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Optimal Tariffs on a Monopoly Platform in Two-sided Markets*

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Abstract

This study investigates how countries set import tariffs on a monopoly platform's product in a two-sided market. Consumers and service providers interact through the platform's product, wherein service providers' entries spur product demand and larger demand invokes more entries. Optimal import policies for importing countries are subsidies when network externalities and the number of importing countries are large, while they are tariffs when they are small. There is a case where optimal non-cooperative policies are import tariffs, but optimal cooperative policies are import subsidies. These results suggest that promoting digital trade and cooperative actions in tariff settings is important to advance trade liberalization for the platform's products.

Keywords: Two-sided markets; Tariffs; Platform monopoly
JEL classification: F12, F13, L11, L12

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1 Introduction

As the world becomes increasingly digitalized, many firms now provide platforms to connect consumers and supplies through online markets. The behaviors on the consumers's side affect suppliers' outcomes and suppliers' behaviors affect consumers' outcomes via platforms; thus, such markets are characterized by two-sided network externalities, and referred to as two-sided markets. Consumers usually need to purchase a platform product to acquire online products or services. Platforms themselves can be provided online, but are sometimes physically provided. The latter platform products include video game consoles and smartphones, for which games and application software are provided in online markets.

Led by the seminal works of Caillaud and Jullien (2003), Rochet and Tirole (2003), and Armstrong (2006), many studies analyze two-sided markets. Some consider the impact of government policies. For example, Kind et al. (2008) demonstrate that a government's taxes on goods on both sides of two-sided markets can prevent a monopoly platform's overproductions of goods. Rasch and Wenzel (2013) find that protecting software from piracy benefits software developers, but its effect on user prices is ambiguous. Bourreau et al. (2018) analyze the welfare effects of taxing data collection when a digital monopoly platform collects consumers' personal data.

Although platform products and services are provided globally, few studies investigate these two-sided markets in the context of international trade. One exception is Kao and Mukunoki (2021), which explores the effect of parallel imports. The authors find that permitting parallel imports improves consumer surplus and social welfare in all countries when the network externalities for both sides are large; however, when one of the externalities is low, it harms consumers and diminishes welfare. This study is related to the literature incorporating network externalities into trade models. For instance, Klimenko and Saggi (2007) determine that if the network externality is strong, a foreign firm prefers to acquire the rival domestic firm as a mode of foreign direct investment and become a monopolist, rather than establishing a new firm. However, the foreign government prefers the establishment of a new firm to maintain the competition between the two firms.

This study analyzes the effects of an import tariff imposed on a monopoly platform in two-sided market. Platform products are sometimes subjected to import tariffs, as some countries, particularly developing countries, impose import tariffs on video game consoles and machines (HS Code 950450). For instance, India, Thailand, and the Russian Federation impose 20%, 5%, and 8.33% import tariffs on video game consoles, respectively. In 2019, the United States proposed, though did not subsequently enact, an 25% import tariffs on video game consoles, most of which are produced in and imported from China. Countries also tend to impose import tariffs on smartphones and other cellular network telephones. Because these platforms' products connect users and suppliers of online games/software/applications via internet connection, the effects of tariffs on those products can differ from those on a non-platform's goods. Even if the platform products are provided online, a digital service tax may be imposed on foreign platform providers' revenue.[1] Therefore, considering tariffs on a monopoly platform can reveal the effects of existing tariffs on platform products as well as the potential effects of digital service taxes.

Examining the effects of tariffs under a monopoly dates back to the influential study of Brander and Spencer (1984), demonstrating that an importer's optimal tariff on a foreign monopolist is positive unless the demand curve is sufficiently convex. For instance, if the demand curve is linear, the importing country imposes the positive tariff to maximize its welfare. By imposing an import tariff, the importing country can extract a portion of the monopoly profits as a tariff revenue, which exceeds the consumer loss caused by the tariff-induced price increase as long as the demand curve is not so convex.[2] In other words, the tariff is not fully passed through to the consumer price and the increase in the consumer price is lower than the tariff rate as long as the demand curve is not too convex.[3] This study revisits the importing country's optimal tariff on a monopolist whose product serves as a platform connecting consumers and service providers.

The results of previous studies suggest that whether the optimal import tariff is posi-

[1]Several countries including India, Israel, Italy, Turkey, and the United Kingdom have already implemented a digital service tax.

[2]More specifically, as long as the elasticity of the slope of the demand function with respect to price is not so high such that the slope of the marginal revenue curve is steeper than the slope of the demand curve evaluated as the same price, the optimal tariff is positive.

[3]Kowalzcyk and Skeath (1994) extend Brander and Spencer (1984) comparing a specfic import tariff and an ad valorem import tariff.

tive or negative depends on the extent of the network externalities on both consumer and service provider sides. If these externalities are large enough, the optimal tariff level is zero or even negative, resulting in an import subsidy.[4] In this case, eliminating a positive import tariff always improves the welfare of all countries. Since the model employs demand that is linear in nature, this result contrasts with Brander and Spencer's (1984) results, as the price elasticity of tariffs in two-sided markets becomes larger than that of a conventional, linear-demand model of foreign monopoly. This is because a tariff increases consumer price and has an effect on reducing the service provider's entry. A decreased number of online services decreases consumers' utility and willingness to pay for a platform product, making the demand more sensitive to tariff changes. Since protecting online services from piracy and securing cross-border data flows will increase network externalities on the service provider side, the result indicates that promoting digital trade boosts trade liberalization on physically traded platform products.

We also extend the model to multiple importing countries to consider strategic interactions in tariff settings. As the number of importing countries increases, each country's tariff in the Nash equilibrium is more likely to be negative. This is because the network effects are stronger as the platform monopolist serves more markets. Because of the negative effects of an import tariff to other countries' imports, importing countries' tariffs become strategic substitutes if the network externalities and the number of importing countries are small and each country prefers to set a positive import tariff. If the network externalities are large enough, countries set an import subsidy and import policies become strategic complements. When the countries benefit more from the network externalities, there is an incentive to promote imports and the import promotions of other countries increase the gains from its own import promotion.

Since importing countries can internalize the negative externalities of a tariff increase, cooperative tariffs that maximize the joint welfare of the importing countries are more likely to become import subsidies. There is a case in which non-cooperative tariffs are positive while the cooperative tariffs are negative. suggesting the need to seek international

[4]This study also supplements the recent literature indicating that optimal import tariffs can be zero. For instance, Naito (2021) considers the growth effect of trade liberalization, determining that it can be optimal for large countries to set zero import tariffs.

cooperation in setting tariffs on platforms' products.

The rest of the paper is organized as follows. Section 2 presents the model with a single importing country and determines the equilibrium and optimal tariff for the importing country. Section 3 extends the model to consider multiple importing countries and explore the effects of the number of importing countries and the difference between non-cooperative and cooperative tariffs. Section 4 concludes the paper.

2 Model

We consider a two-country model in a two-sided market. There are two countries, country H and country F, where a platform product (such as a game console) is purchased and consumed. A platform monopolist located in country F, firm F, produces and sells the platform product in both countries.

Each consumer decides whether to purchase one unit of the platform product. Let p_i be the price of the platform product in country i $(= H, F)$. The net utility of consumer k in country i is given by

$$u_{ik} = b_{ik} + \alpha m - p_i, \tag{1}$$

where b_{ik} is the consumer's fundamental utility from using the platform product. We assume that b_{ik} is uniformly distributed over the interval $[0, v]$ with unit density and is common in both countries. Online service providers that are independent of the platform producer located outside the two countries provide services (such as online software/games) to both countries. There are M potential service providers and each service provider provides a single service to consumers through the platform. Let m $(\leq M)$ denote the number of services provided to consumers. Although consumers' purchases of the platform product eventually affect m, the amount of consumers is large enough and each consumer maximizes utility such that m is constant. Note that m is common in both countries because consumers in both countries have access to these services. The parameter α captures the magnitude of externalities on the consumers' side. As α becomes higher, consumers gain a higher utility from an increase in the variety of online services. The demand for the platform product in country i is given by:

$$p_i = v + \alpha m - q_i \tag{2}$$

where q_i is the sales of the platform product in country i.

The service providers must pay a fixed fee, R, to the platform monopolist (firm H) to provide services. If $R < 0$, the platform monopolist subsidizes the development of online services rather than charging a development fee. Service providers have different efficiency in developing services. Specifically, each potential service provider chooses whether to provide a new service on this platform by incurring the development cost of entry, f. This fixed cost is uniformly distributed over the interval $f \in [0, \overline{f}]$. Each service provider's profit is given by

$$\pi_S = \phi \sum_{i=H,F} q_i - f - R. \tag{3}$$

In this profit function, parameter ϕ captures the per-unit profit from providing a service. As ϕ becomes higher, an increase in the number of the consumers using this platform raises the service provider's profits. Thus, ϕ reflects the magnitude of the network externalities on the service provider's side, also reflecting the unit cost of providing services. Government policies, such as regulations on cross-border transactions of data and digital taxation, will decrease ϕ because they increase the cost of providing online services.

The profit of the platform monopolist is given by

$$\Pi = \sum_{i=H,F} (p_i - c)q_i - tq_F + mR, \tag{4}$$

where c is the marginal cost of producing the platform product and t is the import tariff on the platform product imposed by country H.

The timing of this process is as follows. In stage 1, the government in country H sets the import tariff to maximize its own welfare. In stage 2, given the import tariff, the platform monopolist produces and sells its product to consumers in all countries. The monopolist also sets the fixed fee charged to online service providers. In stage 3, online service providers enter the services market by incurring the fixed cost and paying the fixed fee set by the platform monopolist. Only consumers who purchased the platform product in the previous stage can use online services.

2.1 Entry of service providers

In stage 3, given the sales of the platform product determined in stage 2, service providers decide whether to enter the market, entering the market as long as $\pi_S \geq 0$ holds. Let $\widehat{f}$ be the level of the development cost such that $\pi_S = 0$ holds. Since f is uniformly distributed over $[0, \overline{f}]$, $\widehat{f}/\overline{f}$ represents the fraction of service providers that enter the market, as long as $\overline{f}$ is large enough to satisfy $\widehat{f} < \overline{f}$. By (3), the equilibrium number of service providers becomes

$$m(q_H, q_F, R) = \left(\frac{\widehat{f}}{\overline{f}}\right) M = \frac{M}{\overline{f}} \left(\phi \sum_{i=H,F} q_i - R\right). \tag{5}$$

By substituting $m(q_H, q_F, R)$ into (2), the demand function is rewritten as

$$p_i(q_H, q_F, R) = v + \frac{\alpha M}{\overline{f}} (\phi q_j - R) - \left(1 - \frac{\alpha \phi M}{\overline{f}}\right) q_i \tag{6}$$

where $j = H, F$, and $j \neq i$. The shape of this demand function depends on $\alpha\phi$, which represents the reinforcing effect of network externalities on the demand for the platform product. As the network externalities on the consumer and provider side become larger, the intercept of the demand curve becomes larger and its slope becomes flatter. To ensure the negative slope of the demand curve, we assume $\overline{f} > \alpha\phi M$ holds. The demand function also depends on the fixed fee, R. A larger R discourages the online service providers' entry, decreasing the intercept of the demand curve through the network effect.

Note that the platform product markets in countries H and F are not segmented but interacted in the sense that the demand of the platform product in one market depends on the sales of the product in the other market. Specifically, an increase in the sales of the platform product in one country promotes more entries of online service providers in the next stage, increasing the demand for the platform product in the other country.

2.2 Platform monopolist's decisions

In stage 2, the platform monopolist (firm F) anticipates that its sales of the platform product affect the entries of online service providers in the next stages. Given the modified demand function of (6) that incorporates the endogenous changes in m, firm F determines q_H, q_F, and R such that they maximize (4). By the first-order conditions of profit maximization, the optimal outputs become

$$
\begin{aligned}
q_H(q_F, R) &= \frac{(v-c)\,\overline{f} + M\{2\alpha\phi q_F + (\phi-\alpha)\,R\}}{2(\overline{f} - \alpha\phi M)}, && (7)\\
q_F(q_H, R) &= \frac{(v-c-t)\,\overline{f} + M\{2\alpha\phi q_H + (\phi-\alpha)\,R\}}{2(\overline{f} - \alpha\phi M)}. && (8)
\end{aligned}
$$

These outputs depend on the other market's outputs. Specifically, a larger output in one market increases the optimal output in the other market because a larger output in one market enhances the entry of online service providers, increasing the demand for the platform product in the other market. The effect of an increase in R depends on the relative magnitude of the network externalities. If the network externality on the service producer's side is larger than the consumer's side ($\phi > \alpha$), an increase in R increases the optimal outputs; however, if $\phi < \alpha$, an increase in R decreases the optimal outputs. A higher output increases the service provider's equilibrium entry, m, increasing the profits earned from charging the online service providers. The profit-increase from a larger m rises as R becomes higher. In contrast, an increase in R decreases the demand for the platform product as indicated by (6), reducing the monopoly platform's gains from increasing q_H.

The optimal fixed fee is given by

$$
R(q_H, q_F) = \frac{(\phi-\alpha)}{2}\,(q_H + q_F)\,. \tag{9}
$$

If $\phi > \alpha$, charging a fee to online service providers benefits the monopoly platform more; however, if $\phi < \alpha$, subsidizing online service providers benefits the monopoly platform more.

By combining (7), (8), and (9), the equilibrium sales of the platform product are

$$\widetilde{q}_H = \frac{4(v-c)\overline{f} - M(\alpha+\phi)^2 t}{4\Gamma}, \tag{10}$$

$$\widetilde{q}_F = \frac{4(v-c)\overline{f} - \{4\overline{f} - M(\alpha+\phi)^2\}t}{4\Gamma}, \tag{11}$$

where $\Gamma = 2\overline{f} - M(\alpha+\phi)^2$. Note that $\widetilde{q}_H > \widetilde{q}_F$ holds. To ensure the platform product's positive sales, $\Gamma > 0$ and $t < \bar{t} \equiv 4(v-c)\overline{f}/\{4\overline{f} - (\alpha+\phi)^2 M\} = 4(v-c)\overline{f}/(2\overline{f}+\Gamma)$ must hold. Country H's import tariff decreases sales in both countries, $\partial\widetilde{q}_H/\partial t < 0$ and $\partial\widetilde{q}_F/\partial t < 0$. The equilibrium fixed fee on online service providers is given by

$$\widetilde{R} = \frac{(\phi-\alpha)\{2(v-c)-t\}\overline{f}}{2\Gamma}. \tag{12}$$

As explained above, whether to charge a fixed fee or provide a fixed subsidy for online service providers depends on the relative magnitude of ϕ and α.

An increase in tariff directly reduces q_H, and this decrease discourages online-service provider's entry in the next stage, reducing consumer demand for the platform product through the network effect. This indirect effect reduces both $\widetilde{q}_H$ and $\widetilde{q}_F$. The total sales of the platform product is given by

$$\widetilde{q}_H + \widetilde{q}_F = \frac{\{2(v-c)-t\}\overline{f}}{\Gamma}. \tag{13}$$

The equilibrium number of service provides becomes

$$\widetilde{m} = \frac{M(\alpha+\phi)\{2(v-c)-t\}}{2\Gamma}. \tag{14}$$

A positive tariff on the platform product reduces the number of service providers, and its magnitude rises as the extent of network externalities, α and ϕ, is larger. By substituting (10), (11), and (12) into (4), the equilibrium profit of the platform monopolist is given by:

$$\widetilde{\Pi} = \frac{8(v-c)(v-c-t)\overline{f} + \{4\overline{f} - M(\alpha+\phi)^2\}t^2}{8\Gamma}. \tag{15}$$

Since $\partial\widetilde{\Pi}/\partial t = -[4(v-c)f - \{4\overline{f} - M(\alpha+\phi)^2\}t]/(4\Gamma) < 0$ by applying $t < \bar{t}$, a tariff increase hurts the monopoly platform.

2.3 Optimal tariff on the monopoly platform

In stage 1, the government in country H sets a tariff to maximize its own welfare. The social welfare of country H is given by

$$W_H = \frac{\overline{f} - \alpha\phi M}{2\overline{f}} \left(\widetilde{q}_H\right)^2 + t\widetilde{q}_H, \tag{16}$$

where the first term is the consumer surplus and the second term is the tariff revenue. The optimal import tariff on the platform product that maximizes W_F is given by solving $dW_F/dt = 0$:

$$\widetilde{t} = \frac{4(v-c)\overline{f}[4\overline{f}^2 - \{3\left(\alpha^2+\phi^2\right) + 2\alpha\phi\}M\overline{f} - \alpha\phi\left(\alpha+\phi\right)^2 M^2]}{(2\overline{f}+\Gamma)\Omega}, \tag{17}$$

where $\Omega = 12\overline{f}^2 - \{7\left(\alpha^2+\phi^2\right) + 10\alpha\phi\}M\overline{f} - \alpha\phi\left(\alpha+\phi\right)^2 M^2$. To satisfy the second-order condition of welfare maximization, $\Omega > 0$ must hold. Whether $\widetilde{t}$ is positive or negative depends on the sign of the second parentheses of the denominator. $\widetilde{t}$ is more likely to be negative as the extent of the two network externalities, α and ϕ, rises. We can prove that $\widetilde{t}$ is indeed negative when α and ϕ are sufficiently large. In particular, the interaction terms of the two externalities in the parentheses , $\alpha\phi$, imply that the two externalities are mutually reinforced. Even if one externality is large, the optimal tariff remains positive if the other externality is small. We present the following proposition.

Proposition 1. *The importing country's optimal trade policy on the platform product is an import tariff if the network externalities are small, whereas it is an import subsidy if externalities are large.*

If the optimal tariff is negative, the elimination of the positive import tariff always improves the welfare of the importing country. The two key parameters, α and ϕ, are also affected by governments' policies. As Rasch and Wenzel (2013) suggested, if countries strengthen the protection of online services from piracy behavior, ϕ will increase. In contrast, restrictions on cross-border data flows, such as local storage requirements or digital

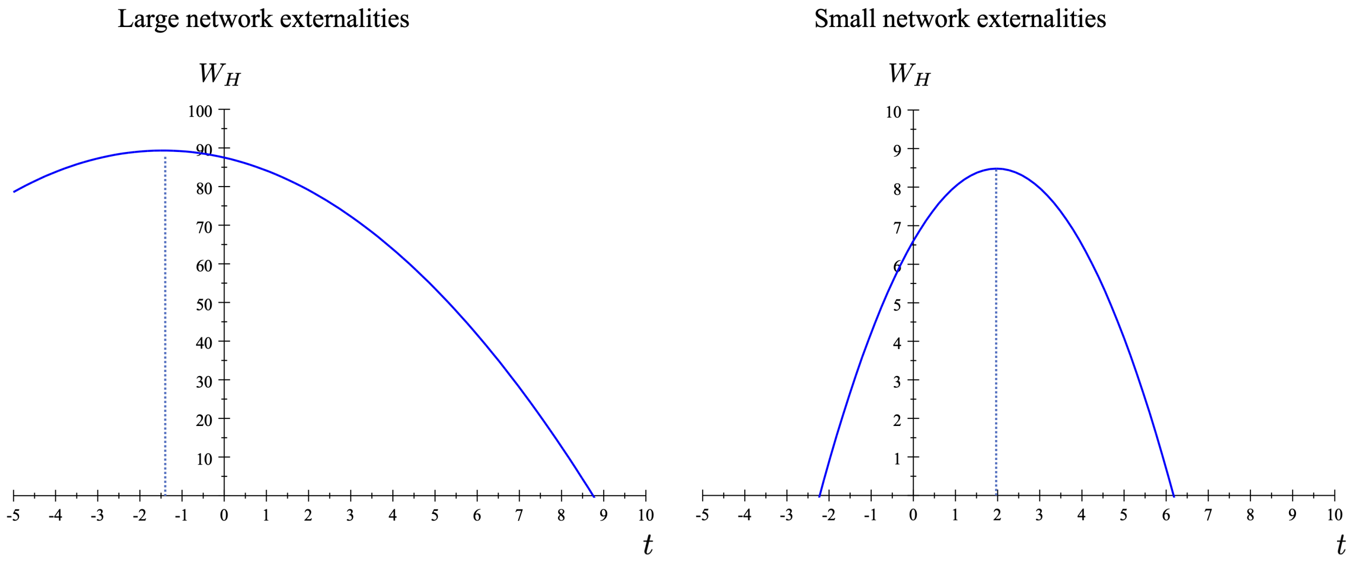

Figure 1: Optimal Tariffs

service taxes, will decrease ϕ. Concerning α, enhancing the quality of online services will increase it. This result implies that protecting the service providers' property rights and facilitating cross-border data flows are important for not only amplifying network externalities in two-sided markets but also advancing trade liberalization for the platform product.

Figure 1 presents numerical examples of the negative optimal tariff (subsidy) and the positive optimal tariff.[5] The left figure depicts the case with large network externalities ($\alpha = \phi = 3$) and W_H is maximized at $t = -1.4583$. The right figure depicts the case with small network externalities ($\alpha = \phi = 2$), where W_H is maximized at $t = 1.9768$.

The native import tariff cannot be the optimal policy if there are no network externalities, $\alpha = \phi = 0$. In this case, as Brander and Spencer (1984) suggest, the circumstance becomes a standard foreign monopoly and the optimal tariff is always positive ($\widetilde{t} = (v - c)/12$) with the linear demand.

The welfare of the foreign country includes the consumer surplus and the monopoly platform's profit, which is given by $W_F = (\overline{f} - \alpha\phi M)\left(\widetilde{q}_F\right)^2/(2\overline{f}) + \widetilde{\Pi}$. Because an increase in t decreases $\widetilde{q}_F$ and $\widetilde{\Pi}$, a positive import tariff of country H always worsens the welfare of country F.

[5]Parameters are set at $v = 10$, $c = 5$, $\bar{f} = 420$, and $M = 20$. These parameter values are consistent with $\Gamma > 0$ and $\Omega > 0$.

3 Multiple importing countries

We have examined a single country's import tariff. When the marginal cost of the monopolist is constant and markets are segmented, the trade policies of other countries do not affect each country's optimal import tariff. Since markets interact through the platform in two-sided markets, the number of importing countries and other countries' trade policies affect the optimal import policy. Subsequently, we next extend the baseline model to include multiple importing countries.

We consider N countries, one of which is country H and the other $N-1$ countries are foreign countries. Let $\mathcal{F}$ denote the set of foreign countries and $k \in \mathcal{F}$ is the index of a foreign country. The equilibrium sales of the platform product become:

$$q_H = \frac{4(v-c)\overline{f} - M(\alpha+\phi)^2 \sum_{l\in\mathcal{F}} t_l}{2\Upsilon}, \tag{18}$$

$$q_k = \frac{4(v-c)\overline{f} - M(\alpha+\phi)^2 \sum_{l\in\mathcal{F}} t_l}{2\Upsilon} - \frac{t_k}{2}, \tag{19}$$

where $\Upsilon = 4\overline{f} - NM(\alpha+\phi)^2 > 0$. Because of the network externalities, other countries' tariffs decrease platform product sales in each country.

3.1 Non-cooperative tariffs

We start with a case in which importing countries non-cooperatively set their tariffs. In stage 1, each country simultaneously sets its own tariff, t_k, to maximize its own welfare, W_k. Each country's optimal tariff depends on the other countries' tariffs. Let $\boldsymbol{t}_{-k}$ be the tariff vector of the countries other than country k. Then, the optimal tariff of country k becomes:

$$t_k(\boldsymbol{t}_{-k}) = \frac{\Lambda_n\{4(v-c)\overline{f} - (N-2)M(\alpha+\phi)^2 \sum_{l\in\mathcal{F}\backslash k} t_l\}}{\{\Upsilon + M(\alpha+\phi)^2\}\Psi}, \tag{20}$$

where $\Psi = 12\overline{f}^2 - M\{(\alpha^2+\phi^2)(3N+1) + 2\alpha\phi(3N-1)\}\overline{f} - (N-1)M^2\alpha\phi(\alpha+\phi)^2$ and $\Psi > 0$ holds to satisfy the second-order conditions. Meanwhile, $\Lambda_n = 4\overline{f}^2 - M\{(N+1)(\alpha^2+\phi^2) + 2(N-1)\alpha\phi\}\overline{f} - (N-1)M^2\alpha\phi(\alpha+\phi)^2$, which is positive if α, ϕ, and N are small but negative if they are large. We propose the following lemma.

Lemma 1. *Importing countries' tariff settings are strategic substitutes when α, ϕ, and N are small, while they are strategic complements when α, ϕ, and N are large.*

When the two parameters of network externalities and the number of importing countries are small, the importing countries value the rent-shifting effect of an import tariff more than the consumers' benefits from a larger variety of online services. In this case, a tariff-increase in other foreign countries reduces the imports of the platform product. The importing country then has less incentive to increase its own tariff because the reduced imports diminish the gains from rent-shifting from the platform monopolist; however If the network externalities and the number of importing countries are large, the importers value the consumers' benefits more than the rent-shifting effect. In this case, each importing country follows the other countries' import-promotion policies because the other countries' import promotions increase the platform product imports, raising the country's incentive to support consumers by decreasing trade barriers.

In the Nash equilibrium of the tariff-setting game, the foreign countries set the same tariffs because they are assumed to be symmetric. The equilibrium non-cooperative tariff is given by

$$\widetilde{t}_n = \frac{4\Lambda_n \left(v - c\right) \overline{f}}{\{\Upsilon + M\left(\alpha + \phi\right)^2\}\Psi - \Lambda_n (N-2) M \left(\alpha + \phi\right)^2}, \tag{21}$$

where the denominator is positive because of the stability condition of the Nash equilibrium. Since Λ is decreasing in α, ϕ, and N, we present the following proposition.

Proposition 2. *Each importing country's optimal non-cooperative trade policy for the platform product is an import tariff if the degree of network externalities and the number of the importing countries are small, while it is an import subsidy if they are large.*

We have demonstrated that strategic substitutability implies that unilateral tariff reductions in some importing countries increases the optimal tariffs of the other importing countries if the importing countries' optimal tariffs are positive. Because of these reactions, countries become reluctant to reduce import tariffs when network externalities are small.

3.2 Cooperative tariffs

We next consider a case in which the importing countries cooperatively set their tariffs. With the symmetric countries, the optimal cooperative import tariffs are the same across countries and they are set to maximize the importing countries' joint welfare, $\sum_{k\in F} W_k$. The optimal cooperative tariff is given by

$$\widetilde{t}_c = \frac{4\Lambda_c\,(v-c)\,\overline{f}}{(2\overline{f}+\Gamma)\{\Psi-(N-2)\,M\,(\alpha+\phi)^2\,(f-M\alpha\phi)\}}. \tag{22}$$

The second parentheses of the denominator is positive for satisfying the second-order conditions, and $\Lambda_c = 4\overline{f}^2-(2N-1)\,M\{\left(\alpha^2+\phi^2\right)+2\alpha\phi\,(2N-3)\}\overline{f}-M^2\alpha\phi\,(\alpha+\phi)^2$. As before, Λ_c can be either positive or negative and it is decreasing in α, ϕ, and N.

By comparing Λ_n in $\widetilde{t}_n$ and Λ_c in $\widetilde{t}_c$, we have

$$\Lambda_n-\Lambda_c = M\,(\alpha+\phi)^2\,(N-2)\,(\overline{f}-M\alpha\phi) > 0.$$

Therefore, if α, ϕ, and N are in the middle range and are small enough to make $\Lambda_n > 0$ but large enough to make $\Lambda_c < 0$, we have $\widetilde{t}_n > 0 > \widetilde{t}_c$. The following proposition summarizes the result.

Proposition 3. *When the network externalities and the number of the importing countries are in the middle range, the optimal cooperative tariffs are negative, while the optimal non-cooperative tariffs are positive.*

Figure 2 depicts how network externalities, α and ϕ, are associated with the signs of the optimal non-cooperative and cooperative tariffs. The *nn* curve and the *cc* curve represent the combinations of α and ϕ that make $\widetilde{t}_n = 0$ and $\widetilde{t}_c = 0$, respectively. In the two-sided markets, a tariff-increase in one country reduces the service provider's entry, diminishing consumers' utility in the other countries. If countries non-cooperatively set tariffs, they are not concerned about this negative externality experienced by other countries; therefore, the level of import tariffs in the Nash equilibrium is too high from the perspective of individual countries. With tariff cooperation, the importing countries can internalize this externality, lowering the optimal cooperative tariffs that maximize the welfare of each importing coun-

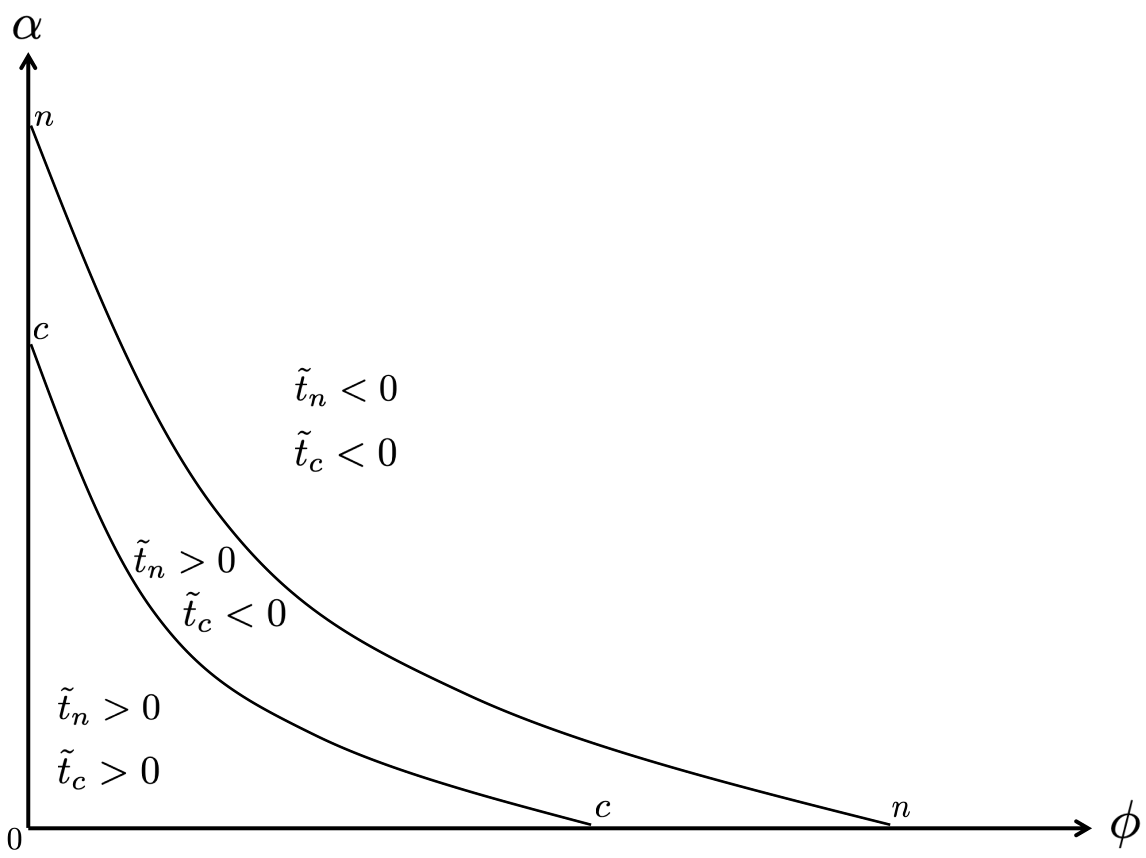

Figure 2: Cooperative vs. Non-cooperative Tariffs

try more than the non-cooperative tariffs, and they can be negative even when the optimal non-cooperative tariffs are positive. This occurs when network externalities are not so small but also not so large. In other words, even if simultaneous reductions in tariffs improves all countries welfare, each country has an incentive to deviate by increasing its tariff when the other countries reduce their tariffs.

This result implies that countries should seek international cooperation in tariff settings on the monopoly platform, as such joint tariff setting benefits both importing countries. The cooperative tariff setting also benefits the exporting countries. In addition, this result suggests that the import tariff set by a members of a free trade agreement (FTA) can be higher than the tariff set by a member of a customs union (CU). Previous literature regarding regional trade agreements suggest that members of CUs tend to set higher tariffs against the non-members than members of FTAs do because the restriction of setting the common external tariffs in CUs can internalize the positive externality of the tariff to other member countries. However, in the two-sided markets, however, a country's tariffs generate negative externalities for other countries through the platform; therefore, the common external tariff of CUs can be lower than the individually optimal tariffs of FTAs in the presence of network externalities.

4 Conclusion

The digitalization of the global economy increases the international trade of the platform products that connect users and suppliers online. Platform products, such as smartphones, laptops, and video game consoles, are physically traded between countries, and sometimes subject to import tariffs. Even if platform products are provided online, digital service taxes can have similar effects as import tariffs.

This study investigates how countries set import tariffs on a platform monopolist's product in a two-sided market. The results suggest that the optimal import tariff of an importing country becomes zero or even negative (i.e., an import subsidy) when both consumer- and supplier-side network externalities are large. These two externalities mutually interact. A larger number of importing countries also make zero tariffs or import subsidies more likely. In contrast, the importing countries set positive import tariffs if the extent of network externalities and the number of importing countries are small. A cooperative tariff setting enables the importing countries to internalize the tariff externalities among them, resulting in a case in which optimal cooperative tariffs are negative, whereas the optimal non-cooperative tariffs are positive. These results suggests that facilitating cross-border data flows and strengthening online service providers' property rights, along with international cooperation regarding trade policies (or digital service taxes), are critical measures for advancing trade liberalization in platform products and securing the welfare gains of free trade in platform products.

Although our model is stylized and relies on some specific assumptions, it is a valuable contribution as one of the first attempts to consider the effects of trade policies in the digitalized economy. There remains room for future research. Although we have considered a monopoly platform, it would be interesting to incorporate competition among multiple platforms and consumers' multi-homing. Exploring the effects of "deep" trade agreements that harmonize digital policies is another important issue.

Appendix

Proof of Proposition 1

By (17), let the second parentheses of the denominator denote $S = 4\overline{f}^2 - \{3\left(\alpha^2+\phi^2\right) + 2\alpha\phi\}M\overline{f} - \alpha\phi\left(\alpha+\phi\right)^2 M^2$. The sign of $\widetilde{t}$ is negative (resp. positive) if and only if $S < 0$ ($S > 0$). S is decreasing in α and ϕ. It is obvious that $S > 0$ when both α and ϕ are close to zero, and $\Gamma > 0$ and $\Omega > 0$ also hold; therefore, the upper bound of S is positive: $\sup S = S|_{\alpha=\phi=0} = 4\overline{f}^2 > 0$.

We can prove that S becomes negative Since $\Gamma = 2\overline{f} - \left(\alpha+\phi\right)^2 M > 0$ must hold and S is decreasing in M, the lower bound of S that satisfies $\Gamma > 0$ becomes

$$\inf S = S|_{M=2\overline{f}/(\alpha+\phi)^2} = -2\left\{\frac{\alpha^2+\phi^2}{\left(\alpha+\phi\right)^2}\right\}\overline{f}^2 < 0.$$

In addition, $\Omega > 0$ implies that $12\overline{f}^2 - \{7\left(\alpha^2+\phi^2\right) + 10\alpha\phi\}\overline{f}M > \alpha\phi\left(\alpha+\phi\right)^2 M^2$ must hold. Since S is decreasing in $\alpha\phi\left(\alpha+\phi\right)^2 M^2$, the lower bound of S that satisfies $\Omega > 0$ becomes

$$\inf S = S|_{\alpha\phi(\alpha+\phi)^2 M^2 = 12\overline{f}^2 - \{7\left(\alpha^2+\phi^2\right)+10\alpha\phi\}\overline{f}M} = -4\Gamma\overline{f} < 0.$$

Therefore, the lower bound of S that satisfies both $\Gamma > 0$ and $\Omega > 0$ is negative.

In sum, the optimal tariff on the monopoly platform is positive when α and ϕ are small and it is negative when α and ϕ are large.

Proof of Proposition 2

It is obvious that Λ_n is positive when α, ϕ, and N are small enough. We should also prove that Λ_n can be negative. Since $\Upsilon = 4\overline{f} - NM\left(\alpha+\phi\right)^2 > 0$ must hold and Λ_n is decreasing in M, the lower bound of Λ_n that satisfies $\Omega > 0$ becomes

$$\inf \Lambda_n = \Lambda_n|_{M=4\overline{f}/\{N(\alpha+\phi)^2\}} = -\frac{4\{N\left(\alpha^2+\phi^2\right) + 2\alpha\phi\left(N-2\right)\}\overline{f}^2}{N^2\left(\alpha+\phi\right)^2} < 0.$$

In addition, $\Psi > 0$ implies that $12\overline{f}^2 - M\{(\alpha^2+\phi^2)(3N+1) + 2\alpha\phi(3N-1)\}\overline{f} > (N-1)M^2\alpha\phi(\alpha+\phi)^2$ must hold. Since Λ is decreasing in $(N-1)M^2\alpha\phi(\alpha+\phi)^2$, the lower bound of Λ_n that satisfies $\Psi > 0$ becomes

$$\inf \Lambda_n = \Lambda_n|_{(N-1)M^2\alpha\phi(\alpha+\phi)^2 = 12\overline{f}^2 - M\{(\alpha^2+\phi^2)(3N+1)+2\alpha\phi(3N-1)\}\overline{f}} = -2\Upsilon\overline{f} < 0.$$

Therefore, the lower bound of Λ_n that satisfies both $\Upsilon > 0$ and $\Psi > 0$ is negative. In sum, the optimal tariff on the monopoly platform is positive when α, ϕ, and N are small and it is negative when they are large.

References

Armstrong, M. (2006) "Competition in two-sided markets," *The RAND Journal of Economics* 37(3): 668-691.

Bourreau, M., Caillaud, B., and De Nijs, R. (2018) "Taxation of a digital monopoly platform," Journal of Public Economic Theory 20(1): 40-51.

Brander, J.A. and Spencer, B.J. (1984) "Trade warfare: tariffs and cartels," *Journal of international Economics* 16(3-4): 227-242.

Caillaud, B. and Jullien, B. (2003) "Chicken & egg: Competition among intermediation service providers," *The RAND Journal of Economics* 34(2): 309-328.

Kao, K.-F. and Mukunoki, H. (2021) "The effects of parallel trade in two-sided markets," *Economics Letters* 199: 109721.

Kind, H.J. and Koethenbuerger, M. (2018) "Taxation in digital media markets," *Journal of Public Economic Theory* 20(1): 22-39.

Klimenko, M. and Saggi, K. (2007) "Technical compatibility and the mode of foreign entry with network externalities," *Canadian Journal of Economics* 40(1): 176-206.

Kowalczyk, C. and Skeath, S.E. (1994) "Pareto ranking optimal tariffs under foreign monopoly," *Economics Letters* 45(3): 355-359.

Naito, T. (2021) "Can the optimal tariff be zero for a growing large country?" *International Economic Review* 62(3): 1237-1280.

Rasch, A. and Wenzel, T. (2013) "Piracy in a two-sided software market," *Journal of Economic Behavior & Organization* 88: 78-89.

Rochet, J.C. and Tirole, J. (2006) "Two-sided markets: a progress report," *The RAND Journal of Economics* 37(3): 645-667.