysis of the effects of these tariffs. In other words, the assumption of constant marginal cost requires that the importing government tends to impose a lower (higher) tariff on the high-cost (low-cost) exporters. However, revisiting trade policy of efficiency of tariff discrimination by allowing exporters to produce under asymmetric increasing marginal costs[1] with the choice of endogenous delegation, the opposite result can always occur in this paper.

In canonical papers on the welfare comparison of uniform tariff and tariff discrimination[2], Choi (1995) examined an importing country's choice between two tariff regimes, focusing on the impact of

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[1] Much like the constant marginal cost models, our approach, too, is conventional in the literature on industrial organization and mixed oligopoly. For example, see Dastidar (1995), Tomaru and Kiyono (2010), Gori et al. (2014), Delbono and Lambertini (2016a, 2016b) and Chen (2022). Most natural case of diminishing-marginal-return technologies is the case where some industries are unable to replicate some inputs, i.e., due to the presence of some fixed inputs (Varian, 1992, p. 16). Basu and Fernald (1997) found that a typical industry appears to have significantly decreasing returns to scale, using aggregate data to estimate production of 34 manufacturing industries in the U.S. and see references therein.

[2] See Bagwell and Staiger (1999), Horn and Mavroidis (2001), McCalman (2002), Saggi (2004) and Bagwell and Staiger (2010) for analyses of the various legal and economic aspects of MFN.

short-run discriminatory tariffs on exporters' long-run choice of technology (or capacity). In particular, Choi (1995) found that the importing country is better off with a uniform tariff policy while the foreign duopolists are better off when the importing country pursues a discriminatory tariff policy. In contrast, Gatsios (1990), Hwang and Mai (1991), Liao and Wong (2006), and Hashimzade et al. (2011a, b), among others, investigated the implications of the strategic choice of tariffs of active exporting governments based on constant marginal costs. Saggi (2004) considered a model of n countries and n firms with differential costs. He found that each country imposes higher tariffs on low-cost producers, while the adoption of the MFN clause by each country improves global welfare. Saggi and Yildiz (2005) considered that each exporting country has two exporters and showed that tariff discrimination can be welfare preferred to MFN globally when highcost exporters are merged and the cost disadvantage of the merged unit relative to competing firms is of intermediate magnitude.

The model employed in these canonical papers is that of two exporting firms competing for the market of a third importing country with the assumption of constant marginal costs. With an increasing marginal cost, we investigate how different types of tariff policies could affect the exporter's choice of delegation types within exporters' firms and the importing country's welfare and global welfare. A firm's choice of delegation type affects the competitive force in the market, especially when the market is in an oligopolistic environment. Firms have chosen diverse organizational forms by adapting to the market environment (Amatori and Colli, 2007). As the separation between ownership and control has entered the theory of international trade, it is important to consider strategic delegation. In this context, understanding why firms have different delegation types and what factors influence the choice of firms' delegation type has always been one of the most fascinating questions in economics.

In this context, understanding why firms have different organizational forms and the factors that influence their choice of organizational form has long been of interest in economics (e.g., Maskin et al., 2000; Besanko et al., 2005; Qian et al., 2006; Alonso et al., 2008; Rantakari, 2008; Yang and Zhang, 2019). Reflecting the growing interest in the optimal organizational design, the literature on firms' organizational structure has become richer and more diverse by introducing various factors influencing market outcomes, including firms' strategic incentive to reorganize internally (Baye et al., 1996); managerial delegation within firms (Barcena-Ruiz and Espinosa, 1999; Zhou, 2005), which uses the VFJS model following Vickers (1985), Fershtman and Judd (1987), and Sklivas (1987); and trade policy and internal organization (e.g., Bernard et al., 2009; Guadalupe and Wulf, 2010; Conconi et al., 2012; Bai, 2021). However, most of these studies pay little attention to how firms' delegation is affected by trade policies and the choice of organizational form. Given the above discussion, we examine how the different objectives of delegation forms affect the trade tariff rate and social welfare when two foreign firms compete in the home market.

As competition among firms in the global market intensifies and business activities become more complex, the managerial performance is becoming an important key to the overall performance of the firm. Reflecting these changes in the economic environment, recent advances in international trade theory emphasize strategic incentive of managerial delegation and its implications for trade policies (Das, 1997; Moner-Colonques, 1997; Miller and Pazgal, 2005; Wang et al., 2009; Choi and Lee, 2022). Among others, Das (1997) and Moner-Colonques (1997) examined the interaction between managerial incentives and trade policy. They adopted the standard VFJS model to examine the effectiveness of strategic trade policy and concluded that trade policies under delegation can enhance welfare compared with those under non-delegation. Using relative performance incentive schemes, Miller and Pazgal (2005) showed that the optimal strategic trade policy does not depend on the mode of competition (i.e., Cournot and Bertrand competition). Focusing on market-share delegation and the generalized Nash bargaining, Wang et al. (2008) and Wang et al. (2009) also analyzed the influence of managerial delegation on the strategic trade policy of managerial delegation in a trade duopoly context. They showed that different forms of delegation coupled with cost asymmetry (i.e., subsidies and tariffs) will induce different degrees of government intervention, but did not focus on the endogenous delegation and comparison of alternative tariff regimes. Moreover, Marin and Verdier (2008a) examined how trade integration affects the delegation of authority within monopolistically competitive firms in which managers cannot offered monetary incentives. Marin and Verdier (2008b) examined empirically how changes in the trade environment have affected firms' choices of organization in Germany and Austria.

This paper is distinguished from the canonical papers by adding two components, increasing marginal costs between exporters and endogenous delegation, into the canonical model. We obtain the following completely different theoretical results. First, our model explains the existence of diverse types of delegation in an international oligopolistic market. Unlike VFJS model, in which choosing delegation is the only Nash equilibrium under either Cournot or Bertrand, we show that depending on the degree of product differentiation under Bertrand competition, discriminatory tariffs give rise to delegation or no delegation in equilibrium, while uniform tariffs result in diverse competition modes, such as delegation, no delegation, and asymmetric. This is because unless the degree of product differentiation is sufficiently high, both efficient and inefficient exporters have incentive to produces more output due to the fact that equilibrium uniform or discriminatory tariffs are lower when choosing no delegation than when choosing delegation, and vice versa when the degree of product differentiation is relatively higher.

Second, given asymmetrically increasing marginal costs and endogenous delegation structures, the discriminatory tariffs can always achieve Pareto superiority from the perspectives of consumers surplus, social and global welfare, regardless of the degree of product differentiation and difference cost between the efficient and inefficient exporters. The main intuition behind this is that (i) the total output under discriminatory tariff regime is always greater than that under uniform tariff regime and (ii) the importing country sets high tariff rates for the inefficient exporter and low tariff rates for the efficient exporter, which implies that the inefficient exporter is handicapped, while the efficient exporter is subsidized under the discriminatory tariff regime.

Third, based on tariff levels, the inefficient exporter always prefers the uniform tariffs while the efficient exporter's preference for tariff regime varies for any degree of product differentiation. From the second main results, the forward-looking inefficient exporter always has an incentive produce less under uniform tariff regime recognizing that the inefficient exporter is handicapped, whereas the efficient exporter is subsidized under a discriminatory tariff regime. For an efficient exporter's profit, it is desirable to produce less under uniform tariffs unless the degree of imperfect substitutability is high, while an efficient exporter has an incentive to produce more output given lower discriminatory tariff regime. This is because discriminatory tariffs are lower than the uniform tariff imposed on the inefficient exporter.

In sum, asymmetrically increasing marginal costs do make a difference in tariff policies. Regardless of degree of product differentiation, the preferences for discrimination tariff regime obtain the Pareto efficiency with the same direction for the consumers surplus, social and global welfare except for exporters' profits. For the economic implications, we see that when the product differentiation is large (small) enough implying that competition is fierce (loose), endogenous delegation (no delegation) equilibrium under discriminatory tariffs can be beneficial for the importing country, achieving consumers surplus, social and global welfare. As analyzed the issue of vertical separation and integration in Bonanno and Vickers (1988) in closed economy, our results could be interpreted in the international trade with alternative tariff regimes. The case of a vertically integrated (separated) firm corresponds to no delegation (delegation), which the model involves the vertically related market in the international trade comparing alternative tariff regimes[3].

[3]According to McLaren (2000), the international trade affects the trade-off between the hold-up problem and the governance costs of a larger organization by increasing the number of alternative buyers abroad and so making arms-length transactions more remunerative.

2 The Model

Consider a "home" country that imports heterogeneous products from two foreign producers, firm i and firm j, located in country i and country j, respectively. We assume that these foreign producers do not sell their products in other markets and that there are no home producers. The utility function of the representative consumer in the home country is given by $U = a(q_f + q_g) - \frac{q_f^2+q_g^2+2dq_fq_g}{2} + m; f, g = i, j, f \neq g$, where m is the consumption of the outside good, q_f represents the quantity of good f, a is a positive constant (for simplicity, we assume that $a = 1$), and $d \in (0, 1)$ denotes the degree of product substitutability; i.e., the higher the value of d, the higher will be the degree of substitutability between products. Given the utility function of the representative consumer, the direct demand function for good f can be written as follows:

$$q_f = \frac{1 - d - p_f + dp_g}{1 - d^2}; \quad f, g = i, j, f \neq g, \tag{1}$$

where p_f refers to the market price of good f. The social welfare for the home country is given by

$$W = U - \sum_{f=i}^{j} p_f q_f + \sum_{f=i}^{j} t_f q_f \tag{2}$$

where the consumers' surplus is $CS = U - \sum_{f=1}^{j} p_f q_f$, and the tariff revenue of the home country. Under a discriminatory tariffs, t_i and t_j are allowed to differ, whereas the same tariff rate, $t_i = t_j = t$, must be set for imports from both countries under the uniform tariffs.

We now turn to the supply side of the model. The process cost is given in a quadratic-linear form: $TC_i = t_i q_i + (m/2)q_i^2$ and $TC_j = t_j q_j + (1/2)q_j^2$ where we assume $m \in (1, 2)$. Throughout the paper, we assume that firm i is less efficient than firm j in terms of marginal cost. Furthermore, we assume that each firm has one owner who decides whether to employ a manager and to delegate price decision to him (known as a strategic delegation). Following the basic setting in Kopel and Pezzino (2018), we assume that when the owner decides to employ a manager, she offers the following compensation scheme (w_f) based on firm's profit (Π_f; Π_i is firm i's profit and Π_j is firm j's profit):

$$w_f = A_f + B_f[\Pi_f + \theta_f q_f]; \Pi_i = (p_i - t)q_i - \frac{m}{2}q_i^2 \text{ and } \Pi_j = (p_j - t)q_j - \frac{1}{2}q_j^2; \; f, g = i, j, f \neq g \tag{3}$$

where A_f is the fixed payment regardless of the manager's performance, B_f is the rate of bonus, while θ_f is the incentive rate affecting the manager's output decision. Given this compensation scheme, the manager chooses p_f to maximize w_f, provided that his participation constraint is satisfied: $w_f \geq U_f$ where U_f is his reservation income (or outside option). We assume $U_f = 0$ to remove this already known logic[4]. Then, given the compensation scheme, the manager's objective can be simplified to maximizing the terms in the bracket of Eq. (3):

$$O_i = \Pi_i + \theta_i q_i, \quad O_j = \Pi_j + \theta_j q_j \tag{4}$$

where the parameters $\theta_f, f = i, j$ identify the weight attached to the volume of sales. Depending on the value of θ_f chosen by each owner of firm, the manager's perception of firm on marginal costs either goes up or down. As a result, if $\theta_f > (<)0$, the manager is induced to be more aggressive (defensive), while for $\theta_f = 0$ the manager simply maximizes profits.

[4]Kopel and Pezzino (2018) show that managers' positive outside options may give rise to owners' asymmetric delegation decisions. All our results hold if assuming $U_f > 0$.

The owner, on the other hand, chooses A_f, B_f and θ_f to maximize her net profit $(\Pi_f - w_f)$ subject to the manager's participation constraint $w_f \geq 0$. It is clear that A_f and B_f are chosen such that the participation constraint binds. Therefore, the owner's objective can be simplified as choosing θ_f to maximize Π_f. Vickers-type model in linear incentive scheme makes the analysis of our model tractable. The incentive scheme for the managers, assumed in Eqs. (3) and (4), can be shown to be equivalent to $O_i = M_i = (1-\beta_i)\Pi_i + \beta_i p_i q_i$ and $O_j = M_j = (1-\beta_j)\Pi_j + \beta_j p_j q_j$, where $\beta_i = \frac{2\theta_i}{2t+mq_i}$ and $\beta_j = \frac{2\theta_j}{2t+q_j}$. Thus, our approach is equivalent to assuming that the incentive scheme is a weighted average of profits and revenues, as in Fershtman and Judd (1987) and Sklivas (1987).

From social welfare, global welfare, G, is defined as the sum of the welfare levels of the three countries:

$$G = W + \Pi_i + \Pi_j \tag{5}$$

We posit a four-stage game. At stage 1, each owner of firm decides to delegate or not to delegate. At stage 2, the import government imposes the import tariff on per unit of imports. At stage 3, if the owner decides to delegate, then the owner of firm sets its profit weight θ_f so as to maximize its profit. Finally, at stage 4, each manager sets the price[5]. We solve the subgame perfect Nash equilibrium (SPNE) through backward induction[6].

3 Discriminatory Tariffs and Delegation Structure

Suppose that the government of importing country (home country) retains full discretionary power in setting the tariff rate in the sense that it is able to adopt an optimal ex post tariff rate that could be different (hence "discriminatory") between the two producers. Let t_i and t_j be the discriminatory tariff rates against the respective foreign duopolists. Following the backward induction method, we first solve four types of sub-games in a duopoly model—two symmetric delegation structures and two asymmetric vertical structures—and then examine the endogenous determination of delegation structure.

3.1 Market Equilibrium under Each Delegation Structure

We first consider a vertical no delegation. The owner of firm f sets the prices p_f so as to maximize its profit for a given rival's price p_g. Its maximization problem is as follows: $\max_{p_i} \Pi_i = (p_i - t_i)q_i - (m/2)q_i^2$ and $\max_{p_j} \Pi_j = (p_j - t_j)q_j - (1/2)q_j^2$. Solving the first-order conditions with asymmetry, we obtain

[5] Some readers may concern that it should consider the case of Cournot competition. If we employ Cournot competition with same setting, we can find that choosing delegation for both exporters is dominant strategy whether the tariff regime is uniform or discriminatory. Contrast to previous results, the inefficient exporter is handicapped while the efficient exporter is subsidized in a discriminatory tariff regime. Thus, with increasing marginal costs, the profit of the inefficient (efficient) exporter is smaller (larger) under the discriminatory tariff than under the uniform tariff, compared to conventional wisdom with the constant marginal costs. Regardless of the degree of cost asymmetry and delegation types, total output, social and global welfare are always greater under discriminatory tariff than under uniform tariff. The detailed derivations are available from the authors on request.

[6] The timing that home and foreign firms' decision precedes the government's tariff policy suggests the view that as long as the government of the importing country can change its tariff rate after the owners of foreign firms decide their delegation structure. If the government imposes the tariff rate before delegation decision, firms may neglect any tariff rate announcement, which means incredible commitment. Thus, we reflect that the tariff rate changes often in the international trade, justifying our timing of game as a reasonable assumption. See Section 5 in our study.

the equilibrium prices as follows:

$$p_i^{NN} = \frac{(1-d^2+m)[3-d^2-d(1-t_j)] + (3-2d^2)t_i}{6-6d^2+d^4+(3-d^2)m}, \tag{6}$$

$$p_j^{NN} = \frac{(2-d^2)[2-d^2+m-d(1-t_i)] + (2-2d^2+m)t_j}{6-6d^2+d^4+(3-d^2)m} \tag{7}$$

where the superscript 'NN' denotes the case that both firms choose the no delegation.

At stage two, we obtain the home country's social welfare function in terms of tariff level and network parameters: $W(t_f) = CS + t_i q_i + t_j q_j$. Therefore, in the third stage of the game, the problem of the domestic government is $\max_{t_f} W(t_f)$. More formally, we obtain

$$\frac{\partial W(t_f)}{\partial t_f} = \underbrace{\sum_{f=i}^{j}\left(1-\frac{\partial p_f}{\partial t_f}\right)}_{\text{terms of trade gain}(+)} + \underbrace{t_f\sum_{f=i}^{j}\frac{\partial q_f}{\partial t_f}}_{(-)}. \tag{8}$$

The first term on the right-hand side (RHS) of Eq. (8) represents the gain from terms of trade improvement; and the second term, the revenue loss due to the tax-wedge effect. Additionally, we find that $\frac{\partial W(t_f)}{\partial t_f}\big|_{t_f=0} = \sum_{f=i}^{j} q_f\big(1-\frac{\partial p_f}{\partial t_f}\big) > 0$, implying that a small tariff benefits the importing country. Solving $\frac{\partial W^{NN}}{\partial t_i} = 0$ for $f = i, j$ simultaneously gives the optimal import tariff t_i^{NN}. Using the optimal tariffs, t_{iD}^{NN} where subscript "D" denotes discriminatory tariffs in equilibrium, we obtain the equilibrium market outcomes under no delegation, as we show in Table A-1 of Appendix A.

We now turn to the delegation case. Solving manager i profit maximization problem, $\max_{p_i} O_i(\equiv (p_i-t_i)q_i - (m/2)q_i^2 + \theta_i q_i)$ and manager j profit maximization problem $\max_{p_j} O_j(\equiv (p_j-t_j)q_j - (1/2)q_j^2 + \theta_j q_j)$ yield equilibrium prices at this stage as follows:

$$p_i^{DD} = \frac{3-4d^2+d^3+d^4+(3-d-d^2)m+(3-2d^2)(t_i-\theta_i)+d(1-d^2+m)(t_j-w_j)}{6-6d^2+d^4+(3-d^2)m}, \tag{9}$$

$$p_j^{DD} = \frac{(1-d)(2+d)(2-d^2)+(2-d^2)[m+d(t_i-\theta_i)]+(2-2d^2+m)(t_j-\theta_j)}{6-6d^2+d^4+(3-d^2)m} \tag{10}$$

At stage three, by applying the envelope theorem, we obtain

$$\frac{\partial \Pi_f[\theta_i,\theta_j;t_f]}{\partial \theta_f} = \underbrace{-\theta_f \overbrace{\frac{\partial q_f}{\partial p_f}}^{(-)}\overbrace{\frac{\partial p_f}{\partial \theta_f}}^{(-)}}_{\text{strategic distortion effect}} + (p_f-t_f)\Bigg[\underbrace{\overbrace{\frac{\partial q_f}{\partial p_g}}^{(+)}\overbrace{\frac{\partial p_g}{\partial \theta_f}}^{(-)}}_{\text{strategic rent-shfting effect}}\Bigg], \tag{11}$$

where $\frac{\partial q_f}{\partial p_f} = \frac{-d}{1-d^2} < 0$ and $\frac{\partial q_f}{\partial p_g} = \frac{d}{1-d^2} > 0$ from demand function and $\frac{\partial p_j}{\partial \theta_i} = \frac{-d(2-d^2)}{6-6d^2+d^4+(3-d^2)m} < 0$ and $\frac{\partial p_i}{\partial \theta_j} = \frac{-d(1-d^2+m)}{6-6d^2+d^4+(3-d^2)m} < 0$ from Eq. (11). The right-hand side (RHS) of Eq. (11) indicates effects of an increase in θ_f (i.e., encouraging sales by owner of firm f): the first term is strategic distortion effect that occurs because owners offer non-profit maximization objective for their managers; the second term includes the profit loss due to the rent shift from firm f to the rival firm g[7]. Note that the strategic distortion effect, the first term, captures the profit impact of delegation to managers via the

[7]As pointed out in Das(1997), whether with quantity or price competition, delegation to managers has rent shifting effects.

change in the price of its own products, which is negative (resp. positive) as long as θ_i is positive (resp. negative).

Given t_f, if we evaluate Eq. (11) at $\theta_f = 0$ to examine the incentive of delegation, we find that

$$\left.\frac{\partial \Pi_f(\theta_i, \theta_j; t_f)}{\partial \theta_f}\right|_{\theta_f=0} = (p_f - t_f)\left[\frac{\partial q_f}{\partial p_g}\frac{\partial p_g}{\partial \theta_f}\right]_{\theta_f=0} < 0. \tag{12}$$

Eq. (12) implies that given t_f, the owner of firm f wants the manager to behave defensively in the market. Solving the maximization problems in $\max_{\theta_f} \Pi_f$, we obtain the incentive parameters, respectively:

$$\theta_i^{DD} = \frac{-d^2(2-d^2)\{(1-t_i)[4d^2 - 3(2+m)] - (1-t_j)d[d^2 - (2+m)]\}}{(2-d^2)(18-15d^2+d^4) + (36-30d^2+5d^4)m + 3(3-d^2)m^2}, \tag{13}$$

$$\theta_j^{DD} = \frac{-d^2(1-d^2+m)\{(1-t_i)d(3-d^2) - (1-t_j)[3(2+m) - d^2(3+m)]\}}{(2-d^2)(18-15d^2+d^4) + (36-30d^2+5d^4)m + 3(3-d^2)m^2} \tag{14}$$

where $\frac{\partial \theta_i^{DD}}{\partial t_i} > 0, \frac{\partial \theta_i^{DD}}{\partial t_j} < 0$, and $\frac{\partial \theta_j^{DD}}{\partial t_j} > 0, \frac{\partial \theta_j^{DD}}{\partial t_i} < 0$. The government of the importing country chooses t_i and t_j. Solving the first order condition of welfare maximization under separation yields the optimal import tariff t_{fD}^{DD} for $f = i, j$. Using the optimal tariffs, t_{fD}^{DD}, we obtain the equilibrium market outcomes under delegation, as we show in Table A-1 of Appendix A.

We now solve the remaining two sub-games, asymmetric delegation structure. Consider the situation in which firm $f (f = i, j)$ chooses the delegation while the other firm chooses no delegation. Under asymmetric delegation structure, p_i and p_j are obtained at the intersection of the two reaction functions and substituting p_f^{DN} into the demand function, we obtain

$$p_i^{DN} = \frac{(1-d^2+m)(3-d-d^2) + (3-2d^2)(t_i - \theta_i) + d(1-d^2+m)t_j}{6-6d^2+d^4+(3-d^2)m} \tag{15}$$

$$p_j^{DN} = \frac{(1-d)(2+d)(2-d^2) + (2-d^2)[m + d(t_i - \theta_i)] + (2-2d^2+m)t_j}{6-6d^2+d^4+(3-d^2)m} \tag{16}$$

where superscript 'DN' denotes that firm i (firm j) chooses delegation (no delegation).

At stage three, the owner of firm i sets the incentive parameter θ_i so as to maximize its profits for a given rival's no delegation. Its maximization problem is as follows: $\max_{\theta_i}\ \Pi_i = (p_i - t_i)q_i - \frac{m}{2}q_i^2$. Solving the response function yields

$$\theta_i^{DN} = \frac{-d^2(2-d^2)[(3-d^2)(1-t_i) - d(1-t_j)]}{(3-d^2)[2(3-2d^2) + (3-d^2)m]}, \tag{17}$$

where $\frac{\partial \theta_i^{DN}}{\partial t_i} > 0$ and $\frac{\partial \theta_i^{DN}}{\partial t_j} < 0$.

At stage two, the home government chooses t_i and t_j to maximize its welfare. The market equilibrium in the last stage of the game is obtained by substituting θ_i^{DN} into Eqs. (15) and (16). Solving $\frac{\partial W^{DN}}{\partial t_i} = 0$ and $\frac{\partial W^{DN}}{\partial t_j} = 0$ simultaneously yields the optimal tariffs in this regime, t_{iD}^{DN} and t_{jD}^{DN}. Using the optimal outputs, t_{fD}^{DN}, we obtain the equilibrium market outcomes under an asymmetric vertical structure, as we show in Table A-2 of Appendix A.

In this subsection, we examine the case where only firm i takes no delegation. Repeating the same procedure as in the previous game, we obtain the equilibrium market outcomes under an asymmetric delegation structure (ND), as we show in Table A2 of Appendix A.

3.2 Endogenous Delegation Structure under Discriminatory Tariffs

Before explaining the choice of the endogenous delegation structure at stage one, let us compare the equilibrium outputs, tariff and incentive parameters between delegation and no delegation. Comparing the optimal import tariffs for each regime and noting that the subscript "D" denotes discriminatory tariffs, we obtain the following lemma.

Lemma 1: *Suppose that the home country adopts a discriminatory tariff regime. Then, the following relationship holds:*
(i) $q_{iD}^{ND} > q_{iD}^{NN} > q_{iD}^{DD} > q_{iD}^{DN}; q_{jD}^{DN} > q_{jD}^{NN} > q_{jD}^{DD} > q_{jD}^{ND}$.
(ii) $0 < \theta_{iD}^{DN} < \theta_{iD}^{DD}$ *and* $0 < \theta_{jD}^{ND} < \theta_{jD}^{DD}$.
(iii) $t_{iD}^{NN} > t_{jD}^{NN}, t_{iD}^{DD} > t_{jD}^{DD}, t_{iD}^{DN} > t_{jD}^{DN}$.
However, $t_{iD}^{ND} < t_{jD}^{ND}$ *if* $d > \tilde{d}(\equiv \sqrt{m - \sqrt{2-m}})$, *and vice versa if* $d < \tilde{d}$.
(iv) $t_{iD}^{DD} > t_{iD}^{ND} > t_{iD}^{DN} > t_{iD}^{NN}$ *if* $d > d^{t}$[8]*; Otherwise,* $t_{iD}^{DD} > t_{iD}^{DN} > t_{iD}^{ND} > t_{iD}^{NN}$.
(v) $t_{jD}^{DD} > t_{jD}^{DN} > t_{jD}^{ND} > t_{jD}^{NN}$ *regardless of* d *and* m.

Proof. See Appendix B.

Based on Lemma 1(iv) and Lemma 1 (v), Lemma 1 (i) for the rankings of outputs suggests the following intuition. Given a rival exporter's delegation structure, no delegation results in more output than delegation. This implies that Sklivas (1987) finding that delegation-to-no delegation shift in delegation structure results in more output irrespective of the delegation type, holds true, even when the importing country implements certain trade policies. Thus, as with canonical case of Bertrand competition, Lemma 1 (ii) suggests that both owners want managers to behave more defensively in their choice of production level than when only the owner of firm does.

Lemma 1(iii) implies that, in most delegation structures, the importing country sets a higher tariff on imports from the more inefficient exporter rather than on imports from the more efficient exporter. This is in sharp contrast to the results in previous studies. Our model suggests that this conventional wisdom does not hold true when considering the increasing marginal costs. Consequently, import tariff discrimination diverts production from an inefficient country to a relatively an efficient one, which may result in world production efficiency.

Lemmas (iv) and (v) relate to the magnitude of the rent-extraction effects of import tariffs under different delegation structures. Starting from a free trade situation, a small import tariff will increase the domestic price and lower the foreign exporter's supply price. The importing country's improved terms of trade allow the tariff revenue to more than compensate for the loss in consumer surplus. Further, the rent-extracting effect of the import tariff is largest in delegation, lower in asymmetric delegation structure, and lowest in no delegation because the tariff pass-through ratio is highest in delegation and lowest in no delegation.

In the first stage, we examine the delegation type chosen for two competing exporters. For the analysis of the endogenous choice of delegation type in this subsection, we define $\Delta\Pi_{fD}^{D|N}$ (resp. $\Delta\Pi_{fD}^{N|D}$) as firm f's profit change from a no delegation-to-delegation (resp. no delegation-to-delegation) shift in delegation (resp. no delegation) type given that the competitor chooses the delegation (resp. no delegation). See also Figure 1.

In the discriminatory tariff regime, we find that if $d > d^a$ and $d > d^c$ ($d > d_D^*$ and $d > d^b$), we

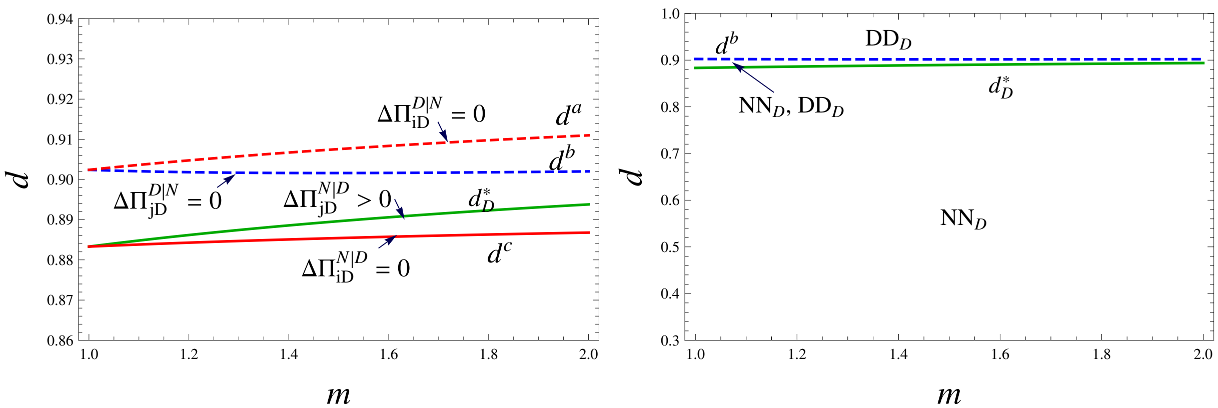
[8] We omit the value of d^t since it is complicated.

obtain

$$\Delta\Pi_{iD}^{D|N} \equiv \Pi_{iD}^{NN} - \Pi_{iD}^{DN} < 0,\ \Delta\Pi_{iD}^{N|D} \equiv \Pi_{iD}^{DD} - \Pi_{iD}^{ND} > 0,$$
$$\left(\Delta\Pi_{jD}^{N|D} \equiv \Pi_{jD}^{DD} - \Pi_{jD}^{DN} > 0,\ \Delta\Pi_{jD}^{D|N} \equiv \Pi_{jD}^{NN} - \Pi_{jD}^{ND} < 0\right)$$

and vice versa if $d < d^a$ and $d < d^c$ ($d < d_D^*$ and $d < d^b$).

We summarize these findings in Proposition 1 (note that DD_D (NN_D) in Figure 1 (b) means delegation (no delegation) equilibrium where the subscript 'D' is used to stand for discriminatory tariff).



(a) Strategies

(b) Equilibrium

Figure 1: Endogenous Determination of Delegation under Discriminatory Tariffs

Proposition 1. *Under a discriminatory tariff regime, we have the following;*
(i) if $d \in (0, d_D^*)$*, then* NN_D *(no delegation) emerges in equilibrium.*
(ii) if $d \in (d_D^*, d^b)$*, then* NN_D *or* DD_D *emerges in equilibrium.*
(iii) if $d \in (d^b, 1)$*, then* DD_D *(delegation) emerges in equilibrium.*

Proposition 1 suggests that depending on the degree of d given m, there is always symmetric equilibrium. The intuition behind Proposition 1 is as follows. From Lemma 1, in the case of $d \in (0, d_D^*)$, both exporters always have incentives to produce more when choosing no delegation than when choosing delegation, since tariffs are lower on the former. However, in the case of $d \in (d^b, 1)$ both exporters always have incentives to produce less when choosing delegation than when choosing no delegation, since tariffs are higher on the former. This implies that although the tariff effect is stronger and seems to restrict output when choosing the delegation, the tariff effect dominates the quantity effect and achieves higher profits when the degree of product differentiation is sufficiently high, regardless of the rival's strategy[9].

4 Uniform tariff: Endogenous Determination of Delegation Type

When the uniform tariff is applied, we examine the type of delegation preference for the two competing exporters. Note that the subscript "U" in each equilibrium stands for the uniform tariff rule. The

[9] As with canonical case of Bertrand competition, consumer surplus, and social and global welfare are greater when both exporters decide to choose no delegation over delegation. However, depending on the degree of product differentiation, each profit is larger under delegation than under no delegation, there could be prisoners' dilemma. We omit here to provide the endogenous delegation and comparisons between uniform and discriminatory tariff regimes.

market equilibrium in the last stage of the game is obtained by replacing t_{iD} and t_{jD} with t_U and t_U in Eqs. (6) $\sim$ (17). As the same process is repeated, except for the discriminatory tariffs t_{iD} and t_{jD}, the computations for these are in the Appendix A.

By comparing the equilibrium output in different delegation types under the uniform tariff, we derive the following lemma with respect to output ranking across the delegation types (see also Figure 2).

Lemma 2. *Under the uniform tariff regime, we have the following inequalities;*
(i) $q_{iU}^{ND} > q_{iU}^{NN} > q_{iU}^{DD} > q_{iU}^{DN}$, *and* $0 < \theta_{iU}^{DN} < \theta_{iU}^{DD}$ *if* $d > \kappa^a \approx \kappa^b$;
Otherwise, $q_{iU}^{NN} > q_{iU}^{ND} > q_{iU}^{DN} > q_{iU}^{DD}$ *and* $0 < \theta_{iU}^{DD} < \theta_{iU}^{DN}$ *if* $d < \kappa^a \approx \kappa^b$
(ii) $q_{jU}^{DN} > q_{jU}^{NN} > q_{jU}^{DD} > q_{jU}^{ND}$ *and* $0 < \theta_{jU}^{ND} < \theta_{jU}^{DD}$ *if* $d > \kappa^c$;
Otherwise, $q_{jU}^{NN} > q_{jU}^{DN} > q_{jU}^{ND} > q_{jU}^{DD}$ *and* $0 < \theta_{jU}^{DD} < \theta_{jU}^{ND}$ *if* $d < \kappa^c$.
(iii) $t_U^{DD} > t_U^{ND} > t_U^{DN} > t_U^{NN}$.

Proof. See Appendix B and Figure 2.

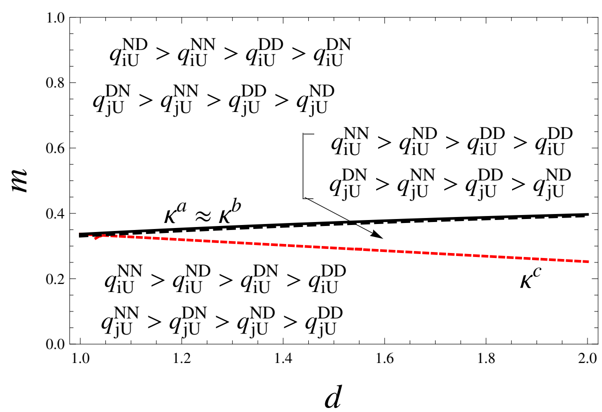


Figure 2: Comparison of Outputs under Uniform Tariff

Compared with Lemma 1, Lemma 2(i) suggests that given an efficient exporter j's delegation structure, no delegation for the inefficient exporter i results in more output than delegation. However, Lemma 2(ii) suggest that depending on the degree of d, there is a preference to choose delegation that has higher output than to choose no delegation. From Lemmas 2 (ii), we find that if $d > \kappa^c$, given the inefficient exporter's delegation, then we have $q_{jU}^{DD} < q_{jU}^{DN}$ and vice versa if $d < \kappa^c$; that is, if the degree of imperfect substitutability is high, then output under the delegation's output for the efficient exporter tends to be greater than that under asymmetric delegation, given the inefficient exporter's strategy.

On the other hand, similar to Lemma 1, the rent-extracting effect of the import tariff is largest in delegation, lower in asymmetric delegation structure, and lowest in no delegation because the tariff pass-through ratio is highest in delegation and lowest in no delegation. The intuition behind Lemma 2 (iii) is as follows. If the uniform tariff is substantially lower ($t_U^{DD} > t_U^{ND}$ (or $t_U^{DD} > t_U^{DN}$)) maintaining $q_{jU}^{DN} > q_{jU}^{NN} > q_{jU}^{DD} > q_{jU}^{ND}$, the efficient exporter has an incentive to produce more under no delegation than under the delegation if $d > \kappa^c$, and vice versa in the case of $d < \kappa^c$. This has the different effect on the inefficient exporter. That is, when the uniform tariff is substantially lower regardless of d, the inefficient exporter has an incentive to produce more with no delegation with delegation. Consequently, if the degree of product difference is high, then each exporter has a different delegation preference to cover the higher tariff, given the rival's strategy.

Now, we turn to the mode of competition of the two competing exporters in the first stage of the game under the uniform tariff. From the proof of Lemma 2, we find that if $d > d_U^c$ and $d > d_U^b$, we obtain

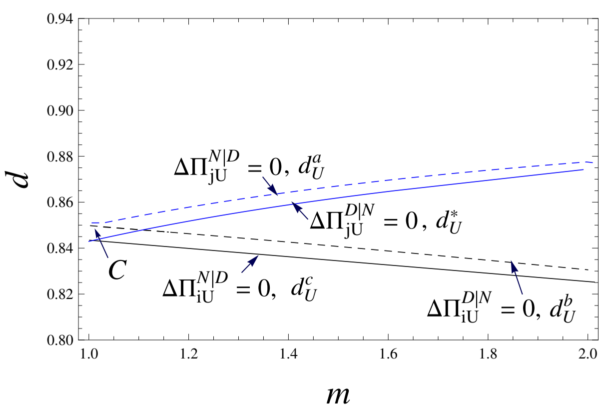
$$\Delta\Pi_{iU}^{N|D} \equiv \Pi_{iU}^{DD} - \Pi_{iU}^{ND} > 0, \quad \Delta\Pi_{iU}^{D|N} \equiv \Pi_{iU}^{NN} - \Pi_{iU}^{DN} < 0,$$

and vice versa if $d < d_U^c$ and $d < d_U^b$.

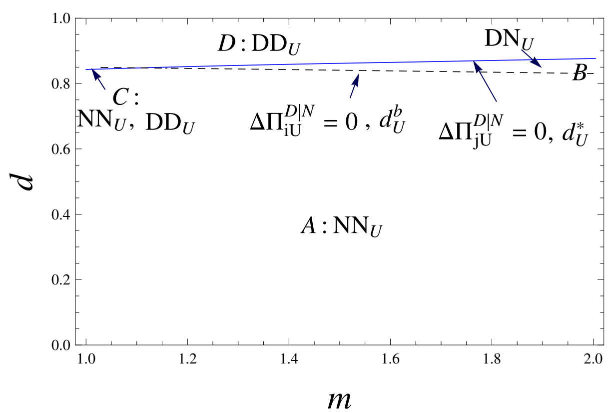
However, given the strategy of the inefficient exporter, a straightforward comparison of the efficient exporter payoffs gives the following results (see also Figure 3): if $d > d_U^*$ and $d > d_U^a$, we obtain

$$\Delta\Pi_{jU}^{D|N} \equiv \Pi_{jU}^{NN} - \Pi_{jU}^{ND} < 0, \quad \Delta\Pi_{jU}^{N|D} \equiv \Pi_{jU}^{DD} - \Pi_{jU}^{DN} > 0,$$

and vice versa if $d < d_U^*$ and $d < d_U^a$.



(c) Strategies



(d) Equilibrium

Figure 3: Endogenous Determination of Delegation under Uniform Tariff

Figure 3 (d) shows that the area (d, m) is divided into four regions: A, B, C and D. In region A (D) when both exporters choose the no delegation (delegation) structure emerges in equilibrium. In region B, the inefficient exporter i chooses the delegation (as the dominant strategy) regardless of the efficient exporter's choice, and efficient exporter j chooses no delegation (as the dominant strategy) regardless of the inefficient exporter's choice. As seen notations in previous section, the NN_U, DD_U and DN_U emerge in these regions, where the subscript 'U' is used to stand for uniform tariff.

We summarize these findings in Proposition 2 (see also Figure 3).

Proposition 2: *In the uniform tariff regime, we have the following;*
(i) if $d \in (0, d_U^b)$, then NN_U (no delegation) emerges in equilibrium.
(ii) if $d \in (d_U^b, d_U^*)$, then choosing delegation for the inefficient exporter and choosing no delegation for the efficient exporter emerges in equilibrium; DN_U.
(iii) if $d \in (d_U^*, 1)$, then DD_U (delegation) emerges in equilibrium.
(iv) if $d \in (d_U^*, d_U^a)$ in region C, then DD_U (delegation) or NN_U (no delegation) emerges in equilibrium.

Proposition 2 suggests that the possibility of asymmetric equilibrium depending on the degree of d. The intuition behind Proposition 2 is as follows:

Consider the case of $d \in (0, d_U^b)$ of region A. From Lemma 2, the inefficient exporter always has an incentive to produce more output when choosing no delegation than when choosing delegation if $d < d_U^c$. This is mainly because the equilibrium uniform tariff is lower when the inefficient exporter chooses no delegation rather than delegation implying that managers behave defensively in the market; $0 < \theta_{fU}^{DD}$. As the inefficient exporter's production under a uniform tariff is substantially higher when an efficient exporter chooses no delegation rather than delegation, an efficient exporter achieves higher profits when it choose no delegation rather than delegation. Both exporters have a dominant strategy as with no delegation, and they have incentives to produce more output with lower tariffs; $q_{iD}^{NN} > q_{iD}^{DN} \Leftrightarrow t_U^{DN} > t_U^{NN}$ and $q_{jD}^{DD} < q_{jD}^{DN} \Leftrightarrow t_U^{DD} > t_U^{DN}$. Thus, in the range of $d \in (0, d_U^b)$, the no delegation emerges in equilibrium.

However, in the case of $d \in (d_U^*, 1)$ in region D, the inefficient exporter has an incentive to produce less output with a higher final price, even under a higher uniform tariff when choosing the delegation over the no delegation. This is because $q_{iU}^{DD} < q_{iU}^{ND} \Leftrightarrow t_U^{DD} > t_U^{ND}$ from Lemma 2. Given the inefficient exporter's strategy in the case of $d \in (d_U^*, 1)$ of region D, the efficient exporter also produces less output under delegation than no delegation; $q_{jU}^{DD} < q_{jU}^{DN}$ under a higher uniform tariff; $t_U^{DD} > t_U^{DN}$. Hence, when paying higher uniform tariffs, both exporters have incentives to weaken competition because the total cost for the inefficient exporter is relatively low compared that for the efficient exporter[10]. Accordingly, as with $q_{jD}^{DD} - q_{iD}^{DD} = \frac{(m-1)[q(d)+q(d)m+q(d)m^2+q(d)m^3]}{\Theta_D} > 0$, we can confirm that in the case of $d \in (d_U^*, 1)$, both exporters always has an incentive to produce less when choosing delegation. Thus, choosing delegation for both exporters is a dominant strategy.

Next, we consider the case of $d \in (d_U^b, d_U^*)$ of region B. Given the m range, when d becomes larger from the region A, given the inefficient exporter's delegation strategy, the efficient exporter produces more when it chooses no delegation over delegation; $q_{jU}^{DN} > q_{jU}^{DD}$ with a lower uniform tariff $t_U^{DD} > t_U^{DN}$. However, given the inefficient exporter's no delegation strategy, the efficient exporter produces more when it chooses no delegation over delegation; $q_{jU}^{NN} > q_{jU}^{ND}$ with a lower uniform tariff $t_U^{NN} < t_U^{ND}$. Hence, the efficient exporter is paying lower a uniform tariff with higher output regardless of the inefficient delegation type. Thus, choosing no delegation for the efficient exporter is the dominant strategy. Given the dominant strategy of the efficient exporter, it is desirable for the inefficient exporter to choose delegation over no delegation with lower output; $q_{iU}^{DN} < q_{iU}^{NN}$. This occurs when paying higher a uniform tariff; $t_U^{DN} > t_U^{NN}$ implying that the tariff effect dominates the quantity effect. This leads to higher profits for the inefficient exporter in the case of $d \in (d_U^b, d_U^*)$ of region B. Thus, the inefficient exporter chooses delegation, given that the efficient exporter always chooses no delegation in the case of $d \in (d_U^b, d_U^*)$ of the region B.

In sum, owning to the restriction of one's attention to the subgame perfect Nash equilibrium of the three-stage game, one significant result can be derived from Proposition 2. Consequently, consumer surplus, and social welfare are greater when both exporters decide to choose no delegation over delegation. From simple calculations of $\sum_{i=1}^{2}(q_{iU}^{NN} - q_{iU}^{DN}) > \sum_{i=1}^{j}(q_{iU}^{DN} - q_{iU}^{ND}) > \sum_{i=1}^{j}(q_{iU}^{ND} - q_{iU}^{DD}) > 0$ and due to $\mid \theta_{iU}^{DD} > \theta_{iU}^{DN} > \theta_{jU}^{ND} \mid$, the reducing output with only the inefficient exporter's delegation is smaller than both delegation or only efficient exporter's delegation[11]. Hence, we summarize these findings in Lemma 3.

Lemma 3. *In the uniform tariff, the following relationships hold;*
$CS_U^{NN} > CS_U^{DN} > CS_U^{ND} > CS_U^{DD}$, $W_U^{NN} > W_U^{DN} > W_U^{ND} > W_U^{DD}$ *and*
$G_U^{NN} > G_U^{DN} > G_U^{ND} > G_U^{DD}$.

[10] $TC_{iD}(\equiv t_U^{DD} q_{iD}^{DD} + \frac{m}{2}(q_{iD}^{DD})^2) - TC_{jU}(\equiv t_U^{DD} q_{jD}^{DD} + \frac{1}{2}(q_{jD}^{DD})^2) = \frac{-(m-1)[a(d)+a(d)m+a(d)m^2+a(d)m^3+a(d)m^4+a(d)m^5+a(d)m^6+a(d)m^7]}{2\Theta_D} < 0$, where $[a(d) + a(d)m + a(d)m^2 + a(d)m^3 + a(d)m^4 + a(d)m^5 + a(d)m^6 + a(d)m^7] > 0$.

[11] We can easily confirm this, thus, omit complicated computations.

Proof. Since those comparisons are simple, we can omit.

5 Caveat: The Order of Import Tariffs on Foreign Exporters

Before analyzing welfare comparison between tariff regimes with which the delegation structure precedes policy of importing government, we provide the case of which the policy of importing government precedes delegation structure (i.e. if we assume that the tariff is chosen first stage). This is because it is important to study that trade policy influences the organizational structure of firms, which ultimately determines the intensity of competition in the market. Denoting '$\wedge$' that the firm's profit before the tariff is set and comparing firms' profits from Sections 3 and 4 when the policy of importing government precedes delegation structure yields

$$\hat{\Pi}_{iD}^{DD} - \hat{\Pi}_{iD}^{ND} = \frac{d^4(2-d^2)[(6-4d^2+3m)(1-t_{iD}) - d(2-d^2+m)(1-t_{jD})]^2\sigma_1}{2(6-5d^2+3m)^2(2-d^2+m)^2\sigma_0}$$
$$\hat{\Pi}_{iD}^{DN} - \hat{\Pi}_{iD}^{NN} = \frac{d^4(2-d^2)^2[(3-d^2)(1-t_{iD}) - d(1-t_{jD})]^2}{2(3-d^2)[6-6d^2+d^4+m(3-d^2)]^2[2(3-2d^2)+m(3-d^2)]} > 0,$$
$$\hat{\Pi}_{jD}^{DD} - \hat{\Pi}_{jD}^{DN} = \frac{d^4(1-d^2+m)[(6-3d^2+3m-d^2m)(1-t_{jD}) - d(3-d^2)(1-t_{iD})]^2\sigma_2}{2(3-d^2)^2[2(3-2d^2)+m(3-d^2)]\sigma_0}$$
$$\hat{\Pi}_{jD}^{ND} - \hat{\Pi}_{jD}^{NN} = \frac{d^4(1-d^2+m)^2[(2-d^2+m)(1-t_{jD}) - d(1-t_{iD})]^2}{2(6-5d^2+3m)(2-d^2+m)[6-6d^2+d^4+m(3-d^2)]^2} > 0,$$

where $\sigma_0 \equiv [(2-d^2)(18-15d^2+d^4)+(36-30d^2+5d^4)m+3(3-d^2)m^2]^2$, $\sigma_1 \equiv [2(2-d^2)(36-54d^2+19d^4+d^6)+4(54-75d^2+27d^4-d^6)m+4(9-d^2)(3-2d^2)m^2+3(6-d^2)m^3]$ and $\sigma_2 \equiv [(2-d^2)(3-2d^2)(18-9d^2-d^4)+(3-2d^2)(72-60d^2+11d^4)m+(3-d^2)(45-36d^2+5d^4)m^2+3(3-d^2)^2m^3]$. Note that the comparison of exporters' profit under the uniform tariff regime is obtained by replacing t_{iD} and t_{jD} with t_U and t_U in equations above. As the same process is repeated, we obtain $\hat{\Pi}_{iU}^{DD} > \hat{\Pi}_{iU}^{ND}, \hat{\Pi}_{iU}^{DN} > \hat{\Pi}_{iU}^{NN}$ and $\hat{\Pi}_{jU}^{DD} > \hat{\Pi}_{jU}^{DN}, \hat{\Pi}_{jU}^{ND} > \hat{\Pi}_{jU}^{NN}$.

If the tariff is chosen first stage, then since the tariff is paid both by delegated or not delegated structure, it will have no direct effect on the choice of delegation structure. These findings are summarized in Result 1.

Result 1. *If the policy of importing government precedes delegation structure under Bertrand competition with export rivalry market, then delegation for both foreign firms is a dominant strategy under either uniform or discriminatory tariff regime.*

Result 1 suggests that if the policy of importing government precedes delegation structure, then it has no direct effect on the firms' choice of delegation, as the tariff is the same regardless of whether the firm chooses delegation or not. To see this that there are two effects which firms take into account when making the delegation decision. These are the Stackelberg and rival incentive effects. If the rival firm does not choose delegation, then the latter effect is not present and thus a firm will choose delegation so as to commit to Stackelberg outcomes for any trade policy. If the rival chooses to delegate, then a firm will maintain the strategic rent-shifting opportunity afforded by delegation and choosing delegation so as to soften or reinforce rival incentive effect depending on the degree of product differentiation as seen in Eqs. (13) and (14)(i.e. response function in DD regime). Since an import tariff determines the position but not the slope of the after-tax producing marginal cost, it will have zero effect on the choice of delegation structure.

6 Welfare Comparison between Tariff Regimes

Here, we examine the economic implications of discriminatory and uniform tariff regimes. As shown in Figure 4, the area (d, m) is divided into six regions: A, B, C, D_0, D_1 and D_2 when considering both tariff alternatives (for simplicity, we omit the intuition for regions C and D_0).

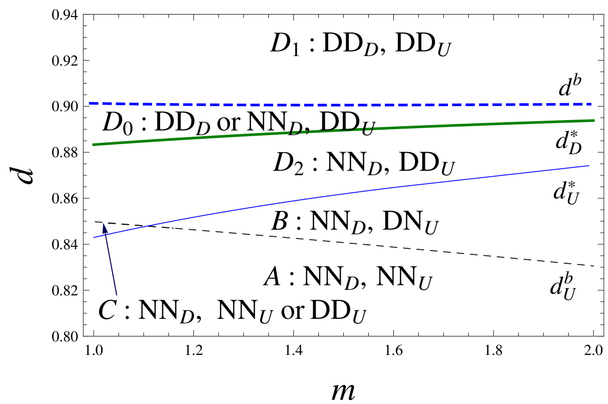


Figure 4: Equilibrium Delegation under Both Tariff Regimes

We need to compare the social welfare (W), global welfare (G), exporters' profits, and consumer surpluses (CS) between uniform tariffs in (a)symmetric equilibrium and discriminatory tariffs in symmetric equilibrium. As with the results from Propositions 1 and 2, if (d, m) is in regions A, $d \in (0, d_U^b)$ and $D_1, d \in (d_D^*, 1)$, the NN_D vs. NN_U and DD_D vs. DD_U emerge in each equilibrium under each tariff regime. Hence, we obtain the main results as follows.

Proposition 3. *Suppose $m > 1$ and region A (i.e., $d \in (0, d_U^b)$) or D_1(i.e., $d \in (d_D^*, 1)$). When comparing the NN_D and DD_D under discriminatory tariffs and the NN_U and DD_U under uniform tariffs, respectively, we have the following inequalities;*
(i) $\Pi_{iD}^{DD} < \Pi_{iU}^{DD}, \Pi_{jD}^{DD} > \Pi_{jU}^{DD}$, $t_{iD}^{DD} > t_U^{DD} > t_{jD}^{DD}$; $CS_D^{DD} > CS_U^{DD}, W_D^{DD} > W_U^{DD}, G_D^{DD} > G_U^{DD}$.
(ii) $\Pi_{iD}^{NN} < \Pi_{iU}^{NN}, \Pi_{jD}^{NN} > \Pi_{jU}^{NN}$, $t_{iD}^{NN} > t_U^{NN} > t_{jD}^{NN}$; $CS_D^{NN} > CS_U^{NN}, W_D^{NN} > W_U^{NN}, G_D^{NN} > G_U^{NN}$.

Proof. See Appendix C.

The intuition behind Proposition 3 is as follows. The total output is larger under discriminatory tariffs than that under uniform tariffs (i.e., $q_{iD}^{DD} + q_{jD}^{DD} > q_{iU}^{DD} + q_{jU}^{DD}$ and $q_{iD}^{NN} + q_{jD}^{NN} > q_{iU}^{NN} + q_{jU}^{NN}$)[12], by giving tariff discount to the efficient exporter whose marginal cost is increasing at a slower rate, discriminatory tariff could reduce the efficient exporter costs and enhance both social and global welfare.

Moreover, when considering the increasing marginal costs in regions A and D_1, we have the ranking of tariffs, $t_{iD}^{DD} > t_U^{DD} > t_{jD}^{DD}$ and $t_{iD}^{NN} > t_U^{NN} > t_{jD}^{NN}$. In other words, the importing country sets high tariff rates for the inefficient exporter and low tariff rates for the efficient exporter regardless of the degree of product differentiation. This implies that the inefficient exporter is handicapped under the uniform tariff, while the efficient exporter is subsidized under the discriminatory tariff regime. Based on tariff levels, it shows that the efficient exporter produces more and the inefficient exporter produces less

[12]When comparing DD_D with DD_U, we obtain $\mid \theta_{iU}^{DD} + \theta_{jU}^{DD} > \theta_{iU}^{DD} + \theta_{jU}^{DD} \mid$, which implies that reducing output with the degrees of both exporters' delegation under discriminatory tariff is smaller than those of them under uniform tariff.

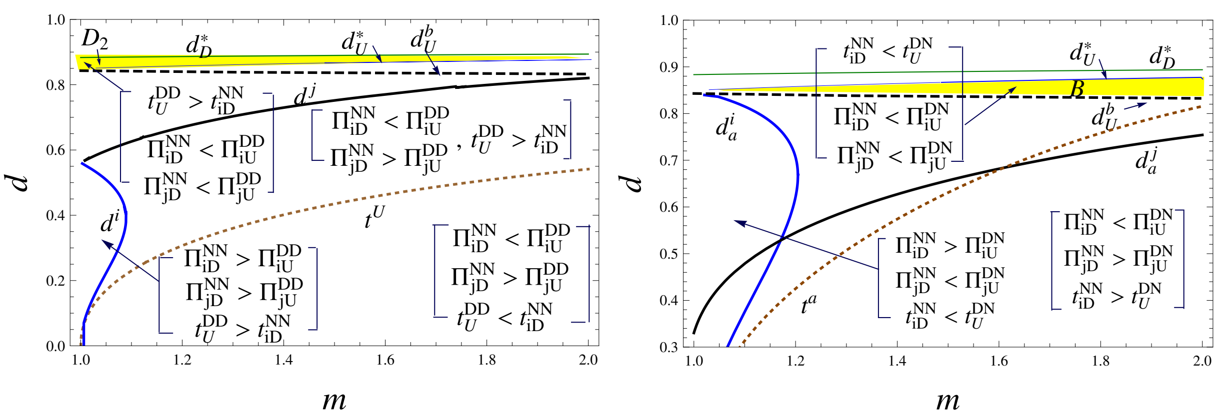
under the discriminatory tariffs than under the uniform tariff rule. The profit of the efficient exporter is greater in the DD_D and NN_D under the uniform tariff than that under the discriminatory tariff rule in the DD_U and NN_U. However, there is a low uniform tariff rates for the inefficient exporter, compared to discriminatory tariff, which leads to smaller profits for the inefficient exporter in the DD_D and NN_D under the discriminatory tariff than those the uniform tariff rule, which leads to a comparison of exporters' profits; $\Pi_{iD}^{DD} < \Pi_{iU}^{DD}, \Pi_{jD}^{DD} > \Pi_{jU}^{DD}$ and $\Pi_{iD}^{NN} < \Pi_{iU}^{NN}, \Pi_{jD}^{NN} > \Pi_{jU}^{NN}$.

Next, we compare the asymmetric delegation equilibrium under uniform tariff with no delegation under discriminatory tariff rules. As with the result from Propositions 1 and 2, if $d \in (d_U^b, d_D^*)$; the regions B and D_1 in Figures 5(e) and 5 (f), the endogenous choice of delegation types is determined by (a)symmetric delegation equilibrium, the DN_U or DD_U under uniform tariffs and NN_D under discriminatory tariffs. We obtain the main results as follows.

Proposition 4. *Suppose $m > 1$ and $d \in (d_U^b, d_D^*)$. When comparing NN_D with DD_U and NN_D with DN_U, we have the following inequalities;*
(i) $\Pi_{iD}^{NN} < \Pi_{iU}^{DD}, \Pi_{jD}^{NN} < \Pi_{jU}^{DD}$, $t_U^{DD} > t_{iD}^{NN} > t_{jD}^{NN}$; $CS_D^{NN} > CS_U^{DN}, W_D^{NN} > W_U^{DN}, G_D^{NN} > G_U^{DN}$.
(ii) $\Pi_{iD}^{NN} < \Pi_{iU}^{DN}, \Pi_{jD}^{NN} < \Pi_{jU}^{DN}$, $t_U^{DN} > t_{iD}^{NN} > t_{jD}^{NN}$; $CS_D^{NN} > CS_U^{DD}, W_D^{NN} > W_U^{DD}, G_D^{NN} > G_U^{DD}$.

Proof. See Appendix C.

The intuition behind Proposition 4 (i) is as follows. Similar to Proposition 3, the total output is larger under discriminatory tariffs than that under uniform tariffs (i.e., $q_{iD}^{NN} + q_{jD}^{NN} > q_{iU}^{DD} + q_{jU}^{DD}$ and $q_{iD}^{NN} + q_{jD}^{NN} > q_{iU}^{DN} + q_{jU}^{DN}$), resulting in greater consumer surplus, social and global welfare under discriminatory tariffs than under uniform tariffs.



(e) Comparison of profits with DD_U and NN_D (f) Comparison of profits with DN_U and NN_D

Figure 5: Comparison of Profits with Symmetric Competitions

Moreover, when considering the increasing marginal costs in the region D_2; $d \in (d_U^*, d_D^*)$, if $d > t^U$, then we have the ranking of tariffs, $t_U^{DD} > t_{iD}^{NN} > t_{jD}^{NN}$. In other words, the importing country sets the highest uniform tariff rates for both inefficient and efficient exporters between NN_D and DD_U, compared to the discriminatory tariff under NN_D; $d > t^U$ in Figure 5 (e). This implies that if $d > d^i, d^j$, the inefficient exporter is handicapped under either the uniform or discriminatory tariffs, while the efficient exporter is subsidized under the discriminatory tariff regime, which leads to a comparison of exporters' profits; $\Pi_{iD}^{NN} < \Pi_{iU}^{DD}, \Pi_{jD}^{NN} < \Pi_{jU}^{DD}$. That is, given the ranking of $t_U^{DD} > t_{iD}^{NN} > t_{jD}^{NN}$, both exporters have incentive to produce less output under the uniform tariff with delegating $\theta_{iD}^{DD} < 0, \theta_{jD}^{DD} < 0$ even though higher paying uniform tariff, which yields higher both exporters' profits. In the region of D_2 with $d \in (d_U^*, d_D^*)$, anticipating exporters' incentives, the importing country prefers to choose the discriminatory tariff to increase its own country social welfare resulting in enhancing global welfare under the discriminatory tariff with higher importing goods.

Similar to the case of comparison of NN_D with DD_U, when comparing NN_D with DN_U, if $d > t^a$, then we have the ranking of tariffs, $t_U^{DN} > t_{iD}^{NN} > t_{jD}^{NN}$ (see also Figure 5 (f)). From the ranking of tariffs, the intuition behind exporters' profit and both welfare is the exactly same. That is, both exporters have incentive to produce less output under the uniform tariff with delegating $\theta_{iD}^{DN} < 0$, which yields higher both exporters' profits under uniform tariff. In the region of B with $d \in (d_U^b, d_U^*)$, anticipating exporters' incentives, the importing country prefers to choose the discriminatory tariff to increase its own country social welfare resulting in enhancing global welfare under the discriminatory tariff with higher importing goods. In the region of B with $d \in (d_U^b, d_U^*)$, both exporters have incentive to produce less output under the uniform tariff even though higher paying uniform tariff.

Propositions 3 and 4 suggest that, in contrast to conventional wisdom, the importing country's social welfare, consumers surplus and global welfare have different effects when asymmetrically increasing marginal costs are considered. In other words, these Propositions 3 and 4 provide that the tariff discrimination regime in endogenous choice of delegation types can always obtain Pareto superiority except for exporters' profits, compared to the uniform tariff regime[13].

Additionally, since the importing country tends to impose a lower (higher) tariff on the efficient (inefficient) exporter, the inefficient exporter always prefers the uniform tariff to the discriminatory tariff regime while the efficient exporter's preference for tariff regime varies for any degree of product differentiation. For the efficient exporter's profit, it is desirable to choose lower output under the uniform tariff when the degree of imperfect substitutability is relatively large in the regions B and D_2. In contrast, when the degree of imperfect substitutability is relatively small or large in regions A and D_1 as discriminatory tariffs are higher than the uniform tariff imposed on inefficient exporters, it is desirable for the efficient exporter to choose increased output under discriminatory tariffs, given relatively lower tariffs as the competition becomes intense. Given asymmetric increasing marginal costs, the extension to the endogenous choice of delegation types affects tariff regime adoption differently. Asymmetric increasing marginal costs do make a difference. For any given degree of differentiation, the preferences for discriminatory tariff regime always exist in the same direction for consumer surplus, social and global welfare, while the efficient exporter's preference changes according to the degree of product differentiation.

6.1 Implications for Discussion of the Vertical Structure

As analysed in Bonanno and Vickers (1988), the fact that delegation can have strategic advantages has a bearing on several issues in closed economy. For example, the Bertrand and Cournot competition in Sections 3 $\sim$ 6 could be interpreted as follows. Consider O_i in Eq. (4) as the profit of the downstream firm f, that supplied by upstream firm f at an input price of θ_f. Suppose for simplicity that a franchise fee is charged so that the joint profits of each downstream firm f and upstream firm f are enjoyed by the upstream firm in each exporting country, except for a fixed fee to the downstream firm. Then optimal input prices are found from in Appendix A. The case of a vertically integrated

[13] Although Din et al. (2016) showed that the importing government tends to impose a lower (resp. higher) tariff on the low-cost (resp. high-cost) firm and the global welfare is higher under the tariff discrimination than under the uniform tariff if the magnitude cross ownership of financial interests is relatively high. Their results crucially depend on which the magnitude of cross ownership is relatively large compared with the cost difference, assuming constant marginal costs. Our results in this study always hold true without such constraints.

firm corresponds to $\theta_f = 0$, and so the model illustrates the strategic advantage to be had from non-integration. Our example is extremely stylized, but it shows that the argument has coherence at least in the international trade with alternative tariff regimes[14].

7 Concluding Remarks

With increasing marginal costs, we have tackled the question of whether countries can use uniform tariffs or discriminatory tariffs in a mutually beneficial form that also impacts consumers surplus, social and global welfare. Several striking results are derived as follows. We have analyzed this by establishing endogenous delegation among exporters with a forward-looking view of the importing country's trade policy. We have also shown that not only the importing country's welfare but also global welfare increases with the adoption of discriminatory tariff regime in all equilibrium delegation structure. Moreover, we have shown that diverse delegation types such as delegation, no delegation, and asymmetric delegation arise depending on the degree of product substitutability under alternative tariff regimes. In this regard, unless the degree of product differentiation is sufficiently large, then no delegation appears as with different implications for tariff policies. However, the issue of a preferred tariff regime for individual exporter countries is not as simple as that for global welfare. Unless the degree of product differentiation is intermediate, the efficient exporter prefers a discriminatory tariff regime, while the inefficient exporter always prefers the uniform tariffs

We see the following limitations to our study. Our model assumes an export rivalry with two exporters and one importing country. Thus, there is no firm in importing country, which needs to analyze with import-competing model. With each tariff regime, we also need to analyze that the exporters should forwardly see the movement trend of tariff regime switching to an ad valorem tariff from specific tariff policy. Although our results indicate the need for caution in the policy debate on the merits of the uniform tariff, as Choi (1995) points out, the adverse long-run effect still needs to be analyzed in a more extensive model. Extending our model in this regard remains a direction for future research.

[14]With constant marginal costs for exporters, Ziss (1997) examined the endogenous choice of vertical structure using the export rivalry model of Brander-Spencer (1985). Hence, he found that under Bertrand (Cournot) competition, choosing vertical separation (integration) is a dominant strategy for both firms, regardless of whether the decision on the vertical structure occurs before or after the policy decision. See also Acemoglu et al., (2010) and Bai (2021) for the vertical structure.

Appendix A: Equilibrium Values

Table A-1: No Delegation and Delegation under Discriminatory Tariff

$$q_{iD}^{NN}=\frac{5-d-2d^2}{(3-d^2)(5-4d^2)+2(5-2d^2)m},\quad q_{jD}^{NN}=\frac{(1-d)(3+2d)+2m}{(3-d^2)(5-4d^2)+2(5-2d^2)m},$$
$$t_{iD}^{NN}=(1-d^2+m)q_{iD}^{NN},\ t_{jD}^{NN}=(2-d^2)q_{jD}^{NN},\Pi_{iD}^{NN}=\frac{2-2d^2+m}{2}(q_{iD}^{NN})^2,\Pi_{jD}^{NN}=\frac{3-2d^2}{2}(q_{jD}^{NN})^2$$
$$W_D^{NN}=\frac{4-d-2d^2+m}{(3-d^2)(5-4d^2)+2(5-2d^2)m},G_D^{NN}=W_D^{NN}+\Pi_{iD}^{NN}+\Pi_{jD}^{NN}$$

$$q_{iD}^{DD}=\frac{(3-d^2)[10-2d-7d^2+d^3+(5-d)m]}{90-119d^2+40d^4-d^6+15(7-6d^2+d^4)m+10(3-d^2)m^2},q_{jD}^{DD}=\frac{(2-d^2+m)[9-3d-5d^2+d^3+2(3-d^2)m]}{90-119d^2+40d^4-d^6+15(7-6d^2+d^4)m+10(3-d^2)m^2}$$
$$t_{iD}^{DD}=\frac{3-2d^2+(3-d^2)m}{3-d^2}q_{iD}^{DD},\ t_{jD}^{DD}=\frac{4-3d^2+2m}{2-d^2+m}q_{jD}^{DD},\theta_{iD}^{DD}=-\frac{d^2(2-d^2)}{3-d^2}q_{iD}^{DD},\ \theta_{jD}^{DD}=-\frac{d^2(1-d^2+m)}{2-d^2+m}q_{jD}^{DD}$$
$$\Pi_{iD}^{DD}=\frac{2(3-2d^2)+(3-d^2)m}{2(3-d^2)}(q_{iD}^{DD})^2,\Pi_{jD}^{DD}=\frac{6-5d^2+3m}{2(2-d^2+m)}(q_{jD}^{DD})^2$$
$$W_D^{DD}=\frac{24-6d-25d^2+5d^3+6d^4-d^5+(18-3d-10d^2+d^3+d^4)m+(3-d^2)m^2}{90-119d^2+40d^4-d^6+15(7-6d^2+d^4)m+10(3-d^2)m^2},G_D^{DD}=W_D^{DD}+\Pi_{iD}^{DD}+\Pi_{jD}^{DD}$$

Table A-2: Asymmetric Delegations under Discriminatory Tariff

$$q_{iD}^{DN}=\frac{(3-d^2)(5-d-2d^2)}{45-46d^2+11d^4+2(3-d^2)(5-2d^2)m},\quad q_{jD}^{DN}=\frac{9-3d-5d^2+d^3+2(3-d^2)m}{45-46d^2+11d^4+2(3-d^2)(5-2d^2)m},$$
$$t_{iD}^{DN}=\frac{3-2d^2+(3-d^2)m}{3-d^2}q_{iD}^{DN},t_{jD}^{DN}=(2-d^2)q_{jD}^{DN},\theta_{iD}^{DN}=-\frac{d^2(2-d^2)}{3-d^2}q_{iD}^{DN}$$
$$\Pi_{iD}^{DN}=\frac{2(3-2d^2)+(3-d^2)m}{2(3-d^2)}(q_{iD}^{DN})^2,\ \Pi_{jD}^{DN}=\frac{3-2d^2}{2}(q_{jD}^{DN})^2,$$
$$W_D^{DN}=\frac{12-3d-8d^2+d^3+d^4+(3-d^2)m}{45-46d^2+11d^4+2(3-d^2)(5-2d^2)m},G_D^{DN}=W_D^{DN}+\Pi_{iD}^{DN}+\Pi_{jD}^{DN}$$

$$q_{iD}^{ND}=\frac{10-2d-7d^2+d^3+(5-d)m}{(5-3d^2)(6-5d^2)+5(7-5d^2)m+10m^2},q_{jD}^{ND}=\frac{(3-d-2d^2+2m)(2-d^2+m)}{(5-3d^2)(6-5d^2)+5(7-5d^2)m+10m^2},$$
$$t_{iD}^{ND}=(1-d^2+m)q_{iD}^{ND},\ t_{jD}^{ND}=\frac{4-3d^2+2m}{2-d^2+m}q_{jD}^{ND},\theta_{jD}^{ND}=-\frac{d^2(1-d^2+m)}{2-d^2+m}q_{jD}^{ND}$$
$$\Pi_{iD}^{ND}=\frac{2-2d^2+m}{2}(q_{iD}^{ND})^2,\ \Pi_{jD}^{ND}=\frac{6-5d^2+3m}{2(2-d^2+m)}(q_j^{ND})^2$$
$$W_D^{ND}=\frac{(2-d)(4+d-3d^2-d^3)+(2+d)(3-2d)m+m^2}{(5-3d^2)(6-5d^2)+5(7-5d^2)m+10m^2},G_D^{ND}=W_D^{ND}+\Pi_{iD}^{ND}+\Pi_{jD}^{ND}$$

Table A-3: No Delegation and Delegation under Uniform Tariff

$$q_{iU}^{NN}=\frac{(3-d-d^2)(5-2d-2d^2+m)}{\Theta_N},q_{jU}^{NN}=\frac{(2-d-d^2+m)(5-2d-2d^2+m)}{\Theta_N},$$
$$t_U^{NN}=\frac{\tau_N}{\Theta_N},\Pi_{iU}^{NN}=\frac{2-2d^2+m}{2}(q_{iU}^{NN})^2,\Pi_{jU}^{NN}=\frac{3-2d^2}{2}(q_{jU}^{NN})^2$$
$$W_U^{NN}=\frac{(5-2d-2d^2+m)^2}{2\Theta_N},G_U^{NN}=W_U^{NN}+\Pi_{iU}^{NN}+\Pi_{jU}^{NN}$$

$$q_{iU}^{DD}=\frac{(3-d^2)[6-2d-4d^2+d^3+(3-d)m]\xi_D}{\Theta_D},q_{jU}^{DD}=\frac{(2-d^2+m)[6-3d-3d^2+d^3+(3-d^2)m]\xi_D}{\Theta_D}$$
$$t_U^{DD}=\frac{\tau_D}{\Theta_D},\theta_{iU}^{DD}=-\frac{d^2(2-d^2)}{3-d^2}q_{iU}^{DD},\theta_{jU}^{DD}=-\frac{d^2(1-d^2+m)}{2-d^2+m}q_{jU}^{DD},$$
$$\Pi_{iU}^{DD}=\frac{2(3-2d^2)+(3-d^2)m}{2(3-d^2)}(q_{iU}^{DD})^2,\Pi_{jU}^{DD}=\frac{6-5d^2+3m}{2(2-d^2+m)}(q_{jU}^{DD})^2$$
$$W_U^{DD}=\frac{\xi_D^2}{2\Theta_D},G_U^{DD}=W_U^{DD}+\Pi_{iU}^{DD}+\Pi_{jU}^{DD}$$

Table A-4: Asymmetric Delegations under Uniform Tariff

$$q_{jU}^{DN}=\frac{[6-3d-3d^2+d^3+(3-d^2)m]\xi_{DN}}{\Theta_{DN}},t_U^{DN}=\frac{\tau_{DN}}{\Theta_{DN}},\theta_{iU}^{DN}=-\frac{d^2(2-d^2)}{(3-d^2)}q_{iU}^{DN},q_{iU}^{DN}=\frac{(3-d^2)(3-d-d^2)\xi_{DN}}{\Theta_{DN}}$$
$$\Pi_{iU}^{DN}=\frac{2(3-2d^2)+(3-d^2)m}{2(3-d^2)}(q_{iU}^{DN})^2,\Pi_{jU}^{DN}=\frac{(3-2d^2)}{2}(q_{jU}^{DN})^2,W_U^{DN}=\frac{\xi_{DN}^2}{2\Theta_{DN}},G_U^{DN}=W_U^{DN}+\Pi_{iU}^{DN}+\Pi_{jU}^{DN}$$

$$q_{iU}^{ND}=\frac{[6-2d-4d^2+d^3+(3-d)m]\xi_{ND}}{\Theta_{ND}},q_{jU}^{ND}=\frac{(2-d-d^2+m)(2-d^2+m)\xi_{ND}}{\Theta_{ND}},t_U^{ND}=\frac{\tau_{ND}}{\Theta_{ND}},\theta_{jU}^{ND}=-\frac{d^2(1-d^2+m)}{2-d^2+m}q_{jU}^{ND}$$
$$\Pi_{iU}^{ND}=\frac{2-2d^2+m}{2}(q_{iU}^{ND})^2,\Pi_{jU}^{ND}=\frac{6-5d^2+3m}{2-d^2+m}(q_{jU}^{ND})^2,W_U^{ND}=\frac{\xi_{ND}^2}{2\Theta_{ND}},G_U^{ND}=W_U^{ND}+\Pi_{iU}^{ND}+\Pi_{jU}^{ND}$$

$$\Theta_N\equiv 47-26d-66d^2+28d^3+28d^4-6d^5-4d^6+2(19-8d-15d^2+3d^3+3d^4)m+(5-2d^2)m^2,$$
$$\tau_N\equiv(1-d)(17+3d-21d^2-5d^3+6d^4+2d^5)+(17-10d-13d^2+4d^3+3d^4)m+(2-d^2)m^2,$$

$\xi_D \equiv [30 - 12d - 30d^2 + 10d^3 + 7d^4 - 2d^5 + (21 - 6d - 11d^2 + 2d^3 + d^4)m + (3 - d^2)m^2]$,

$\Theta_D \equiv 1692 - 936d - 3816d^2 + 2004d^3 + 3180d^4 - 1584d^5 - 1166d^6 + 556d^7 + 163d^8 - 78d^9 - 2d^{10}$
$+2(1530 - 756d - 2748d^2 + 1257d^3 + 1740d^4 - 728d^5 - 451d^6 + 170d^7 + 39d^8 - 13d^9)m$
$+(1971 - 810d - 2646d^2 + 948d^3 + 1169d^4 - 346d^5 - 188d^6 + 40d^7 + 7d^8)m^2$
$+2(3 - d^2)(87 - 24d - 52d^2 + 8d^3 + 6d^4)m^3 + 5(3 - d^2)^2m^4$,

$\tau_D \equiv 612 - 504d - 1296d^2 + 1068d^3 + 978d^4 - 828d^5 - 290d^6 + 278d^7 + 14d^8 - 34d^9 + 5d^{10}$
$+(1224 - 864d - 2112d^2 + 1434d^3 + 1257d^4 - 826d^5 - 286d^6 + 190d^7 + 15d^8 - 14d^9 + d^{10})m$
$+837 - 486d - 1080d^2 + 570d^3 + 446d^4 - 208d^5 - 62d^6 + 24d^7 + d^8)m^2$
$+(3 - d^2)(75 - 30d - 41d^2 + 10d^3 + 4d^4)m^3 + 2(3 - d^2)^2m^4$,

$\xi_{DN} \equiv [15 - 6d - 9d^2 + 2d^3 + d^4 + (3 - d^2)m]$

$\Theta_{DN} \equiv 180 - 108d - 261d^2 + 144d^3 + 123d^4 - 60d^5 - 19d^6 + 8d^7$
$+2(3 - d^2)(30 - 9d - 27d^2 + 6d^3 + 6d^4 - d^5)m + (3 - d^2)^2(5 - 2d^2)m^2$

$\tau_{DN} \equiv 153 - 126d - 216d^2 + 168d^3 + 105d^4 - 72d^5 - 20d^6 + 10d^7 + d^8$
$+(3 - d^2)(51 - 30d - 48d^2 + 22d^3 + 14d^4 - 4d^5 - d^6)m + (3 - d^2)^2(2 - d^2)m^2$,

$\xi_{ND} \equiv [10 - 4d - 8d^2 + 2d^3 + d^4 + (7 - 2d - 2d^2)m + m^2]$

$\Theta_{ND} \equiv 188 - 104d - 400d^2 + 196d^3 + 296d^4 - 120d^5 - 86d^6 + 24d^7 + 7d^8$
$+2(170 - 84d - 256d^2 + 105d^3 + 114d^4 - 32d^5 - 13d^6)m$
$+(219 - 90d - 200d^2 + 56d^3 + 36d^4)m^2 + 2(29 - 8d - 11d^2)m^3 + 5m^4$

$\tau_{ND} \equiv 2(1 - d)(34 + 6d - 66d^2 - 12d^3 + 41d^4 + 7d^5 - 8d^6 - d^7)$
$+(136 - 96d - 200d^2 + 122d^3 + 85d^4 - 38d^5 - 8d^6)m$
$+(93 - 54d - 80d^2 + 34d^3 + 12d^4)m^2 + (5 + 2d)(5 - 4d)m^3 + 2m^4$.

Appendix B: Proof of Lemmas 1 and 2

Proof of Lemma 1

To show Lemma 1, we use notations as with
$\Psi_D \equiv 90 - 119d^2 + 40d^4 - d^6 + 15(7 - 6d^2 + d^4)m + 10(3 - d^2)m^2$,
$\Psi_N \equiv (3 - d^2)(5 - 4d^2) + 2(5 - 2d^2)m$,
$\Psi_{ND} \equiv (5 - 3d^2)(6 - 5d^2) + 5(7 - 5d^2)m + 10m^2$,
$\Psi_{DN} \equiv 45 - 46d^2 + 11d^4 + 2(3 - d^2)(5 - 2d^2)m$.

(i) Straightforward calculations yield

$$q_{iD}^{ND} - q_{iD}^{NN} = \frac{2d^3[3 - d - 2(d^2 - m)(1 - d^2 + m)]}{\Psi_{ND}\Psi_N} > 0,$$
$$q_{iD}^{NN} - q_{iD}^{DD} = \frac{2d^3[100 - 29d - 157d^2 + 42d^3 + 79d^4 - 18d^5 - 13d^6 + 2d^7 + \xi_1]}{\Psi_N\Psi_D} > 0,$$
$$q_{iD}^{DD} - q_{iD}^{DN} = \frac{2d^3(3 - d^2)(1 - d^2 + m)[9 - 3d - 5d^2 + d^3 + 2(3 - d^2)m]}{\Psi_D\Psi_{DN}} > 0,$$
$$q_{jD}^{DN} - q_{jD}^{NN} = \frac{2d^3(2 - d^2)(5 - d - 2d^2)}{\Psi_{DN}\Psi_N} > 0,$$
$$q_{jD}^{NN} - q_{jD}^{DD} = \frac{2d^2[27 - 29d - 56d^2 + 42d^3 + 39d^4 - 18d^5 - 9d^6 + 2d^7 + \xi_1]}{\Psi_N\ \Psi_D} > 0,$$
$$q_{jD}^{DD} - q_{jD}^{ND} = \frac{2d^3(2 - d^2)(2 - d^2 + m)[10 - 2d - 7d^2 + d^3 + (5 - d)m]}{\Psi_D\Psi_{ND}} > 0.$$

$\xi_1 \equiv (5 + d - d^2)(10 - 7d - 5d^2 + 4d^3)m - 2d(3 - d^2)m^2$,
$\xi_2 \equiv (63 - 25d - 95d^2 + 22d^3 + 41d^4 - 4d^5 - 4d^6)m + 2(24 - 3d - 22d^2 + d^3 + 4d^4)m^2 + 4(3 - d^2)m^3$.

(ii) Using Lemma 1 (i), straightforward calculations yields

$$\theta_{iD}^{DD} - \theta_{iD}^{DN} = q_{iD}^{DN} - q_{iD}^{DD} < 0 \text{ and } \theta_{jD}^{DD} - \theta_{jD}^{ND} = q_{jD}^{DN} - q_{jD}^{DD} < 0,$$

(iii) Straightforward calculations yield

$$t_{iD}^{NN} - t_{jD}^{NN} = \frac{(1-d)(m-1)}{\Psi_N} > 0, \; t_{iD}^{DD} - t_{jD}^{DD} = \frac{(1-d)(m-1)[6-6d^2+d^4+(3-d^2)m]}{\Psi_D} > 0,$$
$$t_{iD}^{DN} - t_{jD}^{DN} = \frac{(1-d)[3-3d^2+d^4-(3-d^2)m]}{\Psi_{DN}} > 0.$$

Comparing discriminatory tariffs among competition modes, if $d > \tilde{d} \equiv \sqrt{m - \sqrt{2-m}}$,

$$t_{iD}^{ND} - t_{jD}^{ND} = \frac{-(1-d)[2-d^4-(1-2d^2)m-m^2]}{\Psi_{ND}} > 0,$$

and vice versa if $d < \tilde{d}$.

(iv) Comparing discriminatory tariffs for the inefficient exporter, we have

$$t_{iD}^{DD} - t_{iD}^{ND} = \frac{d^2(2-d^2)[10-2d-7d^2+d^3+(5-d)m]}{\Psi_D \Psi_{ND}} > 0,$$
$$t_{iD}^{ND} - t_{iD}^{NN} = (1-d^2+m)(q_{iD}^{ND} - q_{iD}^{NN}) > 0,$$
$$t_{iD}^{DD} - t_{iD}^{NN} = \frac{d^2[100-2d-186d^2-14d^3+121d^4+21d^5-31d^6-7d^7+2d^8+\xi_3]}{\Psi_D \Psi_N} > 0,$$

Given $t_{iD}^{DD} > t_{iD}^{NN}$, we obtain that

$$t_{iD}^{DN} - t_{iD}^{NN} = \frac{d^2(2-d^2)(5-d-2d^2)(5-3d^2)}{\Psi_{DN}\Psi_N} > 0.$$

Thus, if $d < d^t$, then we have,

$$t_{iD}^{DN} - t_{iD}^{ND} = \frac{d^2[100-38d-174d^2+74d^3+97d^4-49d^5-17d^6+11d^7+\xi_4]}{\Psi_{DN}\Psi_{ND}} > 0,$$

and vice versa if $d > d^t$.

(v) Moreover, comparing each discriminatory tariff level for the efficient exporter yields

$$t_{jD}^{DD} > t_{jD}^{DN} = \frac{(1-d^2+m)d^2[9-3d-5d^2+d^3+2(3-d^2)m][9-8d^2+d^4+2(3-d^2)m]}{\Psi_{DN}\Psi_D} > 0,$$
$$t_{jD}^{DN} > t_{jD}^{ND} = \frac{d^2[27-89d-53d^2+153d^3+37d^4-85d^5-9d^6+15d^7+\xi_5]}{\Psi_{DN}\Psi_{ND}} > 0,$$
$$t_{jD}^{ND} > t_{jD}^{NN} = \frac{d^3(2-d^2)^2(5-d-2d^2)}{\Psi_N \Psi_{ND}} > 0.$$

$\xi_3 \equiv (50+38d-67d^2-73d^3+31d^4+37d^5-4d^6-4d^7)m+2d(21-3d-21d^2+d^3+4d^4)m^2+4d(3-d^2)m^3.$
$\xi_4 \equiv (50-58d-43d^2+91d^3+3d^4-41d^5+2d^6+4d^7)m-2d(21-3d-21d^2+d^3+4d^4)m^2 4-d(3-d^2)m^3.$
$\xi_5 \equiv (63-55d-104d^2+56d^3+51d^4-13d^5-6d^6)m+2(24-3d-25d^2+d^3+5d^4)m^2+4(3-d^2)m^3.$

Proof of Lemma 2

Note that when comparing the inefficient exporter's output, the critical value, κ^a is very slightly larger than the critical value, κ^b. For simplicity, we assume $\kappa^a \approx \kappa^b$. Moreover, the detailed constants $X_0(d) \sim X_{19}(d)$, $X = \nu, \rho$, and τ in Lemma 2 are available from the author on request.

(i) Straightforward computation yields that if $d > \kappa^a \approx \kappa^b$,

$$q_{iU}^{DD} - q_{iU}^{DN} = \frac{d^2(3-d^2)(1-d^2+m)[6-3d-3d^2+d^3+m(3-d^2)][\nu_0(d)+\nu_1(d)m+\nu_2(d)m^2+\nu_3(d)m^3]}{\Theta_{DN}\Theta_D} > 0,$$

$$q_{iU}^{ND} - q_{iU}^{NN} = \frac{d^2(1-d^2+m)(2-d-d^2+m)[14-80d+36d^2+88d^3-39d^4-32d^5+8d^6+4d^7+\zeta_1]}{\Theta_N\Theta_{ND}} > 0,$$

where $\zeta_1 \equiv (27-88d+20d^2+60d^3-13d^4-10d^5)m+(1-2d)m^3$,

and vice versa if $d < \kappa^a \approx \kappa^b$. Regardless of m and d, we obtain

$$q_{iU}^{NN} - q_{iU}^{DN} = \frac{d^2(2-d^2)(3-d-d^2)\zeta_2}{\Theta_{ND}\Theta_D} > 0,$$

$$q_{iU}^{ND} - q_{iU}^{DD} = \frac{d^2(2-d^2)[\nu_4(d)+\nu_5(d)m+\nu_8(d)m^2+\nu_8(d)m^3+\nu_{10}(d)m^4+\nu_{11}(d)m^5+\nu_{12}(d)m^6]}{\Theta_D\Theta_{ND}} > 0,$$

$$q_{iU}^{ND} - q_{iU}^{DN} = \frac{d^2[\nu_{13}(d)+\nu_{14}(d)m+\nu_{15}(d)m^2+\nu_{16}(d)m^3+\nu_{17}(d)m^4+\nu_{18}(d)m^5]}{\Theta_{ND}\Theta_{DN}} > 0,$$

$\zeta_2 \equiv [429-390d-477d^2+392d^3+213d^4-130d^5-46d^6+14d^7+4d^8+(5-2d^2)(30-12d-20d^2+4d^3+3d^4)m+(3-d^2)(5-2d^2)m^2]$.

(ii) On the other hand, we have

$$q_{jU}^{NN} - q_{jU}^{DD} = \frac{d^2[\rho_0(d)+\rho_1(d)m+\rho_2(d)m^2+\rho_3(d)m^3+\rho_4(d)m^4+\rho_5(d)m^5+\rho_6(d)m^6]}{\Theta_N\Theta_D} > 0,$$

$$q_{jU}^{DN} - q_{jU}^{ND} = \frac{d^2[\rho_7(d)+\rho_8(d)m+\rho_9(d)m^2+\rho_{10}(d)m^3+\rho_{11}(d)m^4+\rho_{12}(d)m^5+\rho_{13}(d)m^6]}{\Theta_{DN}\Theta_{ND}} > 0,$$

Moreover, noting that $\kappa^c < \kappa^a$, we obtain that if $d > \kappa^c$,

$$q_{jU}^{DD} - q_{jU}^{ND} = \frac{d^2(1-d^2+m)[\rho_{14}(d)+\rho_{15}(d)m+\rho_{16}(d)m^2+\rho_{17}(d)m^3+\rho_{18}(d)m^4+\rho_{19}(d)m^5]}{\Theta_D\Theta_{ND}} > 0,$$

$$q_{jU}^{DN} - q_{jU}^{NN} = \frac{-d^2(2-d^2)(3-d-d^2)[51-162d+51d^2+132d^3-49d^4-38d^5+8d^6+4d^7+\zeta_3]}{\Theta_N\Theta_{DN}} > 0,$$

and vice versa if $d < \kappa^c$ ($\zeta_3 \equiv (6-36d+8d^2+24d^3-3d^4-4d^5)m-(3-d^2)m^2$).

(i) and (ii) From the comparison of outputs, we know that if $d > \kappa^a \approx \kappa^b (d > \kappa^c)$,

$$\theta_{iU}^{DD} - \theta_{iU}^{DN} = -\frac{d^2(2-d^2)}{3-d^2}(q_{iU}^{DN} - q_{iU}^{DD}) < 0 \left(\theta_{jU}^{DD} - \theta_{jU}^{ND} = -\frac{d^2(1-d^2+m)}{2-d^2+m}(q_{jU}^{ND} - q_{jU}^{DD}) < 0\right),$$

and vice versa if $d < \kappa^a \approx \kappa^b (d < \kappa^c)$. Hence, we have Lemmas 1 (ii) and (ii).

(iii) Finally, comparing each uniform tariff level yields

$$t_U^{DD} - t_U^{ND} = \frac{d^2(2-d^2)\zeta_4[\tau_0(d)+\tau_1(d)m+\tau_2(d)m^2+\tau_3(d)m^3+\tau_4(d)m^4-\tau_5(d)m^5]}{\Theta_D\Theta_{ND}} > 0,$$

$$t_U^{ND} - t_U^{DN} = \frac{d^2(m-1)[\tau_6(d)+\tau_7(d)m+\tau_8(d)m^2+\tau_9(d)m^3+\tau_{10}(d)m^4+\tau_{11}(d)m^5]}{\Theta_{ND}\Theta_{DN}} > 0,$$

$$t_U^{DN} - t_U^{NN} = \frac{d^2(2-d^2)(3-d-d^2)[153-57d-288d^2+81d^3+194d^4-33d^5-57d^6+\zeta_5]}{\Theta_{DN}\Theta_N} > 0,$$

$\zeta_4 \equiv [6 - 2d - 4d^2 + d^3 + m(3 - d)]$,
$\zeta_5 \equiv 4d^7 + 6d^8 + (18 + 42d - 42d^2 - 52d^3 + 27d^4 + 19d^5 - 5d^6 - 2d^7)m - (3 - 2d)(3 - d^2)(1 - d - d^2)m^2$.

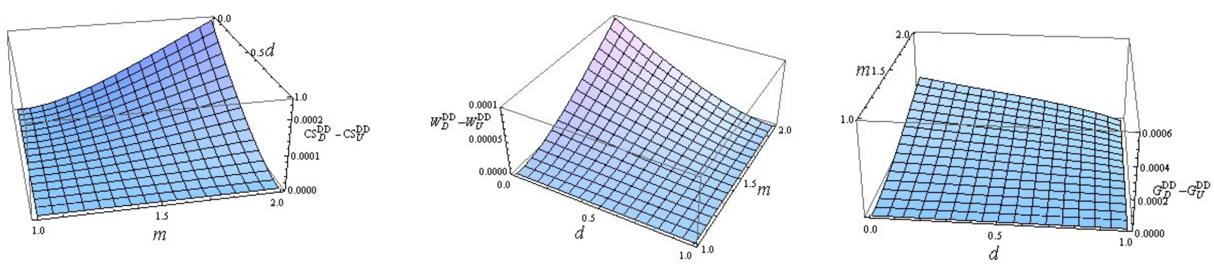
Appendix C: Proof of Propositions 3 and 4

When considering critical values between discriminatory and uniform tariff, note that since the critical parameters are messy, we use 'The Mathematica 4.2'(Wolfram, 1999) for the figures of this paper. Moreover, the detailed constants $Y_0(d) \sim Y_{10}(d)$, $Y = A \sim N$ in Proof of Propositions 3 and 4 are available from the author on request.

Proof of Proposition 3
(i) Straightforward computations yield

$$q_{iD}^{DD} + q_{jD}^{DD} - (q_{iU}^{DD} + q_{jU}^{DD}) = \frac{\eta_0}{\Psi_D \Theta_D} > 0, W_D^{DD} - W_U^{DD} = \frac{\eta_0}{2\Psi_D \Theta_D} > 0,$$
$$CS_D^{DD} - CS_U^{DD} = \frac{\eta_0^2[A_0(d) + A_1(d)m + A_2(d)m^2 + A_3(d)m^3 + A_4(d)m^4 + A_5(d)m^5 + A_6(d)m^6]}{2\Psi_D^2 \Theta_D^2} > 0,$$
$$G_D^{DD} - G_U^{DD} = \frac{\eta_0[B_0(d) + B_1(d)m + B_2(d)m^2 + B_3(d)m^3 + B_4(d)m^4 + B_5(d)m^5 + B_6(d)m^6 + B_7(d)m^7]}{2\Psi_D^2 \Theta_D^2} > 0,$$

For the complement of comparisons of each surplus, since there are very complicated equations, we also provide the figures.



(g) CS_U^{DD} vs. CS_D^{DD} (h) W_U^{DD} vs. W_D^{DD} (i) G_U^{DD} vs. G_D^{DD}

Figure A-1: Comparison of Symmetric Delegations

For the comparisons of tariffs, we obtain

$$t_{iD}^{DD} - t_U^{DD} = \frac{\eta_1[360 - 234d - 630d^2 + 384d^3 + 363d^4 - 204d^5 - 71d^6 + 37d^7 + d^8 - d^9 + \eta_2]}{\Psi_D \Theta_D} > 0,$$
$$t_U^{DD} - t_{jD}^{DD} = \frac{\eta_1[324 - 156d - 624d^2 + 282d^3 + 400d^4 - 170d^5 - 87d^6 + 36d^7 + d^8 - d^9 + \eta_3]}{\Psi_D \Theta_D} > 0,$$

$\eta_0 \equiv (1 - d)^2(3 - d^2)(2 - d^2 + m)(1 - m)^2[6 - 6d^2 + d^4 + m(3 - d^2)]$,
$\eta_1 \equiv (1 - d)(3 - d^2)(2 - d^2 + m)(1 - m)[6 - 6d^2 + d^4 + m(3 - d^2)]$,
$\eta_2 \equiv (540 - 261d - 741d^2 + 306d^3 + 321d^4 - 109d^5 - 43d^6 + 12d^7)m$
$+(3 - d^2)(90 - 24d - 61d^2 + 8d^3 + 7d^4)m^2 + 5(3 - d^2)^2m^3$,
$\eta_3 \equiv (540 - 252d - 768d^2 + 335d^3 + 322d^4 - 131d^5 - 34d^6 + 13d^7)m$
$+(297 - 135d - 264d^2 + 113d^3 + 49d^4 - 20d^5)m^2] + 2(9 - 4d)(3 - d^2)m^3$.

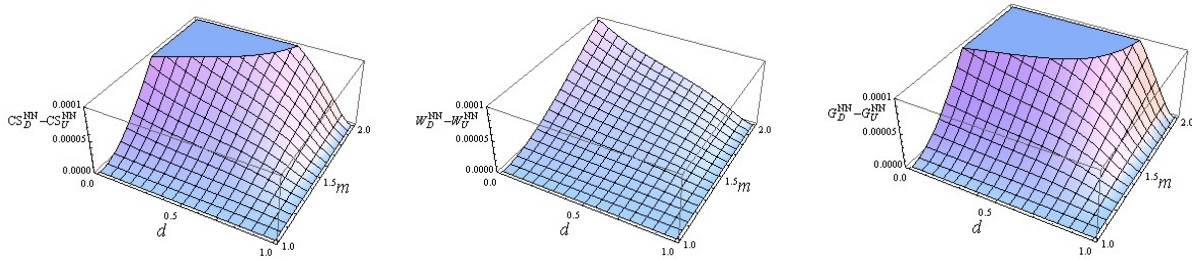
Comparing the exporters' profits yields that

$$\Pi_{jD}^{DD} - \Pi_{jU}^{DD} = (q_{jD}^{DD} + q_{jU}^{DD})(q_{jD}^{DD} - q_{jU}^{DD})$$
$$= \frac{\eta_1[54 - 6d - 72d^2 + 7d^3 + 25d^4 - 2d^5 - d^6 + (63 - 9d - 54d^2 + 7d^3 + 9d^4 - d^5)m + (6 - d)(3 - d^2)m^2]}{\Psi_D \Theta_D} > 0,$$
$$\Pi_{iD}^{DD} - \Pi_{iU}^{DD} = (q_{iD}^{DD} + q_{iU}^{DD})(q_{iD}^{DD} - q_{iU}^{DD})$$
$$= \frac{-\eta_1[60 - 12d - 78d^2 + 13d^3 + 26d^4 - 3d^5 - d^6 + (60 - 6d - 49d^2 + 2d^3 + 8d^4)m + 5(3 - d^2)m^2]}{\Psi_D \Theta_D} < 0.$$

(ii) Comparing NN_D with NN_U yields

$$q_{iD}^{NN} + q_{jD}^{NN} - (q_{iU}^{NN} + q_{jU}^{NN}) = \frac{(1-d)^2(1-m)^2}{\Psi_N \Theta_N} > 0, W_D^{NN} - W_U^{BB} = \frac{(1-d)^2(1-m)^2}{2\Psi_N \Theta_N} > 0,$$
$$CS_D^{NN} - CS_U^{NN} = \frac{(1-d)^2(1-m)^2[C_0(d) + C_1(d)m + C_2(d)m^2 + C_3(d)m^3]}{2\Psi_N^2 \Theta_N^2} > 0,$$
$$G_D^{NN} - G_U^{NN} = \frac{(1-d)^2(1-m)^2[D_0(d) + D_1(d)m + D_2(d)m^2 + D_3(d)m^3}{2\Psi_N^2 \Theta_N^2} > 0,$$

For the complement of comparisons of each surplus, since there are very complicated equations, we also provide the figures.



(j) CS_U^{NN} vs. CS_D^{NN} (k) W_U^{NN} vs. W_D^{NN} (l) G_U^{NN} vs. G_D^{NN}

Figure A-2: Comparison of Symmetric Delegations

Using $t_{iD}^{NN} > t_{jD}^{NN}$, straightforward computation yields that

$$t_{iD}^{NN} - t_U^{NN} = \frac{\eta_4}{\Psi_N \Theta_N} > 0,$$
$$t_U^{NN} - t_{jD}^{NN} = \frac{(1-d)(1-m)[27 - 13d - 37d^2 + 14d^3 + 15d^4 - 3d^5 - 2d^6 + (18 - 8d - 12d^2 + 3d^3 + 2d^4)m]}{\Psi_N \Theta_N} > 0,$$

$\eta_4 \equiv [-120 + 198d + 432d^2 - 475d^3 - 672d^4 + 408d^5 + 558d^6 - 140d^7 - 244d^8 + 8d^9 + 47d^{10} + 4d^{11} - 2d^{12} - (60 - 69d - 218d^2 - 41d^3 + 412d^4 + 207d^5 - 348d^6 - 156d^7 + 116d^8 + 46d^9 - 11d^{10} - 4d^{11})m + (90 - 153d - 63d^2 + 364d^3 - 117d^4 - 274d^5 + 97d^6 + 88d^7 - 16d^8 - 10d^9)m^2 + (75 - 99d - 42d^2 + 131d^3 - 17d^4 - 57d^5 + 7d^6 + 8d^7)m^3 + (3 - d^2)(5 - 5d + 2d^3)m^4]$.

Comparing each exporter's profit yields that

$$\Pi_{jD}^{NN} - \Pi_{jU}^{NN} = (q_{jD}^{NN} + q_{jU}^{NN})(q_{jU}^{NN} - q_{jD}^{NN}) = \frac{(1-d)(m-1)[9 - d - 10d^2 + d^3 + 2d^4 + (6 - d - 2d^2)m]}{\Psi_N \Theta_N} > 0,$$
$$\Pi_{iD}^{NN} - \Pi_{iU}^{NN} = (q_{iD}^{NN} + q_{iU}^{NN})(q_{iD}^{NN} - q_{iU}^{NN}) = \frac{-(1-d)(m-1)[10 - 2d - 10d^2 + d^3 + 2d^4 + (5 - 2d^2)m]}{\Psi_N \Theta_N} < 0.$$

Proof of Proposition 4

(i) Comparing the total output, consumer surplus and welfare yields that

$$q_{iD}^{NN} + q_{jD}^{NN} - (q_{iU}^{DD} + q_{jU}^{DD}) = \frac{[E_0(d) - E_1(d)m - E_2(d)m^2 + E_3(d)m^3 + E_4(d)m^4 + E_5(d)m^5]}{\Psi_N \Theta_D} > 0,$$

$$W_D^{NN} - W_U^{DD} = \frac{[E_0(d) - E_1(d)m - E_2(d)m^2 + E_3(d)m^3 + E_4(d)m^4 + E_5(d)m^5]}{2\Psi_N \Theta_D} > 0,$$

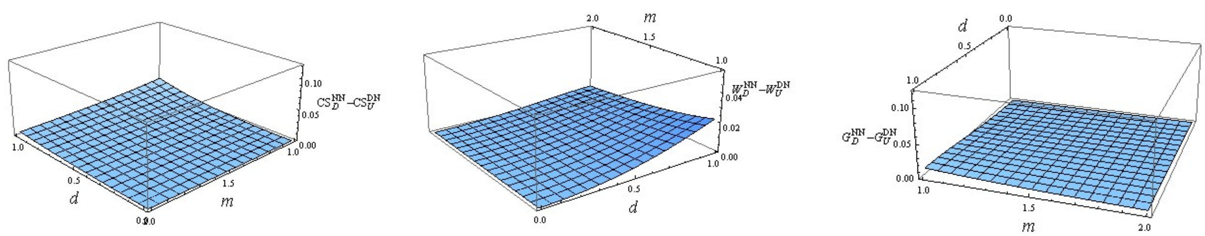
$$CS_D^{NN} - CS_U^{DD} = \frac{[F_0(d) - F_1(d)m - F_2(d)m^2 - F_3(d)m^3 - F_4(d)m^4 + F_5(d)m^5]}{2\Psi_N^2 \Theta_D^2} > 0,$$

$$+ \frac{[F_6(d)m^6 + F_7(d)m^7 + F_8(d)m^8 + F_9(d)m^9 + F_{10}(d)m^{10}]}{2\Psi_N^2 \Theta_D^2} > 0,$$

$$G_D^{NN} - G_U^{DD} = \frac{[G_0(d) + G_1(d)m - G_2(d)m^2 - G_3(d)m^3 - G_4(d)m^4]}{2\Psi_N^2 \Theta_D^2}$$

$$+ \frac{[G_5(d)m^5 + G_6(d)m^6 + G_7(d)m^7 + G_8(d)m^8 + G_9(d)m^9 + G_{10}(d)m^{10}]}{2\Psi_N^2 \Theta_D^2} > 0.$$

For the complement of comparisons, we also provide the figures.



(m) CS_D^{NN} vs. CS_U^{DN} (n) W_D^{NN} vs. W_U^{DN} (o) G_D^{NN} vs. G_U^{DN}

Figure A-3: Comparison of Asymmetric and Symmetric Delegations

For the comparisons of tariffs, given $t_{iD}^{NN} > t_{jD}^{NN}$, we obtain that if $d > t^U$,

$$t_{iD}^{NN} - t_U^{DD} = \frac{H_0(d) + H_1(d)m - H_2(d)m^2 - H_3(d)m^3 - H_4(d)m^4 - H_5(d)m^5}{\Psi_N \Theta_D} < 0,$$

and vice versa if $d < t^U$ (see Figure 5 (e) in the main text). However,

$$t_U^{DD} - t_{jD}^{NN} = \frac{-I_0(d) - I_1(d)m + I_2(d)m^2 + I_3(d)m^3 + I_4(d)m^4 + I_5(d)m^5}{\Psi_N \Theta_D} > 0.$$

Since $t^U < d_U^b$, it always holds $t_U^{DU} > t_{iD}^{NN} > t_{jU}^{NN}$.

Comparing the exporters' profits yields that if $d > d^i (d > d^j)$, we obtain

$$\Pi_{iD}^{NN} - \Pi_{iU}^{DD} = \frac{J_0(d) + J_1(d)m + J_2(d)m^2 - J_3(d)m^3 - J_4(d)m^4 - J_5(d)m^5 - J_6(d)m^6}{2\Psi_N^2 \Theta_D^2},$$

$$- \frac{[J_6(d)m^6 + J_7(d)m^7 + J_8(d)m^8 + J_9(d)m^9]}{2\Psi_N^2 \Theta_D^2} > 0,$$

$$\Pi_{jD}^{NN} - \Pi_{jU}^{DD} = \frac{-[K_0(d) + K_1(d)m + K_2(d)m^2 - K_3(d)m^3 - K_4(d)m^4 - K_5(d)m^5]}{2\Psi_N^2 \Theta_D^2}$$

$$- \frac{[K_6(d)m^6 + K_7(d)m^7 + K_8(d)m^8 + K_9(d)m^9 + K_{10}(d)m^{10}]}{2\Psi_N^2 \Theta_D^2} < 0,$$

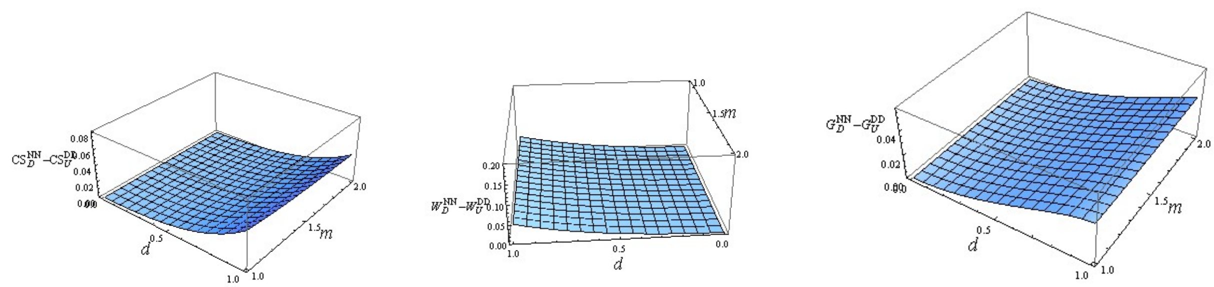
and vice versa if $d < d^i (d < d^j)$ (see Figure 5 (e) in the main text). Since $d^i, d^j < d_U^*$, it always holds $\Pi_{iU}^{DD} > \pi_{iD}^{NN}$ and $\Pi_{jU}^{DD} > \pi_{jD}^{NN}$.

(ii) Next, when comparing DN_U and NN_D, we obtain

$$
\begin{aligned}
&q_{iD}^{NN} + q_{jD}^{NN} - (q_{iU}^{DN} + q_{jU}^{DN}) = \frac{\delta_1}{\Psi_N \Theta_{DN}}, W_D^{NN} - W_U^{DN} = \frac{\delta_1}{2\Psi_N \Theta_{DN}} > 0, \\
&CS_D^{NN} - CS_U^{DN} = \frac{L_0(d) - L_1(d)m - L_2(d)m^2 + L_3(d)m^3 + L_4(d)m^4 + L_5(d)m^5}{2\Psi_N^2 \Theta_{DN}^2} > 0, \\
&G_D^{NN} - G_U^{DN} = \frac{M_0(d) - M_1(d)m - M_2(d)m^2 + M_3(d)m^3 + M_4(d)m^4 + M_5(d)m^5}{2\Psi_N^2 \Theta_{DN}^2} > 0,
\end{aligned}
$$

$\delta_1 \equiv 9 - 18d + 927d^2 - 852d^3 - 1455d^4 + 1302d^5 + 917d^6 - 728d^7 - 301d^8 + 178d^9 + 53d^{10} - 16d^{11} - 4d^{12} - 2(3-d^2)(3 - 6d - 24d^2 + 14d^3 + 30d^4 - 10d^5 - 13d^6 + 2d^7 + 2d^8)m + (1-d)^2(3-d^2)^2 m^2$.

For the complement of comparisons, we also provide the figures.



(p) CS_D^{NN} vs. CS_U^{DD} (q) W_D^{NN} vs. W_U^{DD} (r) G_D^{NN} vs. G_U^{DD}

Figure A-4: Comparison of Asymmetric Delegations

Comparing each exporter's profit yields that if $d > d_a^j (d > d_a^i)$, we obtain

$$
\begin{aligned}
&\Pi_{jD}^{NN} - \Pi_{jU}^{DN} = (q_{jD}^{NN} + q_{jU}^{DN})(q_{jD}^{NN} - q_{jU}^{DN}) \\
&= \frac{81 - 90d - 189d^2 + 405d^3 + 33d^4 - 453d^5 + 84d^6 + 217d^7 - 44d^8 - 48d^9 + 6d^{10} + 4d^{11} - \delta_2}{\Psi_N \Theta_{DN}} < 0, \\
&\left(\Pi_{iD}^{NN} - \Pi_{iU}^{DN} = \frac{N_0(d) + N_1(d)m - N_2(d)m^2 - N_3(d)m^3 - N_4(d)m^4 + N_5(d)m^5}{\Psi_N^2 \Theta_{DN}^2} < 0 \right),
\end{aligned}
$$

and vice versa if $d < d_a^j (d < d_a^i)$ (see Figure 5 (f) in the main text).

On the other hand, given $t_{iD}^{NN} > t_{jD}^{NN}$, we obtain that if $d > t^a$(see Figure 5 (f) in the main text),

$$
t_{iD}^{NN} - t_{iU}^{DN} = \frac{[180 - 297d + 126d^2 + 393d^3 - 702d^4 - 135d^5 + 688d^6 - 11d^7 - 308d^8 + 11d^9 + \delta_3]}{\Psi_N \Theta_{DN}} < 0,
$$

and vice versa if $d < t^a$. Since $t^a < d_U^b$, it always holds $t_U^{DN} > t_{iD}^{NN} > t_{jU}^{NN}$.
$\delta_2 \equiv (3-d^2)(9 - 9d - 15d^2 + 6d^3 + 5d^4 + 5d^5 - d^6 - 2d^7)m - (1-d)(2+d)(3-2d)(3-d^2)^2 m^2$.
$\delta_3 \equiv 68d^{10} - d^{11} - 6d^{12} + d(45 - 6d - 60d^2 + 36d^3 - 31d^4 - 17d^5 + 54d^6 - d^7 - 19d^8 + d^9 + 2d^{10})m - (1-d)(3-d^2)(45 - 24d - 43d^2 + 17d^3 + 10d^4 - 3d^5)m^2 - (1-d)(3-d^2)^2(5-2d^2)m^3$.

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