Tariff policies with firm heterogeneity and variable markups *

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Abstract

This study examines the influence of import tariff policies on welfare in a two-country model with firm heterogeneity and variable markups. In this model, an increase in a country's import tariff increases its welfare through term-of-trade and profit-shifting effects, which create externalities for its trading partner. In particular, the profit-shifting externality has two opposite effects that shifts export profits from less productive exporters to more productive exporters within the tariff-imposed country. If countries cooperatively set import tariffs, the efficient tariff that maximizes the total welfare level of the two countries is positive when an introduction of a country's import tariff generates only a small negative (or a positive) profit-shifting externality. If the efficient tariffs are positive and global free trade prevails, a simultaneous introduction of import tariffs can improve the welfare of both countries not only when countries are close to symmetric, but also when the degree of asymmetry across countries is large.

Keywords: Variable markups, Variable markups, Firm heterogeneity, Monopolistic competition

JEL Classification: D4, D6, F1, L0, L1

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1 Introduction

In trade negotiations between World Trade Organization members, coordinating the interests of member countries tends to become more complicated as the number of members increases, making it difficult to respond quickly to new challenges and rule-making. Consequently, bilateral or regional trade agreements continue to play an important role today, as they allow for relatively easy coordination of interests. However, this raises the question: When a country enters into a bilateral trade agreement, how should the agreement be designed? Should it be concluded between countries that are similar in terms of market size and technology, or should it take the form of a free trade agreement? Although much attention has been devoted to studying international trade models that consider heterogeneous firms since the seminal work of Melitz (2003), little is known about the effects of bilateral trade policy in such models since previous studies mostly focus on the effect of unilateral trade policy.

The impact of a bilateral trade agreement is intrinsically related to the model structure. In particular, in the canonical models of monopolistic competition with constant elasticity of substitution (CES) preferences, which generate constant markups, there is no room for welfare-improving policy intervention: the market equilibrium under free trade is efficient (when there is no other sector than the monopolistically competitive one).[1]

In this study, I analyze the effects of noncooperative and cooperative trade policies on welfare with a focus on import tariff policies by employing a model of monopolistic competition with heterogeneous firms á la Melitz and Ottaviano (2008), who incorporate endogenous markups by introducing the linear demand system into the Melitz (2003)'s model.[2] In this setting, an increase in a country's import tariff affects its welfare through three channels: term-of-trade effect, profit-shifting effect, and volume-of-trade effect. As for the first channel, an increase in the import tariff reduces the pre-tariff price of imported varieties, which positively affects the welfare level. The second channel also positively affects the welfare level of a tariff-imposing country by shifting profits from the country's trading partners to its own country. The last channel negatively affects the welfare level of a tariff-imposing country through reducing import volume. Although the first two channels increase the welfare of a

[1] As Dhingra and Morrow (2019) show, the market outcome is first-best under CES preferences, with demand-side elasticity determining how resources are misallocated.

[2] See Chen, Imbs and Scott (2009), De Loecker et al. (2016), De Loecker and Warzynski (2012), Feenstra and Weinstein (2017), and Hottman, Redding and Weinstein (2016) for empirical evidence of markup variation across firms.

tariff-imposing country, these two effects generate externalities that affect the welfare of the partner country. The terms-of trade externality negatively affects the welfare of the partner country. Meanwhile, the profit-shifting externality has two opposite effects on the welfare of the partner country. One is the negative effect that an increase in a country's import tariff leads the least productive exporters in its trading partner to stop exporting and less productive exporters to reduce their export volume. The other is the positive effect that more productive exporters in the tariff-imposed country increase their export volume. Thus, an increase in a country's import tariff shifts profits from less productive exporters to more productive exporters within the tariff-imposed country (when the tariff level is sufficiently small).

Under a framework with these characteristics, this study characterizes both noncooperative and cooperative import tariff policies, resulting in the following main findings. First, Nash tariffs are positive and higher than the efficient import tariffs that the countries adopt to maximize the total welfare level of the countries.[3] An increase in a country's import tariff increases its welfare through terms-of trade and profit-shifting effects. By contrast, an increase in the import tariff harms its trading partner due to the combined effect of terms-of-trade and profit-shifting externalities, resulting in the efficient tariffs that is lower than the Nash tariffs.

Second, if countries cooperatively set import tariffs, the efficient tariff that maximizes the total welfare level of the two countries is positive when an introduction of a country's import tariff generates only a small negative profit-shifting externality or when it generates a positive profit-shifting externality.

Third, I analyze under what circumstances both countries can mutually benefit from simultaneously introducing import tariffs at the initial situation of global free trade when the efficient tariffs are positive. I find that the simultaneous introduction of the import tariffs improves the welfare of both countries not only when countries are close to symmetric, but also when the degree of asymmetry across countries is large: when one country has a relatively larger population size and more high-productivity firms compared to the other country. This result indicates that it is crucial for countries that participate in a trade agreement to decide their import tariffs based on their relative size.

[3]In this model, the optimal import tariff—which is set by a country to maximize its welfare, with the import tariff set by the country's trading partner as given—is consistent with the Nash tariff. This is because the optimal import tariff is determined independently of the import tariff set by the country's trading partner.

1.1 Related literature

Some studies incorporate tariff policies into the Melitz-Ottaviano model. Bagwell and Lee (2020) incorporate import and export tariffs into the model and study trade policy's impact in a symmetric two-country economy. They show that starting at global free trade, the impact of introducing the total tariff (the sum of tariffs imposed when exporting from one country to the other) and of its symmetric increase on joint welfare depends on a simple relationship among parameters. The present study obtains results that complement this finding even in a model allowing asymmetric countries and without free entry, and shows analytically the condition under which the simultaneous introduction of import tariffs increases not only joint welfare, but also welfare in the individual countries. Bagwell and Lee (2020) also show that, under some assumptions, the symmetric Nash tariff is higher than the efficient tariff when the simultaneous introduction of import tariffs increases joint welfare; the present study confirms this result without requiring the assumptions they impose.[4]

Nocco, Ottaviano and Salto (2019) consider the efficiency properties of the market outcome in a multi-country extension of Melitz and Ottaviano (2008) and characterize the policy tools that national policymakers can use cooperatively to make the market achieve the efficient outcome. Under an unconstrained choice of tools, including domestic and trade policies, and country-specific and firm-specific production subsidies/taxes, Nocco, Ottaviano and Salto (2019) show that the market can achieve the first-best outcome. When firm-specific production subsidies/taxes are unavailable, they consider a second-best scenario in which a per-unit production subsidy is offered to all firms and financed by a lump-sum tax on consumers. The present study differs from theirs in terms of the policy instruments and model structure. In the present study, governments cooperatively choose the efficient ad valorem import tariffs, which are uniform across countries and firms, without using domestic policy instruments. Moreover, depending on whether per-unit or ad valorem taxes are used, the impact of the policy instrument on resource allocation varies.[5]

Demidova (2017) removes the outside good from the Melitz-Ottaviano model and characterizes optimal unilateral import tariffs for small and large countries. She shows that optimal tariffs are positive for both small and large countries. Compared to Demidova (2017), the

[4]To obtain this result, Bagwell and Lee (2020) assume that the symmetric Nash and efficient tariffs are interior solutions and that the joint-welfare function is quasi-concave in the symmetric tariff.

[5]In the Melitz-Ottaviano model, while per-unit production taxes/subsidies dose not affect the output level of each firm, ad valorem taxes increase (decrease) the output level of more (less) productive firms.

present study characterizes a cooperative tariff policy that maximizes the total welfare level of the two countries.

The present study is also related to the following studies. Demidova and Rodríguez-Clare (2009) and Haaland and Venables (2016) consider a small-country version of the Melitz model and characterize a unilateral trade policy that achieves the first-best allocation. Felbermayr, Jung and Larch (2013) extend Demidova and Rodríguez-Clare (2009) to the case of two large countries and characterize the optimal tariff. Campolmi, Fadinger and Forlati (2018) characterize the Nash equilibrium as consisting of first-best-level labor subsidies that achieve production efficiency as well as inefficient import subsidies and export taxes aimed at improving the domestic terms of trade when both domestic and trade policies are available. Costinot, Rodríguez-Clare and Werning (2020) consider the case of available domestic and trade policy instruments and characterize optimal unilateral tariffs when tariffs are firm-specific and uniform in a canonical model of intra-industry trade with monopolistic competition and firm-level heterogeneity. Bagwell and Lee (2018) incorporate a homogeneous good sector in the Melitz model in a symmetric two-country economy and show that starting at global free trade, introducing a symmetric import tariff lowers joint welfare. These studies build on the model with CES preference, which generates constant markups. By contrast, the present study analyzes how a cooperative tariff policy affects the welfare levels in a framework of variable markups and shows the case in which the simultaneous introduction of import tariffs improve welfare in both countries.

1.2 Organization of the article

The rest of the paper is organized as follows. Section 2 describes my model. Section 3 characterizes noncooperative and cooperative tariff policies. Section 4 shows that both countries can simultaneously gain by imposing import tariffs than global free trade, even when the degree of asymmetry across countries is large. Section 5 concludes.

2 Model

In this study, it is assumed that there are two countries labeled H (home) and F (foreign), two sectors, and one production factor, which is labor. Labor L_i $(i = H, F)$ is inelastically

supplied by consumers in each country and is immobile between countries.

2.1 Consumers

The preferences of consumers are defined over a continuum of differentiated varieties of goods and a homogeneous good. The differentiated goods are indexed by $\omega \in \Omega_i$ and the homogeneous good is chosen as the numeraire. All consumers in country i share the same preference and each consumer maximizes the following utility function:

$$U_i = q_{0,i}^c + \alpha \int_{\Omega_i} q_i^c(\omega) d\omega - \frac{\gamma}{2} \int_{\Omega_i} q_i^c(\omega)^2 d\omega - \frac{\eta}{2} \left(\int_{\Omega_i} q_i^c(\omega) d\omega \right)^2, \tag{1}$$

subject to the budget constraint

$$q_{0,i}^c + \int_{\Omega_i} p_i(\omega) q_i^c(\omega) d\omega = I_i,$$

where Ω_i is the set of all available differentiated good varieties in country i; $q_{0,i}^c$ and $q_i^c(\omega)$ are the individual consumption levels of the numeraire good and each variety ω in country i, respectively; $p_i(\omega)$ is the price of variety ω in country i; and I_i is the income of consumers in country i. Income consists of wage, profits, and the lump-sum transfer from a government. I assume that the consumers are stockholders of domestic firms. The parameters α, η, and γ are positive constants. A lower γ indicates that the differentiated varieties become closer substitutes and in the limit case of $\gamma = 0$, consumers care only about the total amount of differentiated goods they consume. η represents the degree of non-separability. When η equals zero, the utility function becomes separable across the differentiated varieties.

Using the first-order conditions for utility maximization, the inverse demand for each variety ω is given by

$$p_i(\omega) = \alpha - \gamma q_i^c(\omega) - \eta Q_i^c, \quad \forall \omega \in \Omega_i^*, \tag{2}$$

where $\Omega_i^* \subset \Omega_i$ represents the subset of varieties in which $q_i^c(\omega) > 0$, and $Q_i^c \equiv \int_{\Omega_i^*} q_i^c(\omega) d\omega$ is the aggregate consumption of all differentiated goods. Integrating both sides of (2) over Ω_i^* yields $Q_i^c = N_i(\alpha - p_i^{ave})/(\gamma + \eta N_i)$, where N_i is the number of consumed (domestic and imported) varieties, and $p_i^{ave} = \int_{\Omega_i^*} p_i(\omega) d\omega / N_i$ is the average price of consumed varieties in country i. Using this expression of Q_i^c and (2), I obtain the following market demand for

variety ω in country i, $q_i(\omega)$:

$$q_i(\omega) = L_i q_i^c(\omega) = \frac{L_i}{\gamma}(p_i^{max} - p_i(\omega)),$$

where

$$p_i^{max} \equiv \frac{\gamma\alpha + \eta N_i p_i^{ave}}{\gamma + \eta N_i} \tag{3}$$

represents the threshold price in country i at which demand for a variety is driven to zero. Note that (2) implies $p_i^{max} \leq \alpha$.

2.2 Firms

Perfect competition prevails in the homogeneous good market. Production of one unit of a homogeneous good requires one unit of labor input. The homogeneous goods are freely traded between the countries. Thus, the wage becomes one in both countries.

In the differentiated goods sector, there is a continuum of K_i potential firms in country i, where K_i is assumed to be constant. They produce the differentiated goods under monopolistic competition. Each firm requires c units of labor to produce one unit of the differentiated good. I assume that the unit labor requirement c follows Pareto distribution:

$$c \sim G_i(c) = \left(\frac{c}{c_i^M}\right)^{\theta}, \quad c \in [0, c_i^M], \quad \theta \geq 1,$$

where $G_i(c)$ is the cost distribution in country i, θ is an index of the dispersion of the cost, and c_i^M is the upper bound of the cost in country i. In addition, when firms in country i export their goods to country j, they face an iceberg trade cost τ_{ij} and an ad valorem import tariff t_{ij}, where $\tau_{ii} = t_{ii} = 1$, $\tau_{ij} \geq 1$, and $t_{ij} \geq 1$ for $i, j \in \{H, F\}$ and $i \neq j$.

Potential firms in country i determine whether they produce or shut down for domestic and foreign markets after governments in the countries set their tariffs. The firms produce for the country in which they can earn positive operating profits, and otherwise shut down. Then, the profit maximization problem for firms in country i with cost c that sells goods to consumers in country j is given by

$$\max(\frac{p_{ij}}{t_{ij}} - \tau_{ij}c)q_{ij}, \qquad \text{s.t.} \quad q_{ij} = \frac{L_j}{\gamma}(p_j^{max} - p_{ij}),$$

where p_{ij} and q_{ij} are the tariff-inclusive price and the quantity sold in country j, respectively. Let $p_{ij}(c)$ and $q_{ij}(c)$ denote the profit-maximizing price and quantity set by country i's firms with cost c to sell their goods to country j. The profit-maximizing price and quantity are, respectively,

$$p_{ij}(c) = \frac{\tau_{ij}t_{ij}}{2}(\frac{p_j^{max}}{\tau_{ij}t_{ij}} + c), \quad q_{ij}(c) = \frac{L_j\tau_{ij}t_{ij}}{2\gamma}(\frac{p_j^{max}}{\tau_{ij}t_{ij}} - c).$$

Next, I define the cost cutoffs. Let c_{ij} be the upper bound of the cost for firms in country i that sell to country j:

$$c_{ii} = \sup\{c : \pi_{ii}(c) > 0\} = p_i^{max}, \quad c_{ij} = \sup\{c : \pi_{ij}(c) > 0\} = \frac{p_j^{max}}{\tau_{ij}t_{ij}} \tag{4}$$

for $i \neq j$. As described in Melitz and Ottaviano (2008), the cost cutoff represents the toughness of competition in a market. In Appendix, I show that $c_{ii} > c_{ij}$ in equilibrium, meaning that there are no firms that export but do not produce domestically. I call c_{ii} the domestic cost cutoff and c_{ij} for $i \neq j$ the export cost cutoff in country i, and assume that c_i^M is sufficiently high to be greater than c_{ii}. Using the cost cutoffs, I obtain the price, quantity, and profit of firms in country i that sell their goods in country j:

$$\begin{aligned} p_{ij}(c) &= \frac{\tau_{ij}t_{ij}}{2}(c_{ij} + c) \left(= \frac{1}{2}(c_{jj} + \tau_{ij}t_{ij}c)\right), \\ q_{ij}(c) &= \frac{L_j\tau_{ij}t_{ij}}{2\gamma}(c_{ij} - c) \left(= \frac{L_j}{2\gamma}(c_{jj} - \tau_{ij}t_{ij}c)\right), \\ \pi_{ij}(c) &= \frac{L_j\tau_{ij}^2t_{ij}}{4\gamma}(c_{ij} - c)^2. \end{aligned} \tag{5}$$

Lower-cost firms set lower prices and higher output levels while earning higher profits with higher markups.

2.3 Equilibrium

The number of sellers in country i, N_i, is composed of domestic producers and exporters in country j, that is,

$$N_i = K_i G_i(c_{ii}) + K_j G_j(c_{ji}) = (k_i + k_j(\tau_{ji} t_{ji})^{-\theta}) {c_{ii}}^{\theta}, \tag{6}$$

where $k_i \equiv K_i / {c_i^M}^{\theta}$ and, from (4),

$$c_{ji} = \frac{c_{ii}}{\tau_{ji} t_{ji}} \quad \text{for} \quad i \neq j. \tag{7}$$

Let k_i be the productivity index of operating firms in country i, which measures the number of productive firms in country i.[6] Using $c_{ii} = p_i^{max}$ (from (4)) and (3), I obtain

$$N_i = \frac{2(\theta+1)}{A} \frac{\alpha - c_{ii}}{c_{ii}}, \tag{8}$$

where $A \equiv \eta/\gamma$ and $p_i^{ave} = (2\theta+1)c_{ii}/2(\theta+1)$. Thus, (6) and (8) determine c_{ii} and N_i. From (6) and (8), c_{ii} is determined by

$$A(k_i + k_j(\tau_{ji} t_{ji})^{-\theta}) {c_{ii}}^{\theta+1} + 2(\theta+1)c_{ii} = 2(\theta+1)\alpha. \tag{9}$$

Since the left-hand side of (9) is increasing in c_{ii}, the solution of (9) uniquely exist. In Appendix, I show the sufficient condition for $c_{ii} < c_i^M$ in equilibrium, meaning that firm selection occurs and only some potential firms operate in equilibrium.

The domestic cost cutoffs vary with changes in the characteristics of goods, technology, and transportation costs. These parameters' effects on the domestic cost cutoff are summarized in the following lemma.

Lemma 1. *The domestic cost cutoff declines as varieties are closer substitutes (lower γ); the degree of non-separability is higher (higher η); the number of more productive firms in*

[6] For instance, the number of more productive firms below cost c' (which is assumed to be sufficiently smaller than c_{ij}) in country i is $K_i G_i(c') = k_i {c'}^{\theta}$. Then, an increase in k_i increases the number of more productive firms below cost c'. Meanwhile, the number of less productive firms above cost c' is $k_i(c_{ii}^{\theta} - {c'}^{\theta})$. As will be explained in Lemma 1, an increase in k_i or k_j decreases the domestic cutoff in country i, c_{ii}, so that a higher level of k_i does not immediately indicate a larger number of all operating firms in country i.

both countries is larger (higher k_i and k_j); and the transportation cost from country j to country i is lower (lower τ_{ji}).

Proof. *Applying the implicit function theorem to* (9)*, I obtain*

$$\frac{dc_{ii}}{dA} = -\frac{(k_i + k_j(\tau_{ji}t_{ji})^{-\theta}){c_{ii}}^{\theta+2}}{2(\theta+1)\left((\theta+1)\alpha - \theta c_{ii}\right)} < 0, \quad \frac{dc_{ii}}{dk_i} = -\frac{A{c_{ii}}^{\theta+2}}{2(\theta+1)\left((\theta+1)\alpha - \theta c_{ii}\right)} < 0,$$
$$\frac{dc_{ii}}{dk_j} = -\frac{A(\tau_{ji}t_{ji})^{-\theta}{c_{ii}}^{\theta+2}}{2(\theta+1)\left((\theta+1)\alpha - \theta c_{ii}\right)} < 0, \quad \frac{dc_{ii}}{d\tau_{ji}} = \frac{\theta A k_j {\tau_{ji}}^{-(\theta+1)}{t_{ji}}^{-\theta}{c_{ii}}^{\theta+2}}{2(\theta+1)\left((\theta+1)\alpha - \theta c_{ii}\right)} > 0,$$

where $A = \eta/\gamma$.

2.4 Impact of import tariff

In the remainder of this section, I investigate the impact of an import tariff on firm behavior. For the impact on the cost cutoffs, applying the implicit function theorem to (9) gives

$$\frac{dc_{ii}}{dt_{ji}} = \frac{\theta A k_j {\tau_{ji}}^{-\theta}}{2(\theta+1)} \frac{{t_{ji}}^{-(\theta+1)}{c_{ii}}^{\theta+2}}{(\theta+1)\alpha - \theta c_{ii}} > 0. \tag{10}$$

Differentiating both sides of (7) with respect to t_{ji} and using (9) and (10), I obtain

$$\frac{dc_{ji}}{dt_{ji}} = -\frac{\tau_{ji}^{-1}t_{ji}^{-2}c_{ii}}{(\theta+1)\alpha - \theta c_{ii}} \left(\alpha + \frac{\theta}{2(\theta+1)} A k_i c_{ii}^{\theta+1}\right) < 0.$$

Thus, an increase in the import tariff imposed by country i increases the domestic cost cutoff in country i and decreases the export cost cutoff in country j. Note that changes in the import tariff set by country i do not affect production activities directed to consumers in country j: $dc_{jj}/dt_{ji} = dc_{ij}/dt_{ji} = 0$.

For the impact of an import tariff on the number of varieties, from (8) and (10), I obtain

$$\frac{dN_i}{dt_{ji}} = -\frac{2(\theta+1)\alpha}{A{c_{ii}}^2} \frac{dc_{ii}}{dt_{ji}} < 0,$$

which implies an increase in the import tariff imposed by country i decreases the number of varieties sold in country i. I summarize these results in the following lemma.

Lemma 2. *For countries i and j with $i, j \in \{H, F\}$ and $i \neq j$, an increase in country i's import tariff increases the domestic cost cutoff in country i; decreases the export cost cutoff in country j; and decreases the number of varieties sold in country i.*

An increase in country i's import tariff intensifies the export competition in country j and relaxes the domestic competition in country i, which makes the least productive exporters stop exporting and the least productive domestic firms start producing domestically (selection effect). Since the former effect, which decreases the number of exporters ($K_j G(c_{ji})$), dominates the latter effect, which increases the number of domestic firms ($K_i G(c_{ii})$), an increase in the import tariff overall decreases the number of varieties sold in country i (variety effect).

In addition to the selection and variety effects, an increase in country i's import tariff also affects the output level of each producer. Using (5) and (10), the effects of country i's import tariff on the output levels are given by

$$\frac{dq_{ii}(c)}{dt_{ji}} = \frac{L_i}{2\gamma}\frac{dc_{ii}}{dt_{ji}} > 0 \tag{11}$$

and

$$\frac{dq_{ji}(c)}{dt_{ji}} = \frac{L_i}{2\gamma}\frac{dc_{ii}}{dt_{ji}} - \frac{L_i}{2\gamma}\tau_{ji}c \begin{cases} > 0 & (0 \leq c < \frac{1}{\tau_{ji}}\frac{dc_{ii}}{dt_{ji}}) \\ < 0 & (\frac{1}{\tau_{ji}}\frac{dc_{ii}}{dt_{ji}} < c \leq c_{ji}) \end{cases}, \tag{12}$$

where $\frac{1}{\tau_{ji}}\frac{dc_{ii}}{dt_{ji}} < c_{ji}$.[7] The impact of an increase in country i's import tariff on output levels can be divided into two effects. The second term in (12) represent the direct effect of an increase in the import tariff that decreases exports from country j. The magnitude of this effect depends on firm productivity: more productive (lower c) exporters have a smaller reduction in their exports. The first terms in (12) and (11) represent the indirect effect of an increase in country i's import tariff that increases production for country i in response to a decrease in the number of exporters in country j: an increase in the import tariff intensifies the export competition in country j and makes the least productive exporters stop exporting. In response to this reduction in exporters, surviving firms producing for country i, both domestic firms in country i and exporters in country j, uniformly increase their production for country i. As a result, an increase in country i's import tariff decreases

[7] Using (7), (9), and (10), I get $\frac{1}{\tau_{ji}}\frac{dc_{ii}}{dt_{ji}} - c_{ji} = -\frac{c_{ji}\left(2(\theta+1)\alpha+\theta A k_i c_{ii}^{\theta+1}\right)}{2(\theta+1)((\theta+1)\alpha-\theta c_{ii})} < 0$.

the output level of less productive exporters in country j, while it increases the output levels of not only domestic firms in country i but also more productive exporters in country j. The impact of an increase in the import tariff on output levels can be summarized as the following lemma.

Lemma 3. *For countries i and j with $i, j \in \{H, F\}$ and $i \neq j$, an increase in country i's import tariff increases (decreases) exports from more (less) productive exporters in country j and increases the domestic output levels of firms in country i.*

For Lemma 3, the fact that an increase in a country's import tariff increases the volume of exports from more productive exporters in its partner country can be observed under a framework allowing for firm heterogeneity and variable markups, and is a key to obtain new implications for tariff policies.

3 Tariff policies

In this section, I examine noncooperative and cooperative tariff policies and their characteristics. First, I decompose the effects of a unilateral tariff increase on the welfare level of both countries. As shown in Appendix, from (1) and (2), the welfare level of country i can be expressed as the following welfare measure:

$$L_i U_i = I_i + \frac{K_i}{2} \int_0^{c_{ii}} (\alpha - p_{ii}(c))\, q_{ii}(c) dG_i(c) + \frac{K_j}{2} \int_0^{c_{ji}} (\alpha - p_{ji}(c))\, q_{ji}(c) dG_j(c), \tag{13}$$

where the second and third terms represent consumer surplus from consumption of domestic and imported varieties, respectively, while income I_i consists of wage, profits from domestic and export sales, and tariff revenue. The welfare effect of its own tariff change can be decomposed into three components. Differentiating (13) with respect to t_{ji} and proceeding in a similar manner to Mrázová (2021), I obtain

$$\frac{dL_i U_i}{dt_{ji}} = TT_i + PS_i + VT_i, \tag{14}$$

where TT_i, PS_i, and VT_i represent a terms-of-trade effect, profit-shifting effect, and volume-of-trade effect generated by country i's import tariff, respectively. They are given by (see

Appendix):

$$TT_i \equiv -K_j \int_0^{c_{ji}} \frac{d\left(\frac{p_{ji}(c)}{t_{ji}}\right)}{dt_{ji}} q_{ji}(c) dG_j(c) = L_i B_i \left[\frac{\theta+2}{2(\theta+1)} A k_i c_{ii}^{\theta+1} + \frac{\theta+2}{\theta}\alpha\right] > 0, \quad (15)$$

$$PS_i \equiv K_i \int_0^{c_{ii}} (p_{ii}(c) - c) \frac{dq_{ii}(c)}{dt_{ji}} dG_i(c) = L_i B_i t_{ji} \frac{\theta+2}{2(\theta+1)} A k_i c_{ii}^{\theta+1} > 0, \quad (16)$$

$$\begin{aligned} VT_i &\equiv K_j \int_0^{c_{ji}} \frac{t_{ji}-1}{t_{ji}} p_{ji}(c) \frac{dq_{ji}(c)}{dt_{ji}} dG_j(c) \\ &= -L_i B_i (t_{ji}-1) \left[\frac{(\theta+2)(2\theta+1)}{2(\theta+1)} A k_i c_{ii}^{\theta+1} + 2(\theta+1)c_{ii} + \alpha\right] \leq 0, \end{aligned} \quad (17)$$

where $B_i \equiv \frac{\theta k_j {\tau_{ji}}^{-\theta}}{4\gamma(\theta+1)(\theta+2)} \frac{{t_{ji}}^{-(\theta+2)} {c_{ii}}^{\theta+2}}{(\theta+1)\alpha - \theta c_{ii}} > 0$ and $p_{ji}(c)/t_{ji}$ represents the pre-tariff price. Thus, an increase in country i's import tariff increases its own welfare level through terms-of-trade and profit-shifting effects, while decreasing the welfare level through volume-of-trade effect.

While an increase in country i's import tariff has positive effects on its own welfare level through terms-of-trade and profit-shifting effects, these two effects generate externalities that affect the welfare level of the partner country. As shown in Appendix, differentiating the welfare level of country j ($L_j U_j$) with respect to t_{ji}, I obtain

$$\frac{dL_j U_j}{dt_{ji}} = TTX_j + PSX_j. \quad (18)$$

where TTX_j and PSX_j represent a terms-of-trade externality and profit-shifting externality generated by country i's import tariff, respectively. They are given by:

$$TTX_j \equiv K_j \int_0^{c_{ji}} \frac{d\left(\frac{p_{ji}(c)}{t_{ji}}\right)}{dt_{ji}} q_{ji}(c) dG_j(c) = -TT_i < 0, \quad (19)$$

$$PSX_j \equiv K_j \int_0^{c_{ji}} \left(\frac{p_{ji}(c)}{t_{ji}} - \tau_{ji} c\right) \frac{dq_{ji}(c)}{dt_{ji}} dG_j(c) = L_i B_i \left[-\frac{\theta+2}{2(\theta+1)} A k_i c_{ii}^{\theta+1} + \alpha - 2c_{ii}\right] \quad (20)$$

As expected, the terms of trade externality is negative, but surprisingly, the profit-shifting externality can be either positive or negative. This is because, from Lemma 3, an increase in country i's import tariff increases the export volume from more productive exporters in country j. From Lemma 1, the profit-shifting externality given by (20) tends to be positive when country j has a large number of more productive firms: when k_j is sufficiently large. Consequently, the following lemma summarizes the net effect of country i's import tariff on

the welfare level of country j.

Lemma 4. *An increase in country i's import tariff generates welfare loss in country j:*

$$\frac{dL_jU_j}{dt_{ji}} = TTX_j + PSX_j = -L_iB_i\left[\frac{\theta+2}{\theta+1}Ak_i{c_{ii}}^{\theta+1} + 2c_{ii} + \frac{2\alpha}{\theta}\right] < 0,$$

where $B_i = \frac{\theta k_j {\tau_{ji}}^{-\theta}}{4\gamma(\theta+1)(\theta+2)} \frac{{t_{ji}}^{-(\theta+2)}{c_{ii}}^{\theta+2}}{(\theta+1)\alpha-\theta c_{ii}} > 0.$

3.1 Noncooperative tarif policy

Here, I clarify the consequences and characteristics of noncooperative tariff policy as a benchmark case. In the absence of trade agreements, each government sets a tariff level that maximizes its own welfare. Substituting (15), (16), and (17) into (14), I obtain

$$\frac{dL_iU_i}{dt_{ji}} = L_iB_i\Bigg[(\theta+2)Ak_ic_{ii}^{\theta+1} + 2(\theta+1)c_{ii} + \frac{2(\theta+1)}{\theta}\alpha - t_{ji}\left(\frac{\theta(\theta+2)}{\theta+1}Ak_ic_{ii}^{\theta+1} + 2(\theta+1)c_{ii} + \alpha\right)\Bigg].$$

In Appendix, I derive unique t_{ji}^n such that $dL_iU_i/dt_{ji} \gtreqless 0$ if and only if $t_{ji} \lesseqgtr t_{ji}^n$. Therefore, I obtain the following proposition.

Proposition 1. *In the two-country economy, Nash tariffs, (t_{FH}^n, t_{HF}^n), are positive.*[8] *They are given by*

$$t_{ji}^n = \left(1+\frac{1}{\theta}\right)\left[1 + \frac{\alpha - 2c_{ii}}{\frac{\theta(\theta+2)}{\theta+1}Ak_i{c_{ii}}^{\theta+1} + 2(\theta+1)c_{ii} + \alpha}\right], \quad i,j \in (H,F), \quad i \neq j, \qquad (21)$$

where c_{ii} is endogenously determined. The solution of (21) *uniquely exists and is on the interval* $\left(1, 2\left(1+\frac{1}{\theta}\right)\right)$.

Proof. *See Appendix.*

[8] In this model, the import tariff in country i that maximizes its welfare (with the import tariff set by country j as given) is determined independently of the import tariff set by country j (see Appendix).

3.2 Cooperative tariff policy

In this subsection, I consider a cooperative tariff policy under which the two countries cooperatively set import tariffs and characterize the efficient tariffs that maximize the total welfare level of the countries, $W \equiv L_H U_H + L_F U_F$. From (14) and (18), the effect of a unilateral tariff change on the total welfare level can be expressed as

$$\begin{aligned}\frac{dW}{dt_{ji}} &= TT_i + PS_i + VT_i + TTX_j + PSX_j \\ &= L_i B_i \left[\alpha - 2c_{ii} - (t_{ji}-1)\left(\frac{\theta(\theta+2)}{\theta+1} A k_i c_{ii}^{\theta+1} + 2(\theta+1)c_{ii} + \alpha\right)\right], \end{aligned} \tag{22}$$

where $TT_i + TTX_j = 0$, meaning that the terms-of-trade effect is canceled out by its externality. Further, if country i starts at unilateral free trade ($t_{ji} = 1$), an introduction of country i's import tariff does not affect the total welfare level through volume-of-trade effect: $VT_i = 0$ when $t_{ji} = 1$ (see (17)). Hence, the profit-shifting effect and its externality determines whether the introduction of the import tariff is desirable. Substituting $t_{ji} = 1$ into (22), I obtain

$$\left.\frac{dW}{dt_{ji}}\right|_{t_{ji}=1} = L_i B_i \left[PS_i^{FT} + PSX_j^{FT}\right] = L_i B_i \left[\alpha - 2c_{ii}^{FT}\right], \tag{23}$$

where the superscript FT represents variables under (unilateral) free trade, that is, $PS_i^{FT} \equiv \lim_{t_{ji}\to 1} PS_i$, $PSX_j^{FT} \equiv \lim_{t_{ji}\to 1} PSX_j$, and $c_{ii}^{FT} \equiv \lim_{t_{ji}\to 1} c_{ii}$.[9] Therefore, the impact of an introduction of country i's import tariff on the total welfare level depends on the sign of $\alpha - 2c_{ii}^{FT}$, and consequently I obtain the following proposition.

Proposition 2. *In the two-country economy, consider a cooperative tariff policy under which the two countries cooperatively set the efficient import tariffs, (t_{FH}^e, t_{HF}^e), that maximize the total welfare level of the countries. The efficient tariff, t_{ji}^e, is positive if and only if $\alpha - 2c_{ii}^{FT} > 0$. Otherwise, (unilateral) free trade is desirable:*

$$t_{ji}^e = \begin{cases} 1 + \frac{\alpha - 2c_{ii}}{\frac{\theta(\theta+2)}{\theta+1} A k_i c_{ii}^{\theta+1} + 2(\theta+1)c_{ii} + \alpha} & \left(\alpha - 2c_{ii}^{FT} > 0\right) \\ 1 & \left(\alpha - 2c_{ii}^{FT} \le 0\right) \end{cases}, \quad i,j \in (H,F), \quad i \neq j, \tag{24}$$

[9] Note that c_{ii}, TT_i, PS_i, VT_i, TTX_j, and PPX_j are independent of t_{ij} (see (9), (15), (16), (17), (19), and (20)).

where c_{ii} is endogenously determined and $1 \leq t_{ji}^e < 2$. The solution of (24) *uniquely exists.*

Proof. *See Appendix.*

Global free trade is inefficient when the domestic cutoff in a country is sufficiently small: when $\alpha - 2c_{ii}^{FT} > 0$ for $i = H, F$.[10] From (23), this inequality holds when the introduction of t_{ji} generates positive profit-shifting effect including its externality: $PS_i^{FT} + PSX_j^{FT} > 0$. The intuition that the sum of profit-shifting effect and its externality can be positive is as follows. As shown in Lemmas 2 and 3, an introduction of country i's import tariff leads the least productive firms in country j to stop exporting as they cannot withstand increased export competition in country j. Similarly, less productive exporters in country j reduce their pre-tariff price ($p_{ji}(c)/t_{ji}$) and export volume with this increased export competition. These two facts imply that profit-shifting effect entails a negative externality for country j. Meanwhile, more productive exporters in country j increase their export volume in response to the introduction of country i's import tariff, although they reduce their pre-tariff price, which implies that profit-shifting effect also entails a positive externality for country j. Therefore, the latter effect, which generates positive externality, reduces the former effect, which generates negative externality, meaning that there can be cases in which the sum of profit-shifting effect and its externality takes a positive value ($PS_i^{FT} + PSX_j^{FT} > 0$). Moreover, if country j has a sufficiently large number of more productive exporters (large k_j), the latter effect dominates the former effect, and the profit-shifting externality itself becomes positive ($PSX_j^{FT} > 0$).

Comparing the efficient tariff and the Nash tariff reveals that the efficient tariff given by (24) has the same form as the second component of the Nash tariff given by (21).[11] Therefore, the first component of the Nash tariff given by (21), $1 + \frac{1}{\theta}$, represents a country i's attempt to manipulate terms of trade and shift profits to its own country ignoring the existence of externalities, which can be eliminated by a cooperative tariff policy. I summarize this result in the following proposition.

[10] This inequality is quite similar to the condition for excessive entry at the market equilibrium in Bagwell and Lee (2020), where they show that this distortion can be corrected by the introduction of a symmetric tariff (see Propositions 4 and 8 in their paper). The model in the present study, which does not consider free entry, is similar to the model in Bagwell and Lee (2020) in that the inequality, $\alpha - 2c_{ii}^{FT} > 0$, holds when there are a sufficient number of potential firms in both countries.

[11] Since the cost cutoffs are determined endogenously, the level of the efficient tariff given by (24) (when $\alpha - 2c_{ii}^{FT} > 0$) is different from the second component in (21).

Proposition 3. *In the two-country economy, the Nash tariffs are higher than the efficient tariffs:*

$$t_{ji}^n > t_{ji}^e, \quad i, j \in (H, F), \quad i \neq j.$$

Proof. *See Appendix.*

As shown in Lemma 4, an increase in a country's import tariff harms its trading partner due to the combined effect of terms-of-trade and profit-shifting externalities, resulting in the efficient tariffs that is lower than the Nash tariffs.

4 Mutual gains from leaving global free trade

In the previous section, I show that the efficient tariff is positive if and only if the introduction of a import tariff generates positive profit-shifting effect including its externality: $PS_i^{FT} + PSX_j^{FT} = \alpha - 2c_{ii}^{FT} > 0$. Thus, in a symmetric-country case that meets this condition, if the countries simultaneously introduce import tariffs from the initial situation of global free trade and gradually increase the tariff levels, the efficient tariff levels can be reached without generating welfare losses for both countries. In an asymmetric-country setting, however, even if the two countries meet the condition, there is a case in which the simultaneous introduction of the import tariffs decreases the welfare of a county while increasing the welfare of the other country.

Thus, in this section, I analyze what kind of asymmetric countries can mutually gain by simultaneously introducing the import tariffs from the initial situation of global free trade, when the efficient tariffs are positive. Let $L \equiv L_i/L_j$ and $k \equiv k_i/k_j$ denote the relative population size and relative size of the productivity index for country i, respectively. In this section, no transport costs are assumed, $\tau_{ji} = \tau_{ij} = 1$, to examine the impact of a departure from completely free trade. I also assume $\alpha - 2c_{ii}^{FT} > 0$ for $i = H, F$ to focus on the case in which the efficient tariffs are positive. Since from (9) the level of c_{ii}^{FT} depends on the aggregate size of the productivity index, $k_i + k_j$, I assume that $k_i + k_j$ is constant and takes a value that ensures $\alpha - 2c_{ii}^{FT} > 0$. Then, changes in the relative size k do not affect the aggregate size $k_i + k_j$ and thereby, c_{ii}^{FT}: $dc_{ii}^{FT}/dk = 0$.

To see the impact of the simultaneous introduction of import tariffs from the initial situation of global free trade, I first set $t_{ji} = t_{ij} \equiv t$. As shown in Appendix, the welfare

effect of changes in t can be expressed as

$$\frac{dL_iU_i}{dt} = TT_i + PS_i + VT_i + TTX_i + PSX_i.$$

Then, the welfare effect of the simultaneous introduction of import tariffs in country i is given by

$$\left.\frac{dL_iU_i}{dt}\right|_{t=1} > 0 \Leftrightarrow L > \frac{2}{\theta+2}\frac{\beta_1 k + \beta_2}{\beta_3 k + \alpha}k \equiv \underline{L}(k), \tag{25}$$

where $\beta_1 \equiv \alpha+\theta c_{ii}^{FT}$, $\beta_2 \equiv (\theta+1)((\theta+1)\alpha-\theta c_{ii}^{FT})$, and $\beta_3 \equiv (2\theta+1)\alpha-2\theta c_{ii}^{FT}$ are positive.[12] Since $\underline{L}(k)$ is an increasing function with respect to k, it can be shown as depicted in Figure 1 (see Appendix). From Figure 1, country i can gain by the simultaneous introduction of import tariffs when the pair of (k, L) is above $\underline{L}(k)$. In other words, the simultaneous introduction of import tariffs improves the welfare of a country that has a larger population or a smaller productivity index.

Next, I derive the welfare effect of the simultaneous introduction of import tariffs in country j. In a similar way to (25), I obtain

$$\left.\frac{dL_jU_j}{dt_w}\right|_{t_w=1} > 0 \Leftrightarrow L < \frac{\theta+2}{2}\frac{\alpha k + \beta_3}{\beta_2 k + \beta_1}k \equiv \overline{L}(k).$$

Since $\overline{L}(k)$ is an increasing function with respect to k and $\underline{L}(k) < \overline{L}(k)$ for $k > 0$ holds (see Appendix), $\overline{L}(k)$ can be shown as in Figure 1. Country j can gain by the simultaneous introduction of import tariffs when the pair of (k, L) is below $\overline{L}(k)$.

As a result, I obtain the following proposition.

Proposition 4. *Assume $\alpha - 2c_{ii}^{FT} > 0$ for $i = H, F$. In a two-country economy, if countries start at global free trade, the simultaneous introduction of import tariffs improves welfare in both countries if and only if $\underline{L}(k) < L < \overline{L}(k)$.*

Proof. *See Appendix.*

The simultaneous introduction of import tariffs improves welfare in both countries even when the degree of asymmetry across countries is large: one country has a larger population and productivity index than the other.

[12]Note that from (9), $c_{ii}^{FT} = c_{jj}^{FT}$ since $\tau_{ji} = \tau_{ij} = 1$

5 Conclusion

By incorporating ad valorem import tariffs, this study examines the impact of bilateral trade policy on welfare in a two-country model with heterogeneous firms and variable markups a la Melitz and Ottaviano (2008). In this model, an increase in a country's import tariff affects its welfare through three channels: term-of-trade effect, profit-shifting effect, and volume-of-trade effect. Although the first two channels increase the welfare level of a tariff-imposing country, these two effects generate externalities that affect the welfare of the tariff-imposed country. In particular, the profit-shifting externality has two opposite effects: an increase in a country's import tariff shifts profits from less productive exporters to more productive exporters within the tariff-imposed country.

Main findings of this study are summarized as follows. First, Nash tariffs are positive and higher than the efficient import tariffs that the countries adopt to maximize the total welfare level of the countries. Second, if countries cooperatively set import tariffs, the efficient tariff that maximizes the total welfare level of the two countries is positive when an introduction of a country's import tariff generates only a small negative profit-shifting externality or when it generates a positive profit-shifting externality. Third, starting at global free trade, a simultaneous introduction of import tariffs can improve the welfare of both countries not only when countries are close to symmetric, but also when the degree of asymmetry across countries is large: when one country has a relatively larger population size and more high-productivity firms compared to the other country.

References

Bagwell, Kyle, and Seung Hoon Lee. 2018. "Trade policy under monopolistic competition with heterogeneous firms and quasi-linear ces preferences." *manuscript*.

Bagwell, Kyle, and Seung Hoon Lee. 2020. "Trade policy under monopolistic competition with firm selection." *Journal of International Economics*, 127: 103379.

Campolmi, Alessia, Harald Fadinger, and Chiara Forlati. 2018. "Trade and domestic policies under monopolistic competition." *manuscript*.

Chen, Natalie, Jean Imbs, and Andrew Scott. 2009. "The dynamics of trade and competition." *Journal of International Economics*, 77(1): 50–62.

Costinot, Arnaud, Andrés Rodríguez-Clare, and Iván Werning. 2020. "Micro to macro: Optimal trade policy with firm heterogeneity." *Econometrica*, 88(6): 2739–2776.

De Loecker, Jan, and Frederic Warzynski. 2012. "Markups and firm-level export status." *American Economic Review*, 102(6): 2437–71.

De Loecker, Jan, Pinelopi K. Goldberg, Amit K. Khandelwal, and Nina Pavcnik. 2016. "Prices, markups, and trade reform." *Econometrica*, 84(2): 445–510.

Demidova, Svetlana. 2017. "Trade policies, firm heterogeneity, and variable markups." *Journal of International Economics*, 108: 260–273.

Demidova, Svetlana, and Andrés Rodríguez-Clare. 2009. "Trade policy under firm-level heterogeneity in a small economy." *Journal of International Economics*, 78(1): 100–112.

Dhingra, Swati, and John Morrow. 2019. "Monopolistic competition and optimum product diversity under firm heterogeneity." *Journal of Political Economy*, 127(1): 196–232.

Feenstra, Robert C., and David E. Weinstein. 2017. "Globalization, markups, and US welfare." *Journal of Political Economy*, 125(4): 1040–1074.

Felbermayr, Gabriel, Benjamin Jung, and Mario Larch. 2013. "Optimal tariffs, retaliation, and the welfare loss from tariff wars in the Melitz model." *Journal of International Economics*, 89(1): 13–25.

Haaland, Jan I, and Anthony J Venables. 2016. "Optimal trade policy with monopolistic competition and heterogeneous firms." *Journal of International Economics*, 102: 85–95.

Hottman, Colin J., Stephen J. Redding, and David E. Weinstein. 2016. "Quantifying the sources of firm heterogeneity." *The Quarterly Journal of Economics*, 131(3): 1291–1364.

Mayer, Thierry, Marc J. Melitz, and Gianmarco I.P. Ottaviano. 2014. "Market size, competition, and the product mix of exporters." *American Economic Review*, 104(2): 495–536.

Mayer, Thierry, Marc J. Melitz, and Gianmarco I.P. Ottaviano. 2016. "Product mix and firm productivity responses to trade competition." *The Review of Economics and Statistics*, 1–59.

Melitz, Marc J. 2003. "The impact of trade on intra-industry reallocations and aggregate industry productivity." *Econometrica*, 71(6): 1695–1725.

Melitz, Marc J., and Gianmarco I.P. Ottaviano. 2008. "Market size, trade, and productivity." *The Review of Economic Studies*, 75(1): 295–316.

Mrázová, Monika. 2021. "Trade agreements when profits matter." *manuscript.*

Mrázová, Monika, and J Peter Neary. 2019. "Selection effects with heterogeneous firms." *Journal of the European Economic Association*, 17(4): 1294–1334.

Nocco, Antonella, Gianmarco I.P. Ottaviano, and Matteo Salto. 2014. "Monopolistic competition and optimum product selection." *American Economic Review*, 104(5): 304–09.

Nocco, Antonella, Gianmarco I.P. Ottaviano, and Matteo Salto. 2019. "Geography, competition, and optimal multilateral trade policy." *Journal of International Economics*, 120: 145–161.

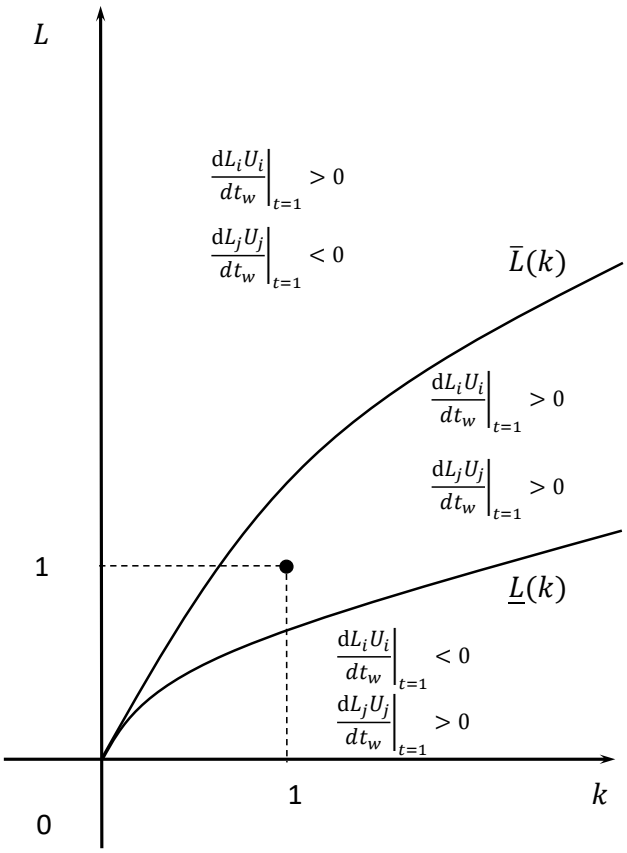

Figure 1: Mutual gains from leaving global free trade