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The Optimal Degree of Reciprocity in Tariff Reduction*

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This paper characterizes the optimal reciprocal trade policy in the environment of Melitz (2003) with firm productivity heterogeneity. In particular, without making parametric assumptions on firm productivity distribution, this paper derives the optimal degree of reciprocal tariff reductions that maximize the world welfare. A reciprocal import subsidy raises the industry productivity, lowering aggregate price; a reciprocal import tariff helps correct the markup distortion, increasing nominal income. With all the conflicting effects of import tariffs on welfare considered, the optimal degree of reciprocity in multilateral tariff reduction is shown to be free trade.

Keywords: Firm Heterogeneity, Reciprocal Trade Policy, Import Tariff, Markup Distortion, Aggregate Productivity

JEL Classification: F12, F13, F15

I. INTRODUCTION

This article contributes to the literature of optimal trade policy in the environment of Melitz (2003) with firm productivity heterogeneity. In particular, without making parametric assumptions on firm productivity distribution, this paper derives the optimal degree of reciprocal tariff reductions that maximize the world welfare. A reciprocal import subsidy raises the industry productivity by shifting market shares toward the more productive exporting firms and trimming the least productive firms. On the other hand, a reciprocal import tariff (by a wedge equal to the monopolistic

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markup) equalizes the opportunity cost of consuming foreign and local varieties, correcting the markup distortion identified by Gros (1987). The two countervailing considerations offset each other at the world aggregate level. Thus, the old doctrine of reciprocal free trade championed in the classical paradigm of perfect competition with homogeneous goods continues to hold up in a world with monopolistic competition and heterogeneous firms.

The optimal trade policy under firm heterogeneity has been analysed by Demidova and Rodríguez-Clare (2009) in a small-country setting and Felbermayr, Jung and Larch (2013) in a large-country setting, under the Pareto assumption for the firm productivity distribution. Their focus is, however, on the *unilateral* optimal degree of trade interventions. The unilateral optimal tariff was shown to be positive, and can be decomposed into wedges corresponding to the markup distortion, entry distortion, and terms-of-trade externality (with the third component present only in the large-country case). Analysis of unilateral optimal policy for small-open economies was further extended by Haaland and Venables (2016) to allow for the presence of an additional perfectly-competitive sector.

The studies by Baldwin (2005) and Baldwin and Forslid (2006) analysed the impacts of trade liberalization on firm-level dynamics and aggregate welfare. Their analysis suggests that countries gain from reciprocal trade freeness. They, however, model the policy variable in terms of iceberg trade cost (rather than tariffs). This limits the policy option to the non-negative domain, and implies a monotonic relationship between trade freeness and aggregate welfare in this domain. As our analysis below suggests, the strength of trade cost on firm dynamics is not identical to that of tariffs, and trade freeness beyond free trade (with reciprocal positive import subsidy) is suboptimal.

This paper is also related to the work of Bagwell and Lee (2018), who studied the unilateral optimal, jointly optimal, and Nash equilibrium trade policy in the Melitz setup, but with Pareto productivity distribution and an additional competitive sector. They find that starting at global free trade, efficiency is enhanced with small import subsidies. This is contrary to the current paper's conclusion. This suggests that labor mobility across sectors (or in general, endogenous changes in the size of labor force employed in the Melitz-type sector), a mechanism not present in the current paper, may introduce another incentive for trade intervention. I elaborate on this further after developing the current paper's theoretical framework.

In Section 2, I start by clarifying the roles played by trade policy, in contrast with iceberg trade cost in the setting of Melitz (2003), before characterizing the optimal reciprocal trade policy. Import tariffs and iceberg trade cost were often taken to be equivalent in the literature following Melitz (2003), and trade liberalization was often modeled as a consequence of exogenous reduction in trade cost. This is contrary to the focus of trade liberalization in practice where trade policy plays a central role and its level is an object of negotiation.

I show in Section 2.3 that import tariffs have a more severe trade-restricting effect than iceberg trade cost, such that the cutoff productivity level for firms to produce is lower and the cutoff productivity level for firms to export is higher. As a result, a larger mass of local firms (varieties) and a smaller mass of competing foreign firms (varieties) can survive with import tariffs than with iceberg trade cost.

The characterization of welfare also changes qualitatively when trade cost is replaced by import tariffs (Section 2.4). In particular, one needs to take into account the nominal income change (via tariff revenues) in addition to the aggregate productivity (price) change as the tariff rate varies. Tariff revenues increase non-monotonically as the tariff increases above the free trade level, while the price decreases non-monotonically as the tariff decreases below the free trade level. The net effect of the two, however, has a unique maximum, and free trade is demonstrated to be the optimal reciprocal policy (Section 2.5). This finding of free trade optimality is nontrivial, given the presence of imperfect competition and price markup on one hand (which tends to encourage the use of import tariffs) and the presence of endogenous intra-industry reallocations of market shares across firms of heterogeneous productivity on the other hand (which tends to encourage the use of import subsidies).

Further discussions of the paper's mechanisms and their parallels to the literature are provided in Section 2.6. Section 3 concludes.

II. MODEL

1. Setup

In Melitz (2003), it is assumed that there are $(n+1)$ symmetric countries, each with a population size L. In each country, a representative consumer has a C.E.S. utility function with an exponent ρ over a continuum of goods. The set of goods produced are endogenously determined and are produced using labor alone. Wage is taken to be the numeraire. There is an unbounded mass of potential firms, who can choose to pay a fixed entry investment cost f_e to draw a productivity parameter φ from a common distribution $g(\varphi)$ and decide whether to produce a good (variety). To produce a good, a firm has to pay a fixed overhead cost f and a constant marginal cost $\frac{1}{\varphi}$. To export to each of the other n countries, a firm has to pay in addition a fixed trade cost f_x, and incur a variable iceberg trade cost; that is, τ units of a good must be shipped in order for one unit to arrive at destination. If firms decide to produce, there is a probability δ per period that they will be hit by bad shocks and exit the market. Given the above cost structure that applies every period, firms calculate the expected profits of entry based on the productivity distribution $g(\varphi)$ and enter the market if the expected profits from all future periods cover the entry cost f_e. Equilibrium is characterized by the cutoff productivity level φ^* for production, the cutoff productivity level φ_x^* for firms to export, the mass M of local varieties produced, and the mass M_x of local varieties exported (or equivalently, the mass of imported varieties from each of the trading partners).

2. Tariffs versus Trade Cost

Let the setup be the same as in Melitz (2003), but let the variable trade cost be replaced by import tariffs. Let τ denote one plus the ad valorem tariff rate. Given the C.E.S. preference, a firm with a productivity level φ will charge a producer price $p_d = \frac{1}{\rho\varphi}$, which is also the consumer price at home, but will charge a higher consumer price abroad $p_x = \frac{\tau}{\rho\varphi}$ to reflect the import tariff. The firm sells a quantity $q_d = Q(p_d/P)^{-\sigma}$ and receives a revenue $r_d = p_d q_d = E(p_d/P)^{1-\sigma}$ in its home market, where $\sigma = \frac{1}{1-\rho}$ is the elasticity of substitution across goods that enter the utility function and equivalently the aggregate quantity index Q, P is the associated aggregate price of the goods, and $E \equiv PQ$ is the corresponding aggregate expenditure. The firm, if it exports, sells a quantity $q_x = Q(p_x/P)^{-\sigma}$ and receives a revenue $r_x = p_d q_x = \tau^{-\sigma} r_d$ from each of the n overseas markets. Let $\pi_d \equiv r_d - (f + q_d/\varphi)$ and $\pi_x \equiv r_x - (f_x + q_x/\varphi)$ denote the corresponding profits made from catering to the domestic market and from each of the n overseas markets by the firm.

Comparing the above expressions with those in Melitz (2003), we could see that import tariffs differ from iceberg trade cost in two fundamental ways. First, recall that in the case of iceberg trade cost, an exporter receives an export revenue $p_x q_x$ from each of the n overseas markets, which is higher compared with the export revenue $p_d q_x$ in the current case of import tariffs. To see why, note that the export revenue in the case of iceberg trade cost can be read in two ways: $p_x q_x = \tau p_d q_x$ (that is, for the consumer in the importing country, the consumer price of the imported good is effectively $p_x = \tau p_d$ for each unit of the good actually received) or $p_x q_x = p_d \tau q_x$ (that is, for the exporter, the producer price is p_d, but more units, τq_x, are produced than actually consumed, q_x). The exporting firm effectively sells the extra units of the good $(\tau - 1)q_x$ that melt away in transit to the consumer at the producer price p_d and receives a revenue $p_d(\tau - 1)q_x$ for producing them. Thus, at the end of the day, the exporter does not bear the iceberg trade cost (although its sales volume q_x is indirectly affected by the higher consumer price p_x); the importing country does. In the case of import tariffs, the exporting firm pays the tariff revenue $(\tau - 1)p_d q_x$ out of its gross sales $p_x q_x$ and receives a net export revenue $p_d q_x$ from each of the n overseas markets. Thus, exporters are affected more severely by import tariffs than iceberg trade cost by a factor of τ in terms of export revenues. As will be shown below, this difference leads to changes in the cutoff productivity level for export (as it takes a more productive firm in the case of import tariffs to make enough revenues to cover the cost of export) and in the cutoff productivity level for production, as well as in the mass of local and foreign varieties available.

Second, although both types of trade restriction leads to a higher overseas consumer price p_x (relative to p_d in the domestic market for a given variety), in the case of import tariffs, the price premium is captured by the importing country as tariff revenues, and the country as a whole pays the same producer price p_d as the home country of the producer; in the case of iceberg trade cost, the units of the good that melt away during the transit are lost to the importing country. Thus, with import tariffs, the welfare calculation changes, as tariff revenues now enter as an extra source of income in addition to the wage income. With import tariffs, the focus of welfare calculation also changes from a positive question (what is the impact on a country's welfare as the level of trade cost changes following an exogenous technology shock) to a normative question (what is the optimal reciprocal tariff rate for countries to levy). With iceberg trade cost, τ is necessarily greater than one; with trade policy, τ could range from being less than one (an import subsidy), one (free trade), to greater than one (an import tariff).

The trade policy studied in this paper corresponds to the multilateral, reciprocal, import policy that is agreed upon by countries and imposed simultaneously against each other. Although the export policy will not be analyzed, the equivalence of an export subsidy (tax) and an import subsidy (tariff) in the current setting is understood. In the current setting with symmetric countries, a country's aggregate export revenue earned by its exporting firms is equal to its aggregate value of imports f.o.b. from its trading partners. Thus, countries by agreeing to levying a reciprocal import tariff $(\tau - 1)$, which discourages the quantity of imports and collects tariff revenues on the reduced import volume, is equivalent to levying a reciprocal export tax of the same magnitude, which reduces the quantity of exports and collects tax revenues from these reduced exports. Both discourage the volume of trade while generate tax revenues. Similarly, a reciprocal import subsidy is equivalent to a reciprocal export subsidy of the same magnitude. Thus, in this setting, it is sufficient to focus the policy negotiations on just the imports or the exports. With this equivalence noted, the following discussions continue with the reference to the import tariff.

3. Characterization of Firm-level Equilibrium

Following the characterization in Melitz (2003), let $\tilde{\varphi}(\varphi)^{\sigma-1} = \frac{1}{1-G(\varphi)}\int_{\varphi}^{\infty}\xi^{\sigma-1}g(\xi)d\xi$, $k(\varphi) = [\tilde{\varphi}(\varphi)/\varphi]^{\sigma-1} - 1$, and $j(\varphi) = [1 - G(\varphi)]k(\varphi)$, where $G(\varphi)$ is the cumulative distribution function corresponding to $g(\varphi)$, $\tilde{\varphi}(\varphi)$ represents the weighted average of firm productivities above a cutoff level φ, $k(\varphi)$ the average firm profit derived from the domestic (overseas) market as a ratio of fixed overhead (export) cost, and $j(\varphi)$ the corresponding unconditional expected profit. Note that $j'(\varphi) = -\frac{1}{\varphi}(\sigma - 1)[1 - G(\varphi)][k(\varphi) + 1] < 0$, as shown in Melitz (2003). Firms with the productivity level φ^* and φ_x^* make just enough variable profits from the domestic market and overseas markets to cover the fixed overhead production cost and the fixed export cost, respectively: $\pi_d(\varphi^*) = r_d(\varphi^*)/\sigma - f = 0$, $\pi_x = r_x(\varphi_x^*)/\sigma - f_x = 0$. These define their relationship:

$$\varphi_x^* = \tau^{\frac{\sigma}{\sigma-1}}(f_x/f)^{\frac{1}{\sigma-1}}\varphi^*. \tag{1}$$

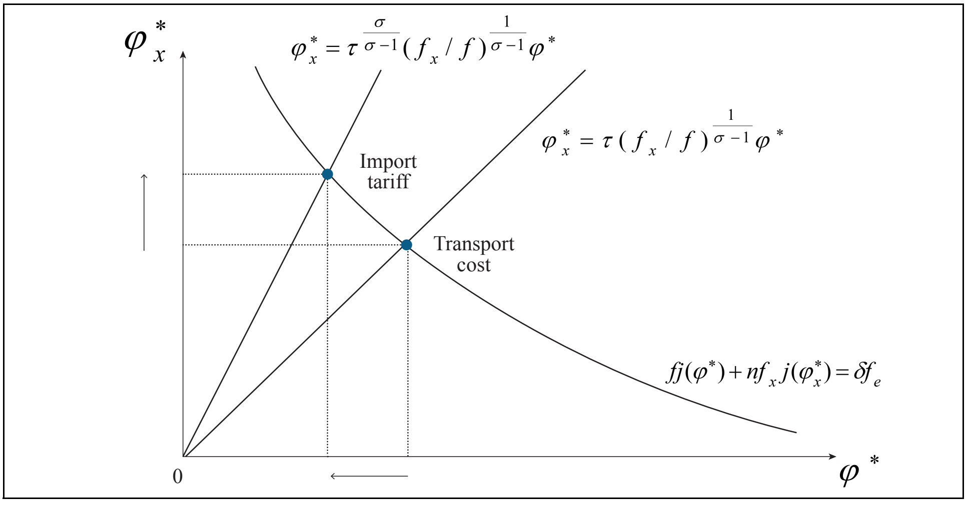
It is assumed that $\tau^{\sigma}f_x > f$ so that not all firms export. This is a weaker condition on the magnitude of trade restriction than in Melitz (2003) by a factor of τ for $\tau > 1$;

the reason for such a difference is the same as mentioned above that exporting is made more difficult with import tariffs than with iceberg trade cost. Free entry ensures that the expected profit of entry equals the entry cost, which leads to another condition on the cutoff productivity levels:

$$fj(\varphi^*) + nf_x j(\varphi_x^*) = \delta f_e, \tag{2}$$

which is the same as in Melitz (2003). Thus, (1) and (2) determine the cutoff productivity levels φ^* and φ_x^*. It is worth noting that the equilibrium lower cutoff productivity level φ^* will be lower and the export cutoff productivity level φ_x^* will be higher with import tariffs than with iceberg trade cost of the same magnitude, as illustrated in Figure 1. This is because (2) is the same in both cases depicting a negative relationship between the two cutoff productivity levels to maintain a constant expected profit of entry. On the other hand, (1) drawing a positive relationship between the two cutoff productivity levels (derived based on relative market shares) has a higher positive slope with import tariffs than with iceberg trade cost. Thus, import tariffs harm exporters and protect local producers more than iceberg trade cost. The average firm profit for successful entrants $\overline{\pi} = \delta f_e / [1 - G(\varphi^*)]$ is therefore lower with import tariffs than with iceberg trade cost.

Figure 1. Relative magnitude of lower cutoff φ^* and export cutoff φ_x^* productivity levels with import tariffs and with iceberg trade cost



It is straightforward to verify that an increase in the import tariff has qualitatively similar effects as an increase in the iceberg trade cost on all the firm level variables such as φ^*, φ_x^*, domestic sales $r_d(\varphi)$ for $\varphi > \varphi^*$, and combined domestic and overseas sales $r_d(\varphi) + nr_x(\varphi)$ for $\varphi > \varphi_x^*$. For example, an increase in import tariffs will lower the survival cutoff productivity level but raises the bar for firms to export:

$$\frac{\partial \varphi^*}{\partial \tau} = -\frac{\sigma}{\sigma-1}\frac{\varphi^*}{\tau}\frac{nf_x j'(\varphi_x^*)\varphi_x^*}{fj'(\varphi^*)\varphi^*+nf_x j'(\varphi_x^*)\varphi_x^*} < 0, \tag{3}$$

$$\frac{\partial \varphi_x^*}{\partial \tau} = -\frac{fj'(\varphi^*)}{nf_x j'(\varphi_x^*)}\frac{\partial \varphi^*}{\partial \tau} > 0. \tag{4}$$

It also increases a firm's domestic sales, lowers an exporter's overseas sales, and overall decreases an exporter's combined domestic and overseas sales: $\frac{\partial r_d(\varphi)}{\partial \tau} > 0$, and $\frac{\partial [r_d(\varphi)+nr_x(\varphi)]}{\partial \tau} < 0$.

4. Characterization of Aggregate Equilibrium and Welfare

I now characterize the aggregate equilibrium. Let R denote the aggregate firm revenue and TR the aggregate tariff revenue. In equilibrium, a country's aggregate expenditure $E = TR + R$ equals its aggregate income $TR + L$ (the aggregate firm profit Π does not enter the aggregate income calculation separately, as with free entry, it is equal to the aggregate labor L_e used for entry investment that is part of L). This implies that $R = L$. The same condition appeared in Melitz (2003). However, bear in mind that in the case of import tariffs, the average firm profit is lower and the probability of export conditional on successful entry $\mathbf{p}_x \equiv [1 - G(\varphi_x^*)]/[1 - G(\varphi^*)]$ is lower; thus, the average firm revenue $\bar{r} \equiv \sigma(\bar{\pi} + f + n\mathbf{p}_x f_x)$ is lower as well. As a result, a larger mass of local firms (goods) $M = R/\bar{r} = L/\bar{r}$ can be supported with import tariffs compared with iceberg trade cost. On the other hand, the mass of foreign varieties imported from each trading partner $M_x \equiv \mathbf{p}_x M = \frac{L/\bar{r}}{1/\mathbf{p}_x} = \frac{L/\sigma}{\bar{\pi}/\mathbf{p}_x + f/\mathbf{p}_x + nf_x} = \frac{L/\sigma}{\delta f_e/[1-G(\varphi_x^*)] + f/\mathbf{p}_x + nf_x}$ is smaller with import tariffs than with iceberg trade cost, as both the unconditional probability of export $1 - G(\varphi_x^*)$ and the conditional probability of export $\mathbf{p}_x$ are lower.

The welfare per capita

$$W = \frac{Q}{L} = \frac{(R+TR)/P}{L} = (1 + TR/L)P^{-1} \tag{5}$$

reflects the real wage component P^{-1} shown in Melitz (2003) and a new component representing the extra source of income from the transfer of tariff revenues $(TR/L)P^{-1}$ in real terms. Let us introduce some notations to characterize these welfare components. First, note that the portion of export sales in the aggregate firm revenue differ from Melitz (2003) by a factor of τ:

$$\begin{aligned} R &= M\bar{r}_d + nM_x\bar{r}_x \\ &\equiv M\left(\frac{\tilde{\varphi}}{\varphi^*}\right)^{\sigma-1} r_d(\varphi^*) + nM_x\left(\frac{\tilde{\varphi}_x}{\varphi_x^*}\right)^{\sigma-1} r_x(\varphi_x^*) \\ &= M\left(\frac{\tilde{\varphi}}{\varphi^*}\right)^{\sigma-1} r_d(\varphi^*) + nM_x\left(\frac{\tilde{\varphi}_x}{\varphi^*}\right)^{\sigma-1}\left(\frac{\varphi^*}{\varphi_x^*}\right)^{\sigma-1} r_d(\varphi_x^*)\tau^{-\sigma} \\ &= M\left(\frac{\tilde{\varphi}}{\varphi^*}\right)^{\sigma-1} r_d(\varphi^*) + nM_x\left(\frac{\tilde{\varphi}_x}{\varphi^*}\right)^{\sigma-1} r_d(\varphi^*)\tau^{-\sigma}, \end{aligned}$$

where $\tilde{\varphi} \equiv \tilde{\varphi}(\varphi^*)$ and $\tilde{\varphi}_x \equiv \tilde{\varphi}(\varphi_x^*)$. Let $M_t \equiv M + nM_x = (1 + n\mathbf{p}_x)M$ denote the total mass of varieties available in each country. Define $\hat{\varphi}_t^{\sigma-1} \equiv [M\tilde{\varphi}^{\sigma-1} + nM_x(\tilde{\varphi}_x/\tau)^{\sigma-1}\tau^{-1}]/M_t$, where $\hat{\varphi}_t$ can be regarded as the weighted average productivity of all firms with their relative output shares as the weights (exporters with a productivity level φ behave in overseas markets just like a local firm with a productivity level φ/τ in terms of pricing and output shares) and with the productivity of all exporters further down-weighted by a factor τ reflecting the part of overseas sales paid to the importing country as tariffs and not captured as export revenues. It follows that

$$R = M_t r_d(\hat{\varphi}_t) = L. \tag{6}$$

Similarly note that,

$$R + TR = M\bar{r}_d + nM_x\bar{r}_x + (\tau - 1)nM_x\bar{r}_x$$
$$= M_t r_d(\tilde{\varphi}_t), \tag{7}$$

with $\tilde{\varphi}_t^{\sigma-1} \equiv [M\tilde{\varphi}^{\sigma-1} + nM_x(\tilde{\varphi}_x/\tau)^{\sigma-1}]/M_t$, where $\tilde{\varphi}_t$ is the average productivity of all firms weighted by their relative output shares. In the case of iceberg trade cost, there is not such a distinction between (6) and (7); instead, it holds that $R = M_t r_d(\tilde{\varphi}_t) = L$ as seen in Melitz (2003). Next, one can verify that

$$P = M_t^{\frac{1}{1-\sigma}} p_d(\tilde{\varphi}_t), \tag{8}$$

whose expressions are the same as in Melitz (2003), as trade cost and tariffs have the same effect on pricing behaviors of firms. Using (6), (7), and (8), we can show that

$$1 + TR/L = \left(\frac{\tilde{\varphi}_t}{\hat{\varphi}_t}\right)^{\sigma-1}, \tag{9}$$

$$P^{-1} = \rho\left(\frac{L}{\sigma f}\right)^{\frac{1}{\sigma-1}}\left(\frac{\tilde{\varphi}_t}{\hat{\varphi}_t}\right)\varphi^*, \tag{10}$$

$$W = \rho\left(\frac{L}{\sigma f}\right)^{\frac{1}{\sigma-1}}\left(\frac{\tilde{\varphi}_t}{\hat{\varphi}_t}\right)^{\sigma}\varphi^*. \tag{11}$$

5. Optimal Reciprocal Trade Policy

I now characterize the comparative statics of the income component and the price component of the welfare as the tariff rate changes. Given the definitions of $\tilde{\varphi}_t$ and $\hat{\varphi}_t$, note that

$$\left(\frac{\tilde{\varphi}_t}{\hat{\varphi}_t}\right)^{\sigma-1} = \frac{1 + n\mathbf{p}_x(\tilde{\varphi}_x/\tilde{\varphi})^{\sigma-1}\tau^{1-\sigma}}{1 + n\mathbf{p}_x(\tilde{\varphi}_x/\tilde{\varphi})^{\sigma-1}\tau^{-\sigma}} = \frac{1 + nB\tau^{1-\sigma}}{1 + nB\tau^{-\sigma}},$$

where $B \equiv \mathbf{p}_x \left(\frac{\tilde{\varphi}_x}{\tilde{\varphi}}\right)^{\sigma-1} = \frac{\left[\int_{\varphi_x^*}^{\infty} \varphi^{\sigma-1} g(\varphi) d\varphi\right]}{\left[\int_{\varphi^*}^{\infty} \varphi^{\sigma-1} g(\varphi) d\varphi\right]}$, which is (roughly speaking) the market-share weighted cumulative density of exporting firms relative to that of all active firms. Obviously, this decreases in the tariff rate ($\partial B/\partial \tau < 0$), since fewer firms enter the export market and more firms enter the local market with a higher tariff, as shown in (3) and (4). It can be shown that

$$\frac{\partial}{\partial \tau}\left(\frac{\tilde{\varphi}_t}{\hat{\varphi}_t}\right)^{\sigma-1} = \left(\frac{\tilde{\varphi}_t}{\hat{\varphi}_t}\right)^{\sigma-1} \left(\frac{nB\tau^{-\sigma}(1+nB\tau^{-\sigma})+\sigma nB\tau^{-\sigma-1}(1-\tau)}{(1+nB\tau^{1-\sigma})(1+nB\tau^{-\sigma})} + \frac{n\tau^{-\sigma}(-\partial B/\partial \tau)(1-\tau)}{(1+nB\tau^{1-\sigma})(1+nB\tau^{-\sigma})}\right), \tag{12}$$

which is positive for $\tau \leq 1$. Thus, the tariff rate that maximizes a country's tariff revenue (and hence income) is positive.

This income effect needs to be weighed against the effect of tariffs on the price level P. It is not immediately clear whether a higher tariff will increase or decrease the aggregate price level. A higher tariff increases the consumer price of imports, but at the same time decreases the output shares (and hence the importance) of imports in the aggregate price index; on the other hand, a higher tariff also admits the survival of less productive firms who charge a higher price. It can be shown that the net effect of an increase in the import tariff above free trade will drive the overall price level up, which imposes a negative effect on welfare. To show this, first note that (3) can be re-expressed as $\frac{\partial \varphi^*}{\partial \tau}\frac{1}{\varphi^*} = -\frac{\sigma}{\sigma-1}\frac{nB\tau^{-\sigma-1}}{1+nB\tau^{-\sigma}}$. Using this and (12), it follows that

$$\begin{aligned}\frac{\partial P^{-1}}{\partial \tau} &= P^{-1}\left(\frac{\partial(\tilde{\varphi}_t/\hat{\varphi}_t)}{\partial \tau}\frac{1}{(\tilde{\varphi}_t/\hat{\varphi}_t)} + \frac{\partial \varphi^*}{\partial \tau}\frac{1}{\varphi^*}\right) \\ &= P^{-1}\frac{1}{\sigma-1}\frac{(1-\sigma)nB\tau^{-\sigma}(1+nB\tau^{-\sigma})+n\tau^{-\sigma}(-\partial B/\partial \tau)(1-\tau)}{(1+nB\tau^{1-\sigma})(1+nB\tau^{-\sigma})},\end{aligned} \tag{13}$$

which is negative for $\tau \geq 1$.

Thus, starting from free trade, there is an incentive to impose an import tariff due to income consideration, but at the same time, there is an incentive to provide an import subsidy due to price consideration. The following derivations show how these two considerations work against each other at different levels of import tariff rates:

$$\frac{\partial W}{\partial \tau} = W\left(\frac{\partial(1+TR/L)}{\partial \tau}\frac{1}{1+TR/L} + \frac{\partial P^{-1}}{\partial \tau}\frac{1}{P^{-1}}\right)$$
$$= W\frac{\sigma}{\sigma-1}\frac{(\sigma-1)nB\tau^{-\sigma-1}(1-\tau)+n\tau^{-\sigma}(-\partial B/\partial\tau)(1-\tau)}{(1+nB\tau^{1-\sigma})(1+nB\tau^{-\sigma})}, \tag{14}$$

where the second equality follows by using the results in (12) and (13). Thus,

$$\frac{\partial W}{\partial \tau} \gtreqless 0 \Leftrightarrow \tau \lesseqgtr 1,$$

and the welfare per capita is maximized at the free trade level. By increasing the import tariff rate above the free trade level, the negative impact of a higher price level outweighs any potential positive impact on income through tariff revenues. Conversely, the negative impact of a lower national income by providing an import subsidy would outweigh any potential positive impact of a lower price level. The optimal reciprocal tariff rate that will maximize every country's welfare turns out to be zero.

This result is nontrivial given the fact that firms are heterogeneous in their productivities and trade policy may alter the composition of firms and hence the industry aggregate productivity. For example, it may be tempting to argue that a reciprocal import subsidy is beneficial, as it raises the industry productivity by shifting market shares toward the more productive exporting firms and trimming the least productive firms. The result above demonstrates that the positive productivity effect, reflected in lower prices, of an import subsidy would be dominated by the subsidy cost.

On the other hand, a frequently heard argument for an import tariff in a monopolistically competitive setting is the distortion introduced by the price markup. In particular, the price of domestic varieties does not reflect their true opportunity cost but are at a markup above their marginal cost of production, whereas the offshore price of imported varieties reflects the importing country's true opportunity cost to obtain these goods. An import tariff on foreign varieties equal to the monopolistic markup restores the relative market prices of foreign versus domestic varieties to their relative opportunity costs, and encourages more consumption of local varieties. The result above shows that such potential positive effects on welfare of an import tariff would be more than offset by its negative impact on the aggregate productivity. Thus, the old doctrine for reciprocal free trade established in the classical paradigm of perfect competition with homogeneous goods remains to hold in a world with monopolistic competition and heterogeneous firms.

6. In Relation to the Literature

To understand the paper's result further in terms of the literature's language, I now draw the parallel between the paper's mechanisms to those identified by the literature. First, the incentive to impose import tariffs due to income consideration is akin to the incentive to correct the markup distortion (the discrepancy between the relative market price and the relative opportunity cost of the domestic and foreign varieties) as discussed above. On the other hand, the incentive to provide import subsidy so as to lower the aggregate price is akin to the incentive to correct the entry distortion identified in the literature (where consumers do not take into account that their spending on imports increases entry by foreign producers, hence the mass of imported varieties). Given that countries are symmetric in the current paper, the terms-of-trade incentive for trade intervention is neutralized with reciprocal liberalization. The optimality of free trade concluded above suggests that the markup and entry distortions offset each other exactly, with balanced market size and with reciprocal free trade. This is in contrast with the literature considering unilateral tariff changes, where the entry distortion is typically found to be dominated by the markup distortion starting from free trade, and as a result, a positive import tariff is welfare-improving. Here, with multilateral trade policy coordination, an import subsidy not only increases foreign varieties' presence in the domestic market, it also increases the entry of local varieties into foreign markets due to more favorable market access reciprocated by foreign countries via an equivalent import subsidy. This amplifies the impact of an import subsidy on industry aggregate productivity, and rivals exactly the incentive for an import tariff to correct the markup distortion, hence the optimality of free trade.

Jørgensen and Schröder (2008) also study the optimal reciprocal trade policy in a setting with heterogeneous firms. However, they model the firm heterogeneity in terms of fixed export cost rather than firm productivities. Firms are identical otherwise. Thus, the dynamic effects of trade policy on the industry aggregate productivity as emphasized here are absent in their framework. Contrary to the current result, they found that the optimal reciprocal import tariff rate is positive. This difference may be explained by the fact that the negative impact of a positive import tariff on the aggregate productivity (and hence on the welfare level) is not taken into account in their framework.

Contrary to multilateral, reciprocal, trade policies, unilateral trade policies are another interesting question. This was studied, for example, by Demidova and

Rodríguez-Clare (2009) in a small-economy setting. Because of the small-economy setting, asymmetric economic structures across countries are allowed; however, parametric assumptions have to be imposed to derive their results. In their framework, trade restrictions will not play a symmetric role as here on the importing and the exporting country, since the rest of the world's expenditure, price level, and cost structure are taken to be fixed. They found that the optimal unilateral policy for a small economy is an import tariff, an export tax, or a consumption subsidy of the same magnitude. This lack of incentives to further lower the import tariff unilaterally to the free trade level may be explained by the lack of extra export revenues (and extra push to the aggregate productivity level) that would be generated if the tariff reduction were reciprocal.

As discussed in the introduction, Bagwell and Lee (2018) find that starting at global free trade, efficiency is enhanced with small import subsidies in the Melitz setup, with Pareto productivity distribution and an additional competitive sector. This finding, contrary to the current paper's, is likely due to the presence of the competitive sector and the possibility of labor reallocation across sectors. In particular, with the additional sector that is perfectly competitive, the market price of the differentiated goods relative to the competitive good is higher than their relative marginal cost of production, since the former sector's goods are priced at a markup over marginal cost, in contrast with the latter sector where price is set at marginal cost. Thus, from the social planner's perspective, the consumption of the differentiated goods, and hence labor allocation to the sector, relative to the competitive sector, is less than optimal without further intervention (from the benchmark of what is called for to address any global inefficiency within the differentiated-good sector, which is shown to be nil in the current paper). An import subsidy in this case lowers the aggregate price of the differentiated-good sector and helps correct this "markup" distortion across sectors.

III. CONCLUSION

As we allow trade restrictions to take on the meaning of trade policy barriers, instead of iceberg trade cost, we see that most of the qualitative effects of trade restrictions on the firm-level variables hold true as they were proposed by Melitz (2003). This similarity probably explains the impressions that trade policy barriers are equivalent to iceberg trade cost. However, we also verify from the above analysis that they are not equivalent in the strength of their trade-restricting effects and of their welfare implications. With import tariffs, welfare includes an extra real tariff revenue component in addition to the real wage component. The variation of welfare with respect to tariff rates can be analyzed by studying the variation of the tariff revenue and the variation of the aggregate price level as the tariff rate changes. Derivations of these comparative statics are complicated by the fact that as the tariff rate varies, the cutoff productivity levels for production and for export and the mass of local and imported varieties all change at the same time, as was the case in Melitz (2003). They are further complicated by the fact that tariff revenues and the aggregate price level are nonlinear in tariff rates in different directions. However, as shown, these derivations are analytically tractable and have sensible economic interpretations. In the end, the conflicting impacts on welfare via these components as the tariff rate varies sum up to a clear-cut result that free trade is the best reciprocal policy.

To conclude, the result of the paper expands the normative support for a free world trading system, from the classical setup of perfect competition to the alternative Melitz (2003) setup with monopolistic competition and firm heterogeneity. Some remarks are in order. The optimality of free trade is derived in this paper with balanced country size and reciprocal trade policy. By allowing for asymmetric country sizes, the efficiency of free trade at the global level likely will continue to hold. However, in this case, large countries benefit less from a reciprocal import subsidy and entry into foreign markets (relative to small countries). The imbalance in welfare concession implies that larger countries are likely to favor import tariffs. As a result, reciprocal trade liberalization likely will stop short of free trade, provided no international transfer mechanism. This might help explain the resistance of developed countries to further multilateral liberalization in the recent decades, with increasingly heterogeneous compositions of GATT/WTO membership and unbalanced concessions.

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