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Abstract

Existing theories of trade agreements suggest that GATT/WTO efforts to reign in export subsidies represent an inefficient victory for exporting governments that comes at the expense of importing governments. Building from the Cournot delocation model first introduced by Venables (1985), we demonstrate that it is possible to develop a formal treatment of export subsidies in trade agreements in which a more benign interpretation of efforts to restrain export subsidies emerges. And we suggest that the gradual tightening of restraints on export subsidies that has occurred in the GATT/WTO may be interpreted as deriving naturally from the gradual reduction in import barriers that member countries have negotiated. Together with existing theories, the Cournot delocation model may help to provide a more nuanced and complete understanding of the treatment of export subsidies in trade agreements.

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1 Introduction

The treatment of export subsidies in trade agreements is puzzling. It is often observed that export subsidies distort market forces and lead to inefficient patterns of trade, and that the use of export subsidies should be restricted by international agreement for this reason. Formalizing this position, however, has proven to be surprisingly elusive. In fact, formal arguments for the treatment of export subsidies in trade agreements point to a starkly different conclusion: rather than restrain export subsidies, international agreements should, if anything, encourage them.[1] At a basic level, this conclusion reflects the trade-volume-expanding nature of export subsidies, which generally aligns these policies with the purpose of a trade agreement.

In practice, the treatment of export subsidies is also complex, and has evolved over time from the early years of the General Agreement on Tariffs and Trade (GATT) to the creation of GATT's successor, the World Trade Organization (WTO).[2] In the early GATT era, a permissive stance was taken on export subsidies, amounting to little more than reporting requirements. Over time GATT restrictions on the use of export subsidies were progressively tightened, and during the final GATT negotiation round (the Uruguay Round) in which the WTO was created, a more comprehensive approach to subsidies was introduced in the Agreement on Subsidies and Countervailing Measures (the SCM Agreement) which includes a prohibition on the use of export subsidies.[3]

Theoretical attempts to understand and interpret the treatment of export subsidies in trade agreements face two challenges. A first challenge is to find situations in which a government actually would be tempted to use an export subsidy. A second challenge is to show that a ceiling on export subsidies would then be beneficial for the negotiating governments. The first step has been taken in the distinct literatures on strategic trade policy and on the political economy of trade policy. The second step is especially perplexing. To be sure, for the models developed in these literatures, the governments of *exporting* countries could enjoy mutual gains from an agreement to impose ceilings on export subsidies. But once importing-country welfare is considered, mutual gains for the negotiating governments would require that exporting countries face *floors* on export subsidies.[4] Therefore, the existing theories imply a provocative interpretation of GATT/WTO efforts to reign in export subsidies: these efforts represent an inefficient victory for exporting governments that comes at the expense of importing governments.

In this paper, we demonstrate that it is possible to develop a formal treatment of export subsidies in trade agreements in which a more benign interpretation of the GATT/WTO efforts to reign in export subsidies emerges. And we suggest that the gradual tightening of restraints on export subsidies that has occurred in the GATT/WTO may be interpreted as deriving naturally from the gradual reduction in import barriers that member countries have negotiated. To make

[1] See, for example, the discussion in Bagwell and Staiger (2002, Ch. 10).
[2] See Sykes (2005) on the evolution of subsidy rules in the GATT/WTO.
[3] The WTO's Agreement on Agriculture provides further elaboration of the rules on subsidies as they apply to agricultural goods.
[4] This is true in the seminal strategic export subsidy model of Brander and Spencer (1985), and it is also true when export subsidies reflect political economy motives (see Bagwell and Staiger, 2001).

these points, we adopt the Cournot delocation model first introduced by Venables (1985). Venables shows that, if countries start at global free trade (i.e., at a set of policies such that each country sets its import and export policy at free trade), then a country gains by introducing a small export subsidy and its trading partner loses. Assuming that countries start at global free trade, Venables also shows that a country gains, and its trading partner again loses, when the country imposes a small import tariff. Venables does not characterize the Nash equilibrium in import and export policies, though, and so does not address the first step mentioned above, namely, confirming that a government actually would use an export subsidy. As well, he does not consider efficiency, and so does not assess the second step mentioned above, namely, confirming that negotiated restraints on export subsidies could lead to mutual gains for the negotiating governments. We focus on a linear model and address both steps.

More specifically, we consider trade policies and agreements in the linear Cournot delocation model. In this model, two countries trade a given homogeneous good subject to trade costs. The markets are segmented and firms compete as Cournot competitors, leading to the possibility of two-way trade in identical products. This model exhibits a firm-delocation effect, whereby a higher trade cost along one channel of trade increases the number of firms in the importing country and decreases the number of firms in the exporting country. And as Venables (1985) emphasizes, by altering the intensity of Cournot competition across markets, the firm-delocation effect can give rise to novel reasons for unilateral trade policy intervention.

We first offer a thorough analysis of the manner in which prices and trade volumes respond to changes in trade costs such as a change in an import or export tax. Following Venables (1985), we then show that, starting at global free trade, the introduction of a small import tariff or export subsidy generates a welfare gain for the intervening country and a welfare loss for its trading partner. We also establish that an efficient set of trade policies in this model entails a net trade tax of zero along each channel of trade; for example, countries achieve an efficient outcome under global free trade. Viewed together, these findings suggest a potential efficiency-enhancing interpretation for WTO rules, which place ceilings on import tariffs and export subsidies.

We show, however, that this interpretation is subtle. In particular, we also consider the Nash equilibrium in trade policies, and we find that export *taxes* are used in the Nash equilibrium, in addition to import tariffs. Thus, if the trade policies of countries are sufficiently close to their non-cooperative levels, then a ceiling on export subsidies by itself would be meaningless.

The finding that countries employ export taxes under non-cooperative interaction arises as well in traditional models that feature perfectly competitive markets; however, it is perhaps unexpected in the Cournot delocation model, given that the optimal export-policy departure from global free trade involves the introduction of an export subsidy. To interpret our characterization of the Nash equilibrium, we show that, if a country's trade policies start at free trade, then that country could gain by introducing a small import tariff combined with a small export tax, where these policy changes are set so as to maintain the free-trade price in the intervening country. This unilateral variation leaves unaltered the level of consumer surplus in the intervening country while generating greater tariff revenue for this country. We provide further interpretation of the Nash equilibrium by showing that, if a country's trade policies start in the neighborhood of free trade, then a novel tariff-complementarity effect exists, whereby the country's import and export tariffs exert a complementary effect on its tariff revenue.

With these results in place, we may then understand why a country is unlikely to use an export subsidy when it is already imposing a significant import tariff. Intuitively, an import tariff induces entry by firms in the intervening country via the firm-delocation effect, which ultimately increases exports and raises the cost of an export-subsidy program. Moreover, we may also understand why, in the presence of a significant import tariff, an export tax begins to look appealing: by inducing entry of firms in the intervening country's trading partner, the firm-delocation effect that is associated with the export tax raises the volume of imports on which the import tariff is applied, thereby enhancing the revenue benefits of the import tariff.

In the Nash equilibrium, therefore, an export tax is used in conjunction with an import tariff. If a tight ceiling on import tariffs is imposed, however, then a country may be tempted to use an export subsidy. From this perspective, we may speculate that the imposition over time in the WTO of tighter restrictions on the use of export subsidies may ultimately be explained by the success that this institution has had over time in facilitating negotiations leading to tighter ceilings on import tariffs by member countries. We thus provide a subtle and potentially rich interpretation of the treatment of export subsidies in the WTO.

Finally, we return to a theme raised in a companion paper (Bagwell and Staiger, 2009) and consider the "politically optimal" policies (the unilateral trade policies that would be chosen if governments were not motivated by the terms-of-trade implications of their respective trade policy selections) in the linear Cournot delocation model. We find that a unique symmetric political optimum exists and that it entails global free trade. Thus, if governments were not motivated by the terms-of-trade implications of their trade policies, then they would achieve an efficient outcome, and in particular each government would eliminate all tariffs and subsidies on imports as well as exports. The prohibition of export subsidies contained in the WTO SCM Agreement is thus compatible with the political optimum in this model. This feature further strengthens the ability of the linear Cournot delocation model to provide an interpretation of the treatment of export subsidies in the GATT/WTO, given that other design features of the GATT/WTO can also be interpreted as guiding governments toward efficient politically optimal outcomes (see Bagwell and Staiger, 1999a, 2009).

The remainder of the paper is organized as follows. In section 2 we develop the linear Cournot delocation model. Section 3 then characterizes unilateral and efficient trade policies, establishing that global free trade is efficient and that from this starting point each country would desire the introduction of a small import tariff or export subsidy. Section 4 derives the Nash equilibrium trade policies, and establishes that the Nash policies involve import tariffs and export taxes. In section 5 we offer an interpretation of these trade policy findings. Finally, section 6 establishes that the unique symmetric politically optimal policies entail global free trade, while section 7 concludes.

2 Cournot Delocation Model

In this section, we develop our model. The model entails two countries that trade a given homogeneous good, where the markets are segmented and firms compete as Cournot competitors. We begin by analyzing the model in a "short-run" setting in which the number of firms is fixed in each country. We then allow for endogenous entry and exit and thus adopt a "long-run" orientation. We present short- and long-run comparative statics results. In later sections, we use this model to analyze trade policies.

2.1 Basic Assumptions

We focus on a good that is produced and consumed in both a domestic or home country and in a foreign country, and we use asterisks ($*$) to denote foreign-country variables.[5] The respective markets are segmented, and so prices may differ across the two markets. The firms compete in a Cournot fashion. As is well known, in this setting, two-way (intra-industry) trade may occur.

To keep the analysis tractable, we assume that demand and cost functions are linear. With the domestic price denoted as P and the foreign price denoted as P^*, the inverse domestic and foreign demand functions are then given by $P(Q) = 1 - Q$ and $P^*(Q^*) = 1 - Q^*$, respectively, where Q denotes the units of the good supplied to the domestic market and Q^* denotes the units of the good supplied to the foreign market. Whether a firm is located in the domestic or foreign market, the firm has a constant marginal cost of production, c, where $1 > c \geq 0$. Each firm also incurs a fixed cost $F > 0$ upon entry. We assume that the fixed cost is never so large as to preclude entry by more than one firm.

Finally, when a domestic firm exports output to the foreign market, it incurs a per-unit trade cost of $\tau^* > 0$; likewise, when a foreign firm exports output to the domestic market, it incurs a per-unit trade cost of $\tau > 0$. As discussed further in the next section, the trade cost facing any firm is the sum of the specific export tariff that its own country imposes, the specific import tariff that the other country imposes, and the per-unit transport cost, $\phi > 0$. Throughout we assume that these trade costs are non-prohibitive.

2.2 Short-Run Analysis

We first present our short-run analysis, where the number of firms in each country is taken as fixed. Let n_h be the number of home firms and n_f be the number of foreign firms.

We begin by considering the output choices of some home firm i. Let q_h^i be the output for home firm i that is sold in the home market, q_h be the output of each other home firm for sales in the home market, and q_f be the output of each foreign firm for sales in the home market. Similarly, let q_h^{i*} be the output for home firm i that is sold in the foreign market, q_h^* be the output of each other home firm for sales in the foreign market, and q_f^* be the output of each foreign firm for sales

[5] As usual, the model can be interpreted in general-equilibrium terms with the addition of a freely traded second good that enters quasi-linearly into utility.

in the foreign market. With these definitions in place, we may define the short-run profit function for home firm i as

$$\begin{aligned}\pi^{hi} &= [P(q_h^i + (n_h - 1)q_h + n_f q_f) - c]q_h^i \\ &+[P^*(q_h^{i*} + (n_h - 1)q_h^* + n_f q_f^*) - (c + \tau^*)]q_h^{i*} - F.\end{aligned} \tag{1}$$

Recall that $\tau^* > 0$ denotes the total trade cost expressed in specific (per unit) terms for sales of domestic firms in the foreign market.

A domestic firm chooses q_h^i and q_h^{i*} to maximize its short-run profit. Using (1), the first-order conditions for profit maximization are given by

$$\begin{aligned}P(q_h^i + (n_h - 1)q_h + n_f q_f) - c &= q_h^i \\ P^*(q_h^{i*} + (n_h - 1)q_h^* + n_f q_f^*) - (c + \tau^*) &= q_h^{i*},\end{aligned} \tag{2}$$

from which the short-run reaction functions for home firm i may be derived:

$$\begin{aligned}q_h^i(q_h, q_f, n_h, n_f) &= \frac{1 - (n_h - 1)q_h - n_f q_f - c}{2} \\ q_h^{i*}(q_h^*, q_f^*, n_h, n_f, \tau^*) &= \frac{1 - (n_h - 1)q_h^* - n_f q_f^* - (c + \tau^*)}{2}.\end{aligned}$$

We may now impose within-country symmetry and set $q_h = q_h^i$ and $q_h^* = q_h^{i*}$. This yields the home-firm reaction functions:

$$\begin{aligned}q_h(q_f, n_h, n_f) &= \frac{1 - n_f q_f - c}{n_h + 1} \\ q_h^*(q_f^*, n_h, n_f, \tau^*) &= \frac{1 - n_f q_f^* - (c + \tau^*)}{n_h + 1}.\end{aligned} \tag{3}$$

As expected, the reaction function for home firms in the domestic market is decreasing in the number of units imported from abroad, $n_f q_f$, the number of domestic firms, n_h, and the marginal cost of production associated with domestic sales, c. Similarly, the reaction function for home firms in the foreign market is decreasing in the number of units sold by foreign firms in the foreign market, $n_f q_f^*$, the number of domestic firms, n_h, and the marginal cost of foreign sales, $c + \tau^*$.

Consider next the output choices of some foreign firm i. Let q_f^{i*} denote the output of foreign firm i for sales in the foreign market and q_f^i denote the output for foreign firm i for sales in the foreign market. The short-run profit function for foreign firm i is then defined as

$$\begin{aligned}\pi^{fi} &= [P^*(q_f^{i*} + (n_f - 1)q_f^* + n_h q_h^*) - c]q_f^{i*} \\ &+[P(q_f^i - (n_f - 1)q_f - n_h q_h) - (c + \tau)]q_f^i - F,\end{aligned} \tag{4}$$

where recall that $\tau > 0$ denotes the total trade cost expressed in specific (per unit) terms for sales of foreign firms in the domestic market. With the first-order conditions for profit maximization given by

$$\begin{aligned} P^*(q_f^{i*} + (n_f - 1)q_f^* + n_h q_h^*) - c &= q_f^{i*} \\ P(q_f^i - (n_f - 1)q_f - n_h q_h) - (c + \tau) &= q_f^i, \end{aligned} \tag{5}$$

we proceed exactly as above to derive the short-run reaction functions for foreign firm i, and then impose within-country symmetry by setting $q_f^* = q_f^{i*}$ and $q_f = q_f^i$ to arrive at the foreign-firm reaction functions:

$$\begin{aligned} q_f^*(q_h^*, n_h, n_f) &= \frac{1 - n_h q_h^* - c}{n_f + 1} \\ q_f(q_h, n_h, n_f, \tau) &= \frac{1 - n_h q_h - (c + \tau)}{n_f + 1} \end{aligned} \tag{6}$$

As (6) reveals, the short-run comparative statics for a foreign firm also take the expected signs.

Using (3) and (6), we may now solve for the Cournot-Nash equilibrium quantities in each of the two (segmented) markets. For the home market, we find

$$\begin{aligned} q_h^N(n_h, n_f, \tau) &= \frac{1 - c + \tau n_f}{1 + n_h + n_f} \\ q_f^N(n_h, n_f, \tau) &= \frac{1 - c - \tau(1 + n_h)}{1 + n_h + n_f}. \end{aligned} \tag{7}$$

As expected, each home firm produces more in the domestic market when its marginal cost of production is lower, the trade cost facing foreign firms is higher, and the number of domestic or foreign firms is lower. Likewise, each foreign firm produces more in the domestic market when its marginal cost of production is lower, the trade cost that it faces is lower, and the number of domestic or foreign firms is lower. Letting the aggregate Cournot-Nash quantity in the home market be expressed as $Q^N \equiv n_h q_h^N + n_f q_f^N$, it then follows from (7) that

$$\begin{aligned} Q^N(n_h, n_f, \tau) &= \frac{(n_h + n_f)(1 - c) - \tau n_f}{1 + n_h + n_f} \\ P^N(n_h, n_f, \tau) &\equiv 1 - Q^N(n_h, n_f, \tau) = \frac{1 + c n_h + (c + \tau) n_f}{1 + n_h + n_f}. \end{aligned} \tag{8}$$

The Cournot output (price) in the domestic market decreases (increases) with the trade cost, τ, and increases (decreases) with the numbers of domestic and foreign firms, n_h and n_f.

Likewise, for the foreign market, we find

$$\begin{aligned} q_f^{*N}(n_h, n_f, \tau^*) &= \frac{1 - c + \tau^* n_h}{1 + n_h + n_f} \\ q_h^{*N}(n_h, n_f, \tau^*) &= \frac{1 - c - \tau^*(1 + n_f)}{1 + n_h + n_f}. \end{aligned} \tag{9}$$

Letting the aggregate Cournot-Nash quantity in the foreign market be expressed as $Q^{*N} \equiv n_h q_h^{*N} + n_f q_f^{*N}$, we have from (9) that

$$\begin{aligned} Q^{*N}(n_h, n_f, \tau^*) &= \frac{(n_h + n_f)(1-c) - \tau^* n_h}{1 + n_h + n_f} \\ P^{*N}(n_h, n_f, \tau^*) &\equiv 1 - Q^{*N}(n_h, n_f, \tau^*) = \frac{1 + cn_f + (c + \tau^*)n_h}{1 + n_h + n_f}. \end{aligned} \tag{10}$$

Thus, the Cournot output (price) in the foreign market decreases (increases) with the trade cost, τ^*, and increases (decreases) with the numbers of domestic and foreign firms, n_h and n_f.

Finally, the Cournot-Nash quantities from (7) and (9) may be plugged into the domestic-firm profit expression found in (1) to define the short-run maximized profit of a home firm:

$$\begin{aligned} \Pi^h(n_h, n_f, \tau^*, \tau) \equiv\ & [P^N(n_h, n_f, \tau) - c]q_h^N(n_h, n_f, \tau) \\ & + [P^{*N}(n_h, n_f, \tau^*) - (c + \tau^*)]q_h^{*N}(n_h, n_f, \tau^*) - F. \end{aligned}$$

Using the first-order condition for profit maximization as represented in (2), we may simplify and write

$$\Pi^h(n_h, n_f, \tau^*, \tau) = (q_h^N(n_h, n_f, \tau))^2 + (q_h^{*N}(n_h, n_f, \tau^*))^2 - F.$$

Similarly, using (7), (9) and (4), we find that the short-run maximized profit of a foreign firm is

$$\begin{aligned} \Pi^f(n_h, n_f, \tau^*, \tau) \equiv\ & [P^{*N}(n_h, n_f, \tau^*) - c]q_f^{*N}(n_h, n_f, \tau^*) \\ & + [P^N(n_h, n_f, \tau) - (c + \tau)]q_f^N(n_h, n_f, \tau) - F. \end{aligned}$$

Using the first-order conditions for profit maximization as found in (5), we may again simplify and write

$$\Pi^f(n_h, n_f, \tau^*, \tau) = (q_f^{*N}(n_h, n_f, \tau^*))^2 + (q_f^N(n_h, n_f, \tau))^2 - F.$$

We complete our short-run analysis of the model by considering comparative statics properties for the maximized profit functions. These properties are essential below, when we analyze the long-run implications of changes in trade policies. For a home firm, we find that

$$\begin{aligned} \frac{\partial \Pi^h(n_h, n_f, \tau^*, \tau)}{\partial \tau} &= 2q_h^N \frac{\partial q_h^N}{\partial \tau} > 0 \\ \frac{\partial \Pi^h(n_h, n_f, \tau^*, \tau)}{\partial \tau^*} &= 2q_h^{*N} \frac{\partial q_h^{*N}}{\partial \tau^*} < 0, \end{aligned} \tag{11}$$

where for notational simplicity we suppress functional dependencies on the right-hand side of these expressions. Thus, an increase in the trade cost τ that confronts foreign exporters generates an increase in profit for a home firm, whereas an increase in the trade cost τ^* that a home firm faces when exporting results in a decrease in profit for a home firm. Turning now to the effect on a home firm's profit of changes in the numbers of firms, we find

$$\begin{aligned}\frac{\partial\Pi^h(n_h,n_f,\tau^*,\tau)}{\partial n_h} &= 2q_h^N\frac{\partial q_h^N}{\partial n_h}+2q_h^{*N}\frac{\partial q_h^{*N}}{\partial n_h}<0 \\ \frac{\partial\Pi^h(n_h,n_f,\tau^*,\tau)}{\partial n_f} &= 2q_h^N\frac{\partial q_h^N}{\partial n_f}+2q_h^{*N}\frac{\partial q_h^{*N}}{\partial n_f}<0.\end{aligned} \tag{12}$$

Thus, home firm profit also falls when there is an increase in the number of domestic or foreign firms.

Similarly, for a foreign firm, we find that

$$\begin{aligned}\frac{\partial\Pi^f(n_h,n_f,\tau^*,\tau)}{\partial \tau} &= 2q_f^N\frac{\partial q_f^N}{\partial \tau}<0 \\ \frac{\partial\Pi^f(n_h,n_f,\tau^*,\tau)}{\partial \tau^*} &= 2q_f^{*N}\frac{\partial q_f^{*N}}{\partial \tau^*}>0,\end{aligned} \tag{13}$$

and

$$\begin{aligned}\frac{\partial\Pi^f(n_h,n_f,\tau^*,\tau)}{\partial n_f} &= 2q_f^{*N}\frac{\partial q_f^{*N}}{\partial n_f}+2q_f^{N}\frac{\partial q_f^{N}}{\partial n_f}<0 \\ \frac{\partial\Pi^f(n_h,n_f,\tau^*,\tau)}{\partial n_h} &= 2q_f^{*N}\frac{\partial q_f^{*N}}{\partial n_h}+2q_f^{N}\frac{\partial q_f^{N}}{\partial n_h}<0.\end{aligned} \tag{14}$$

These findings may be interpreted in an analogous fashion.

2.3 Long-Run Analysis and the Firm-Delocation Effect

Thus far we have assumed that the numbers of domestic and foreign firms are fixed. A short-run modeling framework is appropriate for understanding how trade policies may shift profits between domestic and foreign firms, and indeed much of the strategic-trade literature employs this framework. In this paper, however, we are interested in the long-run effects of trade policy. We are therefore led to consider the manner in which trade policies may change the numbers of domestic and foreign firms as well as the outputs of individual firms. To this end, we now shift our focus to the long run and use the short-run analysis above as a means of defining and analyzing the long-run industry equilibrium.

The key feature of the long-run analysis is that the numbers of domestic and foreign firms are endogenously determined by free-entry conditions. We thus now define the free-entry numbers of firms, $n_h^N(\tau^*,\tau)$ and $n_f^N(\tau^*,\tau)$, as the solutions to the free-entry conditions:

$$\Pi^h(n_h,n_f,\tau^*,\tau)=0=\Pi^f(n_h,n_f,\tau^*,\tau). \tag{15}$$

In all of our subsequent analysis, we assume that the numbers of domestic and foreign firms adjust to ensure that the free-entry conditions captured in (15) are satisfied.

We can analyze $n_h^N(\tau^*,\tau)$ and $n_f^N(\tau^*,\tau)$ as the solutions to the 2x2 system presented by (15).

This system has the following Jacobian determinant:

$$
\begin{aligned}
|J| &= \frac{\partial \Pi^h}{\partial n_h}\frac{\partial \Pi^f}{\partial n_f} - \frac{\partial \Pi^f}{\partial n_h}\frac{\partial \Pi^h}{\partial n_f} \\
&= (\frac{2}{1+n_h+n_f})^2 [q_h^N q_f^{*N} - q_h^{*N} q_f^N]^2 > 0,
\end{aligned} \tag{16}
$$

where the final expression is derived using (12) and (14). The inequality in (16) is important and follows since

$$
\begin{aligned}
q_h^N - q_h^{*N} &= \frac{\tau^* + n_f(\tau+\tau^*)}{1+n_h+n_f} > 0, \text{ and} \\
q_f^{*N} - q_f^N &= \frac{\tau + n_h(\tau+\tau^*)}{1+n_h+n_f} > 0
\end{aligned} \tag{17}
$$

under our assumption that $\tau > 0$ and $\tau^* > 0$. The inequalities featured in (17) capture a *local-market bias* in firm sales: each firm produces more for sales in its local market than for export, when trade costs are positive. Given that the firms are otherwise symmetric, this means as well that each firm sells more in its local market than do firms that export into this market:

$$
\begin{aligned}
q_h^N - q_f^N &= \tau > 0, \text{ and} \\
q_f^{*N} - q_h^{*N} &= \tau^* > 0.
\end{aligned}
$$

As will become clear below, the local-market bias in firm sales plays a critical role in determining the long-run implications of trade policies.

We next conduct long-run comparative statics on the numbers of domestic and foreign firms. Using the signs for partial derivatives of maximized profit functions as derived above in (11)-(14), along with the sign of the Jacobian as given in (16), it is direct to confirm that $n_h^N(\tau^*, \tau)$ is decreasing in τ^* and increasing in τ and similarly that $n_f^N(\tau^*, \tau)$ is increasing in τ^* and decreasing in τ. Thus, we observe the presence of a *firm-delocation effect*: a higher trade cost along one channel increases the number of firms in the importing country and decreases the number of firms in the exporting country.

For future use, we require explicit expressions for the firm-delocation effects associated with changes in trade policies. In particular, we find that a change in the trade cost that affects foreign exports induces the following changes in the numbers of domestic and foreign firms:

$$
\begin{aligned}
\frac{\partial n_h^N}{\partial \tau} &= \frac{[q_h^N n_f^N((q_f^{*N})^2 + (q_f^N)^2) + q_f^N(1+n_h^N)(q_h^N q_f^N + q_h^{*N} q_f^{*N})]}{[q_h^N q_f^{*N} - q_h^{*N} q_f^N]^2} > 0 \\
\frac{\partial n_f^N}{\partial \tau} &= \frac{-[q_f^N(1+n_h^N)((q_h^N)^2 + (q_h^{*N})^2) + q_h^N n_f^N(q_h^N q_f^N + q_h^{*N} q_f^{*N})]}{[q_h^N q_f^{*N} - q_h^{*N} q_f^N]^2} < 0
\end{aligned} \tag{18}
$$

where our expressions suppress notational dependencies. Similarly, a change in the trade cost that affects domestic exports results in the following changes in the numbers of domestic and foreign firms:

$$\begin{aligned}\frac{\partial n_h^N}{\partial \tau^*} &= \frac{-[q_h^{*N}(1+n_f^N)((q_f^{*N})^2+(q_f^N)^2)+q_f^{*N}n_h^N(q_h^N q_f^N+q_h^{*N}q_f^{*N})]}{[q_h^N q_f^{*N}-q_h^{*N}q_f^N]^2}<0 \\ \frac{\partial n_f^N}{\partial \tau^*} &= \frac{[q_f^{*N}n_h^N((q_h^N)^2+(q_h^{*N})^2)+q_h^{*N}(1+n_f^N)(q_h^N q_f^N+q_h^{*N}q_f^{*N})]}{[q_h^N q_f^{*N}-q_h^{*N}q_f^N]^2}>0.\end{aligned} \tag{19}$$

Thus, as previously indicated, an increase in the trade cost along any one channel of trade causes a decrease in the number of firms in the exporting country and an increase in the number of firms in the importing country.

Finally, we define the following long-run price and quantity functions. It is apparent that the long-run prices are ultimately functions of the trade costs:

$$\begin{aligned}\widetilde{P}^N(\tau^*,\tau) &\equiv P(Q^N(n_h^N(\tau^*,\tau),n_f^N(\tau^*,\tau),\tau)) \\ \widetilde{P}^{*N}(\tau^*,\tau) &\equiv P^*(Q^{*N}(n_h^N(\tau^*,\tau),n_f^N(\tau^*,\tau),\tau^*)).\end{aligned}$$

Similarly, the long-run outputs of domestic and foreign firms in the domestic market is ultimately determined by the underlying trade costs:

$$\begin{aligned}\widetilde{q}_h^N(\tau^*,\tau) &\equiv q_h^N(n_h^N(\tau^*,\tau),n_f^N(\tau^*,\tau),\tau) \\ \widetilde{q}_f^N(\tau^*,\tau) &\equiv q_f^N(n_h^N(\tau^*,\tau),n_f^N(\tau^*,\tau),\tau).\end{aligned}$$

Of course, the long-run outputs of domestic and foreign firms in the foreign market may be similarly characterized:

$$\begin{aligned}\widetilde{q}_h^{*N}(\tau^*,\tau) &\equiv q_h^{*N}(n_h^N(\tau^*,\tau),n_f^N(\tau^*,\tau),\tau^*) \\ \widetilde{q}_f^{*N}(\tau^*,\tau) &\equiv q_f^{*N}(n_h^N(\tau^*,\tau),n_f^N(\tau^*,\tau),\tau^*).\end{aligned}$$

These definitions identify the precise channels through which trade costs alter long-run prices and quantities. Our next step is to characterize the overall effect that a change in a trade cost has on long-run prices and trade volumes.

2.4 Long-Run Comparative Statics on Prices

The comparative statics results for prices reflect the firm-delocation effect. In particular, observe that

$$\frac{\partial \widetilde{P}^N(\tau^*,\tau)}{\partial \tau} = P'(Q^N)[\frac{\partial Q^N}{\partial n_h}\frac{\partial n_h^N}{\partial \tau}+\frac{\partial Q^N}{\partial n_f}\frac{\partial n_f^N}{\partial \tau}+\frac{\partial Q^N}{\partial \tau}].$$

Using (8) and (18), we find that

$$\frac{\partial \widetilde{P}^N(\tau^*,\tau)}{\partial \tau} = \frac{-\widetilde{q}_f^N\widetilde{q}_h^{*N}}{[\widetilde{q}_h^N\widetilde{q}_f^{*N}-\widetilde{q}_h^{*N}\widetilde{q}_f^N]}<0, \tag{20}$$

where the inequality uses the fact that (16) holds in particular at the free-entry values for the numbers of domestic and foreign firms under our assumption that $\tau > 0$ and $\tau^* > 0$. In other words, we see from (20) that long-run prices in this model behave in a surprising manner and in fact exhibit the Metzler paradox: a higher import tariff (or a higher foreign export tariff) induces so much domestic entry that the local domestic price actually falls.

Next, consider the effect on $\widetilde{P}^N$ of an increase in τ^*. We have

$$\frac{\partial \widetilde{P}^N(\tau^*, \tau)}{\partial \tau^*} = P'(Q^N)[\frac{\partial Q^N}{\partial n_h}\frac{\partial n_h^N}{\partial \tau^*} + \frac{\partial Q^N}{\partial n_f}\frac{\partial n_f^N}{\partial \tau^*}].$$

Using (8), (19) and (16), it follows that

$$\frac{\partial \widetilde{P}^N(\tau^*, \tau)}{\partial \tau^*} = \frac{\widetilde{q}_f^{*N}\widetilde{q}_h^{*N}}{[\widetilde{q}_h^N\widetilde{q}_f^{*N} - \widetilde{q}_h^{*N}\widetilde{q}_f^N]} > 0 \qquad (21)$$

under our assumption that $\tau > 0$ and $\tau^* > 0$. Thus, according to (21), when domestic firms incur a higher trade cost as exporters, exit in the domestic country occurs to such a degree that the domestic price actually rises.

Of course, exactly analogous results hold for the price in the foreign country. In particular, employing (10), (18), (19), (16) and our assumption that $\tau > 0$ and $\tau^* > 0$, and proceeding as above, we find that

$$\frac{\partial \widetilde{P}^{*N}(\tau^*, \tau)}{\partial \tau^*} = \frac{-\widetilde{q}_f^N\widetilde{q}_h^{*N}}{[\widetilde{q}_h^N\widetilde{q}_f^{*N} - \widetilde{q}_h^{*N}\widetilde{q}_f^N]} < 0. \qquad (22)$$

and

$$\frac{\partial \widetilde{P}^{*N}(\tau^*, \tau)}{\partial \tau} = \frac{\widetilde{q}_h^N\widetilde{q}_f^N}{[\widetilde{q}_h^N\widetilde{q}_f^{*N} - \widetilde{q}_h^{*N}\widetilde{q}_f^N]} > 0. \qquad (23)$$

The price effects of trade taxes described by (20) through (23) represent the most striking implication of the firm-delocation effect, but they are not by themselves enough to determine the impact of trade taxes on welfare. In order to determine that, we need to know as well how trade taxes impact trade volumes. We turn to this question next.

2.5 Long-Run Comparative Statics on Trade Volumes

Trade taxes impact trade volumes in this model through two channels: they effect the export sales per firm in a given country; and they effect the number of firms located in that country. We have already derived expressions for the second channel. What remains is to derive expressions for the first channel, so that we may then evaluate the impact of trade taxes on trade volumes.

Notice that, for a given market and any given numbers of domestic and foreign firms, and using the linear structure of our model, the first-order conditions (2) and (5) for profit maximization imply that a firm's best-response and thus Cournot-Nash quantity must equal the effective markup for the firm in that market. Consequently, we may use our knowledge of how long-run prices vary with trade costs, as captured above in equations (20)-(23), to deduce how long-run firm quantities vary with trade costs.

Consider, then, export sales per home firm $\widetilde{q}_h^{*N}(\tau^*,\tau)$ .We know from (2) that, for given trade costs and numbers of firms, $P^*(Q^N) - (c+\tau^*) = q_h^{*N}$. This relationship must hold in particular at the free-entry numbers of firms; thus, $\widetilde{P}^{*N}(\tau^*,\tau) - (c+\tau^*) = \widetilde{q}_h^{*N}(\tau^*,\tau)$. Using (23) and (22), we may therefore conclude that

$$\begin{aligned} \frac{\partial \widetilde{q}_h^{*N}(\tau^*,\tau)}{\partial \tau} &= \frac{\partial \widetilde{P}^{*N}(\tau^*,\tau)}{\partial \tau} = \frac{\widetilde{q}_h^N \widetilde{q}_f^N}{[\widetilde{q}_h^N \widetilde{q}_f^{*N} - \widetilde{q}_h^{*N}\widetilde{q}_f^N]} > 0 \\ \frac{\partial \widetilde{q}_h^{*N}(\tau^*,\tau)}{\partial \tau^*} &= \frac{\partial \widetilde{P}^{*N}(\tau^*,\tau)}{\partial \tau^*} - 1 = \frac{-\widetilde{q}_h^N \widetilde{q}_f^{*N}}{[\widetilde{q}_h^N \widetilde{q}_f^{*N} - \widetilde{q}_h^{*N}\widetilde{q}_f^N]} < 0. \end{aligned} \tag{24}$$

Thus, when the trade cost imposed on foreign exports rises, domestic entry and foreign exit occur. The foreign exit is sufficiently intense that the foreign price actually rises, with the result that each domestic firm now exports more. Likewise, when the trade cost imposed on domestic exports rises, foreign entry is unleashed to such an extent that the price in the foreign market falls. With domestic firms now receiving a lower effective markup on exports, both because of the higher trade cost and the lower foreign market price, domestic firms export less.

Of course, similar findings obtain for the export sales per foreign firm $\widetilde{q}_f^N(\tau^*,\tau)$. For given trade costs and numbers of firms, we know from (5) that $P(Q^N) - (c+\tau) = q_f^N$. Evaluating at the free-entry numbers of firms, we thus have that $\widetilde{P}^N(\tau^*,\tau) - (c+\tau) = \widetilde{q}_f^N(\tau^*,\tau)$. Using (20) and (21), we may therefore conclude that

$$\begin{aligned} \frac{\partial \widetilde{q}_f^{N}(\tau^*,\tau)}{\partial \tau} &= \frac{\partial \widetilde{P}^{N}(\tau^*,\tau)}{\partial \tau} - 1 = \frac{-\widetilde{q}_h^N \widetilde{q}_f^{*N}}{[\widetilde{q}_h^N \widetilde{q}_f^{*N} - \widetilde{q}_h^{*N}\widetilde{q}_f^N]} < 0 \\ \frac{\partial \widetilde{q}_f^{N}(\tau^*,\tau)}{\partial \tau^*} &= \frac{\partial \widetilde{P}^{N}(\tau^*,\tau)}{\partial \tau^*} = \frac{\widetilde{q}_f^{*N} \widetilde{q}_h^{*N}}{[\widetilde{q}_h^N \widetilde{q}_f^{*N} - \widetilde{q}_h^{*N}\widetilde{q}_f^N]} > 0. \end{aligned} \tag{25}$$

Thus, when the trade cost imposed on foreign exports is increased, domestic entry occurs and the domestic price falls. Due to the reduced domestic price as well as the direct cost of the higher trade cost, each foreign firm reduces its exports to the domestic market. When the trade cost imposed on domestic exports is increased, domestic exit occurs, the domestic price rises, and so each foreign firm exports more to the domestic market.[6]

[6] We emphasize the impacts of trade costs on export volumes because these impacts will enter directly in the analysis below. But the impacts of trade costs on local-market sales volumes predicted by the model may be of some independent interest, because they are somewhat surprising. Specifically, proceeding as above, it is direct to establish that an increase in the trade cost imposed on foreign exports leads each domestic firm to *reduce* its local-market sales and leads each foreign firm to *increase* its local-market sales; in particular, we find that $\frac{\partial \widetilde{q}_h^N(\tau^*,\tau)}{\partial \tau} = \frac{-\widetilde{q}_f^N \widetilde{q}_h^{*N}}{[\widetilde{q}_h^N \widetilde{q}_f^{*N} - \widetilde{q}_h^{*N}\widetilde{q}_f^N]} < 0$ and $\frac{\partial \widetilde{q}_f^{*N}(\tau^*,\tau)}{\partial \tau} = \frac{\widetilde{q}_h^N \widetilde{q}_f^N}{[\widetilde{q}_h^N \widetilde{q}_f^{*N} - \widetilde{q}_h^{*N}\widetilde{q}_f^N]} > 0$. And similarly, an increase in the trade cost imposed on domestic exports leads each domestic firm to increase its local-market sales and leads each foreign firm to reduce its local-market sales; in particular, we find that $\frac{\partial \widetilde{q}_h^N(\tau^*,\tau)}{\partial \tau^*} = \frac{\widetilde{q}_f^{*N} \widetilde{q}_h^{*N}}{[\widetilde{q}_h^N \widetilde{q}_f^{*N} - \widetilde{q}_h^{*N}\widetilde{q}_f^N]} > 0$ and $\frac{\partial \widetilde{q}_f^{*N}(\tau^*,\tau)}{\partial \tau^*} = \frac{-\widetilde{q}_f^N \widetilde{q}_h^{*N}}{[\widetilde{q}_h^N \widetilde{q}_f^{*N} - \widetilde{q}_h^{*N}\widetilde{q}_f^N]} < 0$.

Armed with (24) and (25) as well as our earlier expressions (18) and (19), we may now turn to the final task of this section and consider how long-run trade volumes vary with trade costs. As noted above, an understanding of the relationship between export volumes and trade costs is needed to determine the impact of trade taxes on welfare, which is in turn important for subsequent sections, when we consider the determination of unilateral, efficient and Nash trade policies. We present our findings initially without an assumption that symmetric trade policies are adopted for the domestic and foreign markets. We then assume symmetric trade policies and report simplified expressions.

To begin, we define the home country's export volume as

$$E^N(\tau^*,\tau) \equiv n_h^N(\tau^*,\tau)\widetilde{q}_h^{*N}(\tau^*,\tau). \tag{26}$$

Now consider how the domestic export volume varies with the trade cost that confronts foreign exports. Using (26), we have that

$$\frac{\partial E^N(\tau^*,\tau)}{\partial \tau} = n_h^N(\tau^*,\tau)\frac{\partial \widetilde{q}_h^{*N}(\tau^*,\tau)}{\partial \tau} + \widetilde{q}_h^{*N}(\tau^*,\tau)\frac{\partial n_h^N(\tau^*,\tau)}{\partial \tau} > 0,$$

where the inequality follows from (24) and (18). Thus, if foreign exporters confront a higher trade cost, then the number of domestic firms, the export sales of each domestic firm and thus the volume of domestic exports must rise. Using (24) and (18), we may derive the following expression:

$$\begin{aligned} &\frac{\partial E^N(\tau^*,\tau)}{\partial \tau} \\ = \ &\frac{n_h^N \widetilde{q}_f^N \widetilde{q}_f^{*N}[(\widetilde{q}_h^N)^2 + (\widetilde{q}_h^{*N})^2] + n_f^N \widetilde{q}_h^{*N}\widetilde{q}_h^N[(\widetilde{q}_f^{*N})^2 + (\widetilde{q}_f^N)^2] + \widetilde{q}_h^{*N}\widetilde{q}_f^N(\widetilde{q}_h^N\widetilde{q}_f^N + \widetilde{q}_h^{*N}\widetilde{q}_f^{*N})}{[\widetilde{q}_h^N\widetilde{q}_f^{*N} - \widetilde{q}_h^{*N}\widetilde{q}_f^N]^2} > 0. \end{aligned} \tag{27}$$

Next, consider how the domestic export volume varies with the trade cost that confronts domestic exports. Referring to (26), we see that

$$\frac{\partial E^N(\tau^*,\tau)}{\partial \tau^*} = n_h^N(\tau^*,\tau)\frac{\partial \widetilde{q}_h^{*N}(\tau^*,\tau)}{\partial \tau^*} + \widetilde{q}_h^{*N}(\tau^*,\tau)\frac{\partial n_h^N(\tau^*,\tau)}{\partial \tau^*} < 0,$$

where the inequality follows from (24) and (19). Thus, if the trade cost that faces domestic exporters increases, then the number of domestic firms, the export volume of each domestic firm and thus the volume of domestic exports must fall. Referring to (24) and (19), we may derive the following useful expression:

$$\frac{\partial E^N(\tau^*,\tau)}{\partial \tau^*} = -\frac{n_h^N(\widetilde{q}_f^{*N})^2((\widetilde{q}_h^N)^2 + (\widetilde{q}_h^{*N})^2) + (\widetilde{q}_h^{*N})^2(1+n_f^N)((\widetilde{q}_f^{*N})^2 + (\widetilde{q}_f^N)^2)}{[\widetilde{q}_h^N\widetilde{q}_f^{*N} - \widetilde{q}_h^{*N}\widetilde{q}_f^N]^2} < 0. \tag{28}$$

In sum, domestic export volume is increasing in the trade cost that confronts foreign exports and decreasing in the trade cost that faces domestic exports.

We can similarly derive long-run comparative statics findings for foreign export volumes. Defining the foreign country's export volume as

$$E^{*N}(\tau^*,\tau) \equiv n_f^N(\tau^*,\tau)\widetilde{q}_f^N(\tau^*,\tau), \tag{29}$$

we then have

$$\frac{\partial E^{*N}(\tau^*,\tau)}{\partial \tau^*} = n_f^N(\tau^*,\tau)\frac{\partial \widetilde{q}_f^N(\tau^*,\tau)}{\partial \tau^*} + \widetilde{q}_f^N(\tau^*,\tau)\frac{\partial n_f^N(\tau^*,\tau)}{\partial \tau^*} > 0,$$

where the inequality follows from (25) and (19). Using (25) and (19), we find that

$$\begin{aligned} &\frac{\partial E^{*N}(\tau^*,\tau)}{\partial \tau^*} \\ = \ &\frac{n_f^N\widetilde{q}_h^{*N}\widetilde{q}_h^N((\widetilde{q}_f^{*N})^2+(\widetilde{q}_f^N)^2)+n_h^N\widetilde{q}_f^N\widetilde{q}_f^{*N}((\widetilde{q}_h^N)^2+(\widetilde{q}_h^{*N})^2)+\widetilde{q}_f^N\widetilde{q}_h^{*N}(\widetilde{q}_h^N\widetilde{q}_f^N+\widetilde{q}_h^{*N}\widetilde{q}_f^{*N})}{[\widetilde{q}_h^N\widetilde{q}_f^{*N}-\widetilde{q}_h^{*N}\widetilde{q}_f^N]^2} > 0. \end{aligned} \tag{30}$$

Finally, we consider how foreign export volume varies with the trade cost that foreign exporters incur. We thus compute

$$\frac{\partial E^{*N}(\tau^*,\tau)}{\partial \tau} = n_f^N(\tau^*,\tau)\frac{\partial \widetilde{q}_f^N(\tau^*,\tau)}{\partial \tau} + \widetilde{q}_f^N(\tau^*,\tau)\frac{\partial n_f^N(\tau^*,\tau)}{\partial \tau} < 0,$$

where the inequality follows from (25) and (18). Referring to (25) and (18), we have that

$$\frac{\partial E^{*N}(\tau^*,\tau)}{\partial \tau} = -\frac{n_f^N(\widetilde{q}_h^N)^2((\widetilde{q}_f^{*N})^2+(\widetilde{q}_f^N)^2)+(\widetilde{q}_f^N)^2(1+n_h^N)((\widetilde{q}_h^N)^2+(\widetilde{q}_h^{*N})^2)}{[\widetilde{q}_h^N\widetilde{q}_f^{*N}-\widetilde{q}_h^{*N}\widetilde{q}_f^N]^2} < 0. \tag{31}$$

In sum, foreign export volume increases when the trade cost facing domestic exports rises and decreases when the trade cost facing foreign exports rises.

A case of particular interest arises when $\tau = \tau^*$ so that trade policies are *symmetric* across markets. At a symmetric point, we have that $\widetilde{q}_f^{*N} = \widetilde{q}_h^N$, $\widetilde{q}_f^N = \widetilde{q}_h^{*N}$ and $n_f^N = n_h^N$. Under symmetry, we may thus express all magnitudes in terms of domestic variables and derive simpler expressions. In particular, at a symmetric point, we may simplify (27) and (30) as follows:

$$\frac{\partial E^N(\tau^*,\tau)}{\partial \tau} = \frac{\partial E^{*N}(\tau^*,\tau)}{\partial \tau^*} = \frac{2\widetilde{q}_h^{*N}\widetilde{q}_h^N[n_h^N((\widetilde{q}_h^N)^2+(\widetilde{q}_h^{*N})^2)+(\widetilde{q}_h^{*N})^2]}{[(\widetilde{q}_h^N)^2-(\widetilde{q}_h^{*N})^2]^2} > 0. \tag{32}$$

Likewise, at a symmetric point, we may simplify (28) and (31) to get:

$$\frac{\partial E^N(\tau^*,\tau)}{\partial \tau^*} = \frac{\partial E^{*N}(\tau^*,\tau)}{\partial \tau} = -\frac{((\widetilde{q}_h^N)^2+(\widetilde{q}_h^{*N})^2)[n_h^N(\widetilde{q}_h^N)^2+(\widetilde{q}_h^{*N})^2(1+n_h^N)]}{[(\widetilde{q}_h^N)^2-(\widetilde{q}_h^{*N})^2]^2} < 0. \tag{33}$$

Note that (17) yields $q_h^N - q_h^{*N} = \tau$ at a symmetric point, and so $q_h^N - q_h^{*N} > 0$ under our assumption that $\tau > 0$.

3 Unilateral and Efficient Trade Policies

With the key properties of the Cournot delocation model now developed, we are ready to consider the determination of trade policies. We begin by defining national welfare. We then ask whether a country could gain by introducing a slight departure from free trade in exactly one of its trade policies. Venables (1985) considers this question as well, and we re-state his results regarding unilateral departures from free trade here. In particular, we find that a country always gains from introducing a slight import tariff, provided only that the other country's trade policies are such that in each market the trade cost is positive and trade is not prohibited. Further, a country gains by introducing a small export subsidy, if all other policies in both countries are set at free trade. Finally, the introduction of an import tariff or an export subsidy also leads to a reduction in the welfare of the other country, if all policies in both countries are initially set at the free-trade level. We also establish the novel finding that free-trade policies (i.e., $\tau = \tau^* = \phi$) are in fact efficient in the linear model studied here.[7]

3.1 Welfare Functions

With $\phi > 0$ representing the transport cost, we let $\tau \equiv \phi + t_h + t_f$ denote the total trade cost imposed on foreign exports, where t_h is the (specific) domestic import tariff and t_f is the (specific) foreign export tariff. Likewise, the total trade cost imposed on domestic exports is $\tau^* \equiv \phi + t_h^* + t_f^*$, where t_h^* is the (specific) domestic export tariff and t_f^* is the (specific) foreign import tariff.

When evaluating trade policies, we assume that the domestic and foreign governments maximize their respective long-run national incomes. In the long run, profits are driven to zero, and national income is simply the sum of consumer surplus and net tariff revenue. Letting $CS(\widetilde{P}^N(\tau^*, \tau))$ denote domestic consumer surplus in the long-run equilibrium, the domestic government thus maximizes

$$\begin{aligned} & G(\tau^*, \tau, t_h, t_h^*) \\ = \; & CS(\widetilde{P}^N(\tau^*, \tau)) + t_h n_f^N(\tau^*, \tau)\widetilde{q}_f^N(\tau^*, \tau) + t_h^* n_h^N(\tau^*, \tau)\widetilde{q}_h^{*N}(\tau^*, \tau) \\ = \; & CS(\widetilde{P}^N(\tau^*, \tau)) + t_h E^{*N}(\tau^*, \tau) + t_h^* E^N(\tau^*, \tau), \end{aligned} \tag{34}$$

where $CS'(\widetilde{P}^N(\tau^*, \tau)) = -D(\widetilde{P}^N(\tau^*, \tau)) \equiv -(1 - \widetilde{P}^N(\tau^*, \tau))$. Similarly, letting $CS^*(\widetilde{P}^{*N}(\tau^*, \tau))$ denote foreign consumer surplus, the foreign government maximizes

$$\begin{aligned} & G^*(\tau^*, \tau, t_f^*, t_f) \\ = \; & CS^*(\widetilde{P}^{*N}(\tau^*, \tau)) + t_f^* n_h^N(\tau^*, \tau)\widetilde{q}_h^{*N}(\tau^*, \tau) + t_f n_f^N(\tau^*, \tau)\widetilde{q}_f^N(\tau^*, \tau) \\ = \; & CS^*(\widetilde{P}^{*N}(\tau^*, \tau)) + t_f^* E^N(\tau^*, \tau) + t_f E^{*N}(\tau^*, \tau), \end{aligned} \tag{35}$$

[7] Markusen and Venables (1988, p. 315, Result 5) report that free trade is efficient in a free-entry linear-demand Cournot segmented-markets setting, where the products of different countries are not perfect substitutes and transport costs between countries are absent. We are unaware of a result that establishes the efficiency of free trade in this setting when products are perfect substitutes and transport costs exist, as in the environment we consider here.

where $CS^{*\prime}(\widetilde{P}^{*N}(\tau^*,\tau)) = -D^*(\widetilde{P}^{*N}(\tau^*,\tau)) \equiv -(1-\widetilde{P}^{*N}(\tau^*,\tau))$.

3.2 Introduction of a Small Import Tariff

Now let us suppose that the domestic country initially adopts free trade with its import and export tariffs. With respect to foreign trade policies, we assume for the moment only that the foreign government's trade policies are such that the trade cost is positive (i.e., $\tau > 0$) and trade is not prohibited (i.e., $E^{*N}(\tau^*,\tau) > 0$). From this starting point, would the domestic government gain by slightly increasing its import tariff? To answer this question, we use (34) and compute

$$\frac{dG}{dt_h} = -D(\widetilde{P}^N(\tau^*,\tau))\frac{\partial \widetilde{P}^N(\tau^*,\tau)}{\partial \tau} + E^{*N}(\tau^*,\tau) + t_h \frac{\partial E^{*N}(\tau^*,\tau)}{\partial \tau} + t_h^* \frac{\partial E^N(\tau^*,\tau)}{\partial \tau}. \tag{36}$$

Under our supposition that the domestic country is initially adopting a free-trade policy with respect to its import and export tariffs, the last two terms in (36) disappear. We may thus rewrite (36) as

$$\frac{dG}{dt_h} = -D(\widetilde{P}^N(\tau^*,\tau))\frac{\partial \widetilde{P}^N(\tau^*,\tau)}{\partial \tau} + E^{*N}(\tau^*,\tau) > 0, \tag{37}$$

where the inequality follows since $D(\widetilde{P}^N(\tau^*,\tau)) > 0$, $E^{*N}(\tau^*,\tau) > 0$ under our assumption that trade is not prohibited, and $\partial \widetilde{P}^N(\tau^*,\tau)/\partial \tau < 0$ by (20) under our assumption that trade costs are positive. Thus, with the firm-delocation effect giving $\partial \widetilde{P}^N(\tau^*,\tau)/\partial \tau < 0$, we see that a positive import tariff is optimal for the domestic country. Intuitively, the import tariff generates domestic entry and thus a lower domestic price, which raises consumer surplus. As well, a positive import tariff raises tariff revenue relative to the free-trade benchmark.

Consider now the impact of a small domestic import tariff on the foreign country. To this end, we use (35) and compute

$$\frac{dG^*}{dt_h} = -D^*(\widetilde{P}^{*N}(\tau^*,\tau))\frac{\partial \widetilde{P}^{*N}(\tau^*,\tau)}{\partial \tau} + t_f^* \frac{\partial E^N(\tau^*,\tau)}{\partial \tau} + t_f \frac{\partial E^{*N}(\tau^*,\tau)}{\partial \tau}. \tag{38}$$

Now, if we suppose that the foreign country also initially adopts a free-trade policy with respect to its import and export tariffs, then the last two terms in (38) disappear. We may then rewrite (38) as

$$\frac{dG^*}{dt_h} = -D^*(\widetilde{P}^{*N}(\tau^*,\tau))\frac{\partial \widetilde{P}^{*N}(\tau^*,\tau)}{\partial \tau} < 0, \tag{39}$$

where the inequality follows at global free trade, since under these policies $D^*(\widetilde{P}^{*N}(\tau^*,\tau)) > 0$ and trade costs are positive so that $\partial \widetilde{P}^{*N}(\tau^*,\tau)/\partial \tau > 0$ by (23). The latter effect is simply the firm-delocation effect: a higher domestic import tariff causes exit in the foreign country to such a degree that the foreign price rises. In other words, starting with all policies in both countries set at free trade, the introduction of a small domestic import tariff raises the foreign price and thus harms foreign welfare by reducing foreign consumer surplus.

Following Venables (1985), we may conclude as follows:

Proposition 1: *If both countries initially adopt a policy of free trade with respect to their imports and exports, then the introduction of a small import tariff by the domestic government generates a welfare gain for the domestic country and a welfare loss for the foreign country.*

Of course, we could similarly argue that the introduction of a small import tariff by the foreign government generates a welfare gain for the foreign country and a welfare loss for the domestic country.

3.3 Introduction of a Small Export Subsidy

We consider next the introduction of a small export subsidy. Any effect of a small export subsidy is the same as that of a small export tariff, once the sign of the effect is reversed. Using (34), we compute that

$$\frac{dG}{dt_h^*} = -D(\widetilde{P}^N(\tau^*,\tau))\frac{\partial \widetilde{P}^N(\tau^*,\tau)}{\partial \tau^*} + E^N(\tau^*,\tau) + t_h \frac{\partial E^{*N}(\tau^*,\tau)}{\partial \tau^*} + t_h^* \frac{\partial E^N(\tau^*,\tau)}{\partial \tau^*}. \tag{40}$$

If the domestic country starts at free trade with respect to its import and export policies, we thus find that the last two terms in (40) again disappear, and so we get

$$\frac{dG}{dt_h^*} = -D(\widetilde{P}^N(\tau^*,\tau))\frac{\partial \widetilde{P}^N(\tau^*,\tau)}{\partial \tau^*} + E^N(\tau^*,\tau). \tag{41}$$

Assuming that the foreign trade policies are nonprohibitive and such that trade costs are positive, we have that $D(\widetilde{P}^N(\tau^*,\tau)) > 0, \partial \widetilde{P}^N(\tau^*,\tau)/\partial \tau^* > 0$ by (21), and $E^N(\tau^*,\tau) > 0$. Referring to (41), we thus see that the introduction of a small export tariff has competing effects on domestic welfare: the export tariff induces exit and thereby a higher domestic price, which reduces consumer surplus, but it also generates additional tariff revenue relative to the free-trade benchmark.

To sign the expression in (41), we use $D(\widetilde{P}^N(\tau^*,\tau)) = n_h^N \widetilde{q}_h^N + n_f^N \widetilde{q}_f^N$, (26) and (21) and find that, at free-trade domestic policies,

$$\frac{dG}{dt_h^*} = -\widetilde{q}_h^{*N} \widetilde{q}_f^N \frac{[\widetilde{q}_f^{*N} n_f^N + n_h^N \widetilde{q}_h^{*N}]}{[\widetilde{q}_h^N \widetilde{q}_f^{*N} - \widetilde{q}_h^{*N} \widetilde{q}_f^N]} < 0,$$

where the inequality follows under our assumptions that $\tau > 0$ and $\tau^* > 0$. Thus, starting from free-trade domestic policies and so long as the trade policies of the foreign country are non-prohibitive and such that trade costs are positive, the domestic government gains when it introduces a small export subsidy. In this model, therefore, when a small export subsidy is introduced, the benefit to domestic consumers of a lower domestic price (due to the firm-delocation effect) exceeds the loss in tariff revenue.

We turn next to consider the implications of a small export tariff for the foreign country. To this end, we use (35) and compute

$$\frac{dG^*}{dt_h^*} = -D^*(\widetilde{P}^{*N}(\tau^*,\tau))\frac{\partial \widetilde{P}^{*N}(\tau^*,\tau)}{\partial \tau^*} + t_f^* \frac{\partial E^N(\tau^*,\tau)}{\partial \tau^*} + t_f \frac{\partial E^{*N}(\tau^*,\tau)}{\partial \tau^*}. \tag{42}$$

If we now suppose that the foreign country also initially adopts a free-trade policy with respect to its import and export tariffs, then the last two terms in (42) disappear. Under this supposition, we may rewrite (42) as

$$\frac{dG^*}{dt_h^*} = -D^*(\widetilde{P}^{*N}(\tau^*,\tau))\frac{\partial \widetilde{P}^{*N}(\tau^*,\tau)}{\partial \tau^*} > 0, \tag{43}$$

where the inequality in (43) follows at global free trade since then $D^*(\widetilde{P}^{*N}(\tau^*,\tau)) > 0$ and trade costs are positive so that $\partial \widetilde{P}^{*N}(\tau^*,\tau)/\partial \tau^* < 0$ by (22). The latter effect is again the firm-delocation effect: a higher domestic export tariff induces sufficient entry in the foreign country that the foreign price falls and foreign consumer welfare rises. Equivalently, starting at global free trade, the introduction of a small export subsidy by the domestic country results in a reduction in the welfare of the foreign country, since it induces foreign exit and thereby a higher foreign price and thus lower foreign consumer surplus.

Following Venables (1985), we may conclude as follows:

Proposition 2: *If both countries initially adopt free-trade policies with respect to their imports and exports, then the introduction of a small export subsidy by the domestic government generates a welfare gain for the domestic country and a welfare loss for the foreign country.*

Again, we could similarly argue that the introduction of a small export subsidy by the foreign government generates a welfare gain for the foreign country and a welfare loss for the domestic country.

3.4 Efficient Trade Policies

Finally, we consider the impact on joint welfare of small deviations from global free trade. If both countries initially adopt free-trade policies with respect to imports and exports, and the domestic country introduces a small import tariff, then we may use (37) and (39) to calculate that the effect on joint welfare, $G + G^*$, is

$$\begin{aligned} & \frac{dG}{dt_h} + \frac{dG^*}{dt_h} \\ = \; & -D(\widetilde{P}^N(\tau^*,\tau))\frac{\partial \widetilde{P}^N(\tau^*,\tau)}{\partial \tau} + E^{*N}(\tau^*,\tau) - D^*(\widetilde{P}^{*N}(\tau^*,\tau))\frac{\partial \widetilde{P}^{*N}(\tau^*,\tau)}{\partial \tau} = 0, \end{aligned} \tag{44}$$

where the final equality follows after using $D(\widetilde{P}^N(\tau^*,\tau)) = n_h^N \widetilde{q}_h^N + n_f^N \widetilde{q}_f^N$, $D^*(\widetilde{P}^{*N}(\tau^*,\tau)) = n_h^N \widetilde{q}_h^{*N} + n_f^N \widetilde{q}_f^{*N}$, (20), (29) and (23). Thus, assuming that all other policies are set at free trade, we see from (44) that the efficient import tariff for the domestic government is free trade. Similarly, under these assumptions, the efficient import tariff for the foreign government is free trade.[8]

The next step is to make sure that free trade is the efficient export policy for the domestic country, when all other policies are set at free trade. Using (37) and (39), we find that at global free trade the impact on joint welfare of the introduction of a small export tariff imposed by the domestic government is

$$\begin{aligned} &\frac{dG}{dt_h^*} + \frac{dG^*}{dt_h^*} \qquad (45) \\ = \quad & -D(\widetilde{P}^N(\tau^*,\tau))\frac{\partial \widetilde{P}^N(\tau^*,\tau)}{\partial \tau^*} + E^N(\tau^*,\tau) - D^*(\widetilde{P}^{*N}(\tau^*,\tau))\frac{\partial \widetilde{P}^{*N}(\tau^*,\tau)}{\partial \tau^*} = 0, \end{aligned}$$

where the final equality uses $D(\widetilde{P}^N(\tau^*,\tau)) = \widetilde{q}_f^{*N} n_f^N + n_h^N \widetilde{q}_h^{*N}$, $D^*(\widetilde{P}^{*N}(\tau^*,\tau)) = n_h^N \widetilde{q}_h^{*N} + n_f^N \widetilde{q}_f^{*N}$, (21), (26) and (22). Assuming that other policies are set at free trade, we see from (45) that the domestic government maximizes joint welfare by adopting an export policy of free trade. Similarly, under these assumptions, the foreign government maximizes joint welfare by adopting an export policy of free trade.[9]

Thus, for our linear model, a policy of free trade in import and export policies by both countries is efficient. Of course, an efficient outcome can be achieved with other trade-policy vectors as well. In particular, we note that joint welfare ultimately depends only on the total trade costs, τ and τ^*. To see this, observe that

$$\begin{aligned} & J(\tau^*,\tau) \equiv G(\tau^*,\tau,t_h,t_h^*) + G^*(\tau^*,\tau,t_f^*,t_f) \\ = \quad & CS(\widetilde{P}^N(\tau^*,\tau)) + t_h E^{*N}(\tau^*,\tau) + t_h^* E^N(\tau^*,\tau) \\ & + CS^*(\widetilde{P}^{*N}(\tau^*,\tau)) + t_f^* E^N(\tau^*,\tau) + t_f E^{*N}(\tau^*,\tau) \\ = \quad & CS(\widetilde{P}^N(\tau^*,\tau)) + CS^*(\widetilde{P}^{*N}(\tau^*,\tau)) + (\tau-\phi)E^{*N}(\tau^*,\tau) + (\tau^*-\phi)E^N(\tau^*,\tau) \end{aligned}$$

Since free trade yields $\tau = \tau^* = \phi$ and is efficient, any combination of trade policies that delivers $\tau = \tau^* = \phi$ is also efficient, and only such combinations are efficient.[10] There is thus a continuum of efficient trade policies, where along any one trade channel any subsidy by one country is exactly offset by a tariff from the other country.

[8] Differentiating (36) and (38) with respect to t_h and evaluating the sum of the resulting expressions at global free trade yields $\frac{\partial E^{*N}(\tau^*,\tau)}{\partial \tau}$, which by (33) is strictly negative. Hence the second-order condition associated with (44) is satisfied.

[9] Differentiating (40) and (42) with respect to t_h^* and evaluating the sum of the resulting expressions at global free trade yields $\frac{\partial E^{N}(\tau^*,\tau)}{\partial \tau^*}$, which by (33) is strictly negative. Hence the second-order condition associated with (45) is satisfied.

[10] To formally establish that $\tau = \tau^* = \phi$ is efficient when τ and τ^* are jointly selected, we observe from (44) and (45) that $\frac{\partial J(\tau^*,\tau)}{\partial \tau} = 0 = \frac{\partial J(\tau^*,\tau)}{\partial \tau^*}$ when $\tau = \tau^* = \phi$, and we confirm that the corresponding second-order conditions are then satisfied. In particular, the second-order conditions hold at $\tau = \tau^* = \phi$ when τ and τ^* are jointly selected if the Jacobian matrix associated with the system of first-order conditions is negative definite. The preceding two footnotes imply that, when $\tau = \tau^* = \phi$, $\frac{\partial^2 J(\tau^*,\tau)}{\partial \tau^2} = \frac{\partial E^{*N}(\tau^*,\tau)}{\partial \tau} = \frac{\partial E^{N}(\tau^*,\tau)}{\partial \tau^*} = \frac{\partial^2 J(\tau^*,\tau)}{\partial \tau^{*2}} < 0$. We further find that $\frac{\partial^2 J(\tau^*,\tau)}{\partial \tau \partial \tau^*} = \frac{\partial E^{N}(\tau^*,\tau)}{\partial \tau} = \frac{\partial E^{*N}(\tau^*,\tau)}{\partial \tau^*}$ when $\tau = \tau^* = \phi$. Using (33) and (32), we may then confirm that $\frac{\partial^2 J(\tau^*,\tau)}{\partial \tau^2}\frac{\partial^2 J(\tau^*,\tau)}{\partial \tau^{*2}} - (\frac{\partial^2 J(\tau^*,\tau)}{\partial \tau \partial \tau^*})^2 > 0$ at $\tau = \tau^* = \phi$ under our assumption that $\phi > 0$.

We may thus conclude as follows:

Proposition 3: *The efficiency frontier is characterized by combinations of trade policies that deliver zero trade taxes on all trade (i.e., $\tau = \tau^* = \phi$); in particular, global free trade ($t_h = t_h^* = t_f^* = t_f = 0$) is efficient.*

Together, Propositions 1, 2 and 3 indicate that global free trade is efficient and yet not a Nash equilibrium in trade policies. Our next task is to characterize the Nash equilibrium trade policies.

4 Nash Trade Policies

At this point, we know that free trade is efficient, and we know that from this starting point each country has a unilateral incentive to impose an import tariff and an export subsidy. These findings thus provide one perspective as to why governments might seek an agreement under which ceilings are imposed on import tariffs and export subsidies. We next consider the Nash equilibrium in trade policies, and we show that governments use import *and* export tariffs in a Nash equilibrium. This result is novel to the literature and provides a richer perspective on the treatment of import tariffs and export subsidies in trade agreements. In particular, an efficiency enhancing trade agreement would place a ceiling on export subsidies only once import tariffs have been reduced through negotiations to a level that is sufficiently close to free trade. As explained in the Introduction, this richer perspective thus provides one interpretation of the introduction of the SCM Agreement into the WTO in 1995, after the completion of several earlier negotiation rounds that led to substantial reductions in import tariffs.

To characterize Nash equilibrium trade policies in the Cournot delocation model, we are led to consider the tariff reaction functions for the domestic and foreign countries, respectively. The domestic first-order conditions for t_h and t_h^* are given by $dG/dt_h = 0$ and $dG/dt_h^* = 0$, respectively, and may be analyzed using (36) and (40) above.[11] Furthermore, since the two countries are symmetric, we may focus on a symmetric Nash equilibrium, in which the domestic Nash import tariff equals the foreign Nash import tariff, and the domestic Nash export tariff equals the foreign Nash export tariff. Thus, we can focus on the domestic tariff reaction functions and the determination of the domestic Nash import tariff, t_h^N and Nash export tariff, t_h^{*N}.

To this end, we first use (40) and (36) and subtract the domestic first-order condition for t_h^*

[11] The second-order conditions for the domestic country's import and export tariff selection hold at the Nash equilibrium if $\frac{\partial^2 G}{\partial t_h^2} < 0$, $\frac{\partial^2 G}{\partial t_h^{*2}} < 0$ and $(\frac{\partial^2 G}{\partial t_h^2})(\frac{\partial^2 G}{\partial t_h^{*2}}) - (\frac{\partial^2 G}{\partial t_h \partial t_h^*}) > 0$, where all expressions are evaluated with all tariffs set at their Nash levels. The second-order conditions are difficult to confirm analytically, since the expressions (54) and (55) that we derive below for the Nash tariff levels are implicit equations. (Recall that the numbers of firms and per-firm quantities are functions of tariffs.) Nevertheless, we can show that the second-order conditions must hold at the Nash equilibrium when the quantity exported by each firm, $\widetilde{q}_h^*$, is sufficiently small. This will be the case if the transportation cost, ϕ, is sufficiently large. In addition, we have confirmed that the second-order conditions are satisfied at the Nash equilibrium for a variety of specifications for the model's parameters, c, F and ϕ.

from the domestic first-order condition for t_h. This yields

$$\begin{aligned} 0 &= \frac{dG}{dt_h} - \frac{dG}{dt_h^*} \\ &= D(\widetilde{P}^N(\tau^*,\tau))[\frac{\partial \widetilde{P}^N(\tau^*,\tau)}{\partial \tau^*} - \frac{\partial \widetilde{P}^N(\tau^*,\tau)}{\partial \tau}] + [t_h^N - t_h^{*N}][\frac{\partial E^N(\tau^*,\tau)}{\partial \tau^*} - \frac{\partial E^N(\tau^*,\tau)}{\partial \tau}], \end{aligned} \tag{46}$$

where we use symmetry to impose $E^{*N}(\tau^*,\tau) = E^N(\tau^*,\tau)$, $\partial E^N(\tau^*,\tau)/\partial\tau^* = \partial E^{*N}(\tau^*,\tau)/\partial\tau$ and $\partial E^N(\tau^*,\tau)/\partial\tau = \partial E^{*N}(\tau^*,\tau)/\partial\tau^*$.

To further simplify (46), we compute $\partial \widetilde{P}^N(\tau^*,\tau)/\partial\tau^* - \partial \widetilde{P}^N(\tau^*,\tau)/\partial\tau$ and $\partial E^N(\tau^*,\tau)/\partial\tau^* - \partial E^N(\tau^*,\tau)/\partial\tau$ at a symmetric point. Using (21) and (20) and simplifying, we find

$$\frac{\partial \widetilde{P}^N(\tau^*,\tau)}{\partial \tau^*} - \frac{\partial \widetilde{P}^N(\tau^*,\tau)}{\partial \tau} = \frac{\widetilde{q}_f^{*N}\widetilde{q}_h^{*N} + \widetilde{q}_f^N\widetilde{q}_h^{*N}}{[\widetilde{q}_h^N\widetilde{q}_f^{*N} - \widetilde{q}_h^{*N}\widetilde{q}_f^N]}.$$

At a point of symmetry, therefore,

$$\frac{\partial \widetilde{P}^N(\tau^*,\tau)}{\partial \tau^*} - \frac{\partial \widetilde{P}^N(\tau^*,\tau)}{\partial \tau} = \frac{\widetilde{q}_h^{*N}}{\widetilde{q}_h^N - \widetilde{q}_h^{*N}} > 0, \tag{47}$$

where the inequality follows since we have from (17) that $\widetilde{q}_h^N - \widetilde{q}_h^{*N} = \frac{\tau^*+n_f(\tau+\tau^*)}{1+n_h+n_f} = \tau > 0$ at a symmetric point, under the assumption that $\tau > 0$. Next, we may similarly use (28) and (27) and establish after simplification that, at a symmetric point,

$$\frac{\partial E^N(\tau^*,\tau)}{\partial \tau^*} - \frac{\partial E^N(\tau^*,\tau)}{\partial \tau} = -\frac{n_h^N[(\widetilde{q}_h^N)^2 + (\widetilde{q}_h^{*N})^2] + (\widetilde{q}_h^{*N})^2}{[\widetilde{q}_h^N - \widetilde{q}_h^{*N}]^2} < 0, \tag{48}$$

where the inequality again follows at a symmetric point under our assumption that $\tau > 0$.

We may now return to our "subtraction" equation (46) and make the substitutions just derived in (47) and (48). After making these substitutions and simplifying, we get, for a symmetric point, that

$$0 = \frac{dG}{dt_h} - \frac{dG}{dt_h^*} = n_h^N[\widetilde{q}_h^N + \widetilde{q}_h^{*N}][\frac{\widetilde{q}_h^{*N}}{\widetilde{q}_h^N - \widetilde{q}_h^{*N}}] - [t_h^N - t_h^{*N}]\frac{n_h^N[(\widetilde{q}_h^N)^2 + (\widetilde{q}_h^{*N})^2] + (\widetilde{q}_h^{*N})^2}{[\widetilde{q}_h^N - \widetilde{q}_h^{*N}]^2}.$$

Thus, at a symmetric Nash equilibrium, we conclude that

$$t_h^N - t_h^{*N} = \frac{n_h^N[\widetilde{q}_h^N + \widetilde{q}_h^{*N}]\widetilde{q}_h^{*N}[\widetilde{q}_h^N - \widetilde{q}_h^{*N}]}{n_h^N[(\widetilde{q}_h^N)^2 + (\widetilde{q}_h^{*N})^2] + (\widetilde{q}_h^{*N})^2}. \tag{49}$$

Importantly, (49) confirms that $t_h^N > t_h^{*N}$, provided that $\widetilde{q}_h^N - \widetilde{q}_h^{*N} = \tau > 0$. In other words, the domestic import tariff is greater than the domestic export tariff precisely because of the local-market bias in firm sales.

Our next step is to use (36) and (40) and add the domestic first-order condition for t_h to the domestic first-order condition for t_h^*. We obtain

$$\begin{aligned} 0 &= \frac{dG}{dt_h} + \frac{dG}{dt_h^*} \qquad (50) \\ &= -D(\widetilde{P}^N(\tau^*,\tau))[\frac{\partial \widetilde{P}^N(\tau^*,\tau)}{\partial \tau} + \frac{\partial \widetilde{P}^N(\tau^*,\tau)}{\partial \tau^*}] + 2E^N(\tau^*,\tau) + [t_h^N + t_h^{*N}][\frac{\partial E^N(\tau^*,\tau)}{\partial \tau} + \frac{\partial E^N(\tau^*,\tau)}{\partial \tau^*}], \end{aligned}$$

where we use symmetry to impose $E^{*N}(\tau^*,\tau) = E^N(\tau^*,\tau)$, $\partial E^N(\tau^*,\tau)/\partial\tau^* = \partial E^{*N}(\tau^*,\tau)/\partial\tau$ and $\partial E^N(\tau^*,\tau)/\partial\tau = \partial E^{*N}(\tau^*,\tau)/\partial\tau^*$.

To further analyze (50), we compute $\partial \widetilde{P}^N(\tau^*,\tau)/\partial\tau + \partial \widetilde{P}^N(\tau^*,\tau)/\partial\tau^*$ and $\partial E^N(\tau^*,\tau)/\partial\tau + \partial E^N(\tau^*,\tau)/\partial\tau^*$ at a symmetric point. Using (20) and (21) and simplifying, we find that

$$\frac{\partial \widetilde{P}^N(\tau^*,\tau)}{\partial \tau} + \frac{\partial \widetilde{P}^N(\tau^*,\tau)}{\partial \tau^*} = \frac{\widetilde{q}_h^{*N}[\widetilde{q}_f^{*N} - \widetilde{q}_f^N]}{[\widetilde{q}_h^N\widetilde{q}_f^{*N} - \widetilde{q}_h^{*N}\widetilde{q}_f^N]}.$$

At a point of symmetry, therefore,

$$\frac{\partial \widetilde{P}^N(\tau^*,\tau)}{\partial \tau} + \frac{\partial \widetilde{P}^N(\tau^*,\tau)}{\partial \tau^*} = \frac{\widetilde{q}_h^{*N}}{[\widetilde{q}_h^N + \widetilde{q}_h^{*N}]} > 0. \qquad (51)$$

Similarly, we may use (27) and (28) and establish after simplification that, at a symmetric point,

$$\frac{\partial E^N(\tau^*,\tau)}{\partial \tau} + \frac{\partial E^N(\tau^*,\tau)}{\partial \tau^*} = -\frac{n_h^N[(\widetilde{q}_h^N)^2 + (\widetilde{q}_h^{*N})^2] + (\widetilde{q}_h^{*N})^2}{[\widetilde{q}_h^N + \widetilde{q}_h^{*N}]^2} < 0. \qquad (52)$$

At this point, we may return to our "addition" equation (50) and make the substitutions just derived in (51) and (52). After making these substitutions and simplifying, we get, for a symmetric point, that

$$0 = \frac{dG}{dt_h} + \frac{dG}{dt_h^*} = n_h^N\widetilde{q}_h^{*N} - [t_h^N + t_h^{*N}]\frac{n_h^N[(\widetilde{q}_h^N)^2 + (\widetilde{q}_h^{*N})^2] + (\widetilde{q}_h^{*N})^2}{[\widetilde{q}_h^N + \widetilde{q}_h^{*N}]^2}.$$

Thus, at a symmetric Nash equilibrium, we conclude that

$$t_h + t_h^* = \frac{n_h^N\widetilde{q}_h^{*N}[\widetilde{q}_h^N + \widetilde{q}_h^{*N}]^2}{n_h^N[(\widetilde{q}_h^N)^2 + (\widetilde{q}_h^{*N})^2] + (\widetilde{q}_h^{*N})^2} > 0. \qquad (53)$$

Importantly, (53) indicates that, at the Nash equilibrium, the total trade tax and thus the total trade cost is positive: $\tau = \tau^* > 0$ indeed holds.

At this point, we may add (49) and (53) to obtain

$$t_h^N = \frac{n_h^N(\widetilde{q}_h^N + \widetilde{q}_h^{*N})\widetilde{q}_h^{*N}\widetilde{q}_h^N}{n_h^N[(\widetilde{q}_h^N)^2 + (\widetilde{q}_h^{*N})^2] + (\widetilde{q}_h^{*N})^2} > 0. \qquad (54)$$

This implicit equation tells us that the Nash import tariff must be positive. Using (53) and (54) and simplifying, we may now recover the Nash export policy as

$$t_h^{*N} = \frac{n_h^N (\widetilde{q}_h^{*N})^2 (\widetilde{q}_h^N + \widetilde{q}_h^{*N})}{n_h^N [(\widetilde{q}_h^N)^2 + (\widetilde{q}_h^{*N})^2] + (\widetilde{q}_h^{*N})^2} > 0. \quad (55)$$

This implicit equation tells us that the Nash export tariff must be positive as well.

We may now conclude as follows:

Proposition 4: *In a (symmetric) Nash equilibrium in trade policies, the Nash import and export tariffs are both positive, with the Nash import tariff being the larger of the two.*

Comparing Propositions 3 and 4, we see immediately that Nash trade policies are inefficient in the linear Cournot delocation model.[12] In particular, using the fact that τ and τ^* take symmetric values in both the efficient free-trade benchmark and the Nash equilibrium, we may conclude from (52) that too little trade occurs under Nash trade policies.

It is also interesting to compare our characterization in Proposition 4 of the Nash equilibrium trade policies with Propositions 1 and 2 of the previous section, where we show that a country can gain by unilaterally departing from global free trade and introducing a small import tariff or a small export subsidy. Viewed from this perspective, our finding of a positive Nash import tariff is perhaps not surprising. Our finding of a positive Nash export tariff, however, is more surprising. How can we reconcile the gain that a country experiences when departing from global free trade and introducing a small export subsidy with the finding that the Nash equilibrium entails an export tariff? We address this question in the next section.

5 Interpretation of Trade Policy Findings

We now have two sets of findings. First, starting at global free trade, each country has an incentive to introduce a small import tariff or alternatively a small export subsidy. Second, in a Nash equilibrium, each country uses an import tariff and an export tariff. We consider now how to explain these seemingly contradictory findings.

When choosing its trade policy, a government seeks to maximize the sum of consumer surplus and tariff revenue. Consumer surplus is governed by the consumption price. Focusing for simplicity on the domestic country, consider then the iso-price relationship $\widetilde{P}^N(\tau^*, \tau) = k$ for some initial value k. We can think of this relationship as generating an iso-price tariff function, $\overline{\tau}^*(\tau, k)$, which has positive slope. In particular, using (20) and (21), we find that

$$\frac{\partial \overline{\tau}^*}{\partial \tau} = -\frac{\partial \widetilde{P}^N(\tau^*, \tau)/\partial \tau}{\partial \widetilde{P}^N(\tau^*, \tau)/\partial \tau^*} = \frac{\widetilde{q}_f^N}{\widetilde{q}_f^{*N}} < 1, \quad (56)$$

[12] In Bagwell and Staiger (2009), we consider a more general representation of the Cournot delocation model and establish that Nash trade policies are inefficient. In that paper, however, we do not offer a detailed analysis of the Nash trade policies. For example, we do not consider there the sign of the Nash export policy.

where the inequality holds so long as $\tau + n_h^N(\tau + \tau^*) > 0$ and thus under our assumption that τ and τ^* are positive. An interesting observation is that a government can adjust its import and export tariffs along the upward-sloping iso-price tariff function, $\overline{\tau}^*(\tau, k)$, without impacting the surplus that its consumers enjoy on the associated good. In particular, there exists a tariff-revenue-maximizing way of delivering any given local price and thus consumer surplus.

Suppose that the foreign government has selected a pair of tariffs, t_f and t_f^*, which along with an initial pair of domestic tariffs, t_h and t_h^*, generate values τ and τ^* and thereby a domestic local price $\widetilde{P}^N(\tau^*, \tau) = k$. Building on the observation made above, we may now ask which pair of domestic tariffs maximizes domestic tariff revenue, when the local price is taken as fixed. The associated program is

$$\begin{aligned} \max_{t_h, t_h^*} TR(t_h, t_h^*, t_f, t_f^*) &= t_h E^{*N}(\tau^*, \tau) + t_h^* E^N(\tau^*, \tau) \\ s.t.\ \widetilde{P}^N(\tau^*, \tau) &= k,\ \tau = t_h + t_f + \phi,\ \tau^* = t_f^* + t_h^* + \phi \end{aligned}$$

or equivalently

$$\max_{t_h} TR(t_h, \overline{t}_h^*(\tau, t_f^*, k); t_f, t_f^*) = t_h E^{*N}(\overline{\tau}^*(\tau, k), \tau) + \overline{t}_h^*(\tau, t_f^*, k) E^N(\overline{\tau}^*(\tau, k), \tau),$$

where with t_f and t_f^* fixed the induced value for $\overline{\tau}^*(\tau, k)$ is achieved via appropriate selections for t_h^* as t_h and thereby τ is varied. In particular, the induced value for t_h^* is $\overline{t}_h^*(\tau, t_f^*, k) \equiv \overline{\tau}^*(\tau, k) - t_f^* - \phi$, where we suppress the dependence on ϕ in the functional notation. The domestic Nash tariffs, for example, must solve this program when $k = \widetilde{P}^N(\tau^{*N}, \tau^N)$.

We can write the first-order condition for this program as

$$\begin{aligned} \frac{dTR(t_h, \overline{t}_h^*(\tau, t_f^*, k), t_f, t_f^*)}{dt_h} &= [E^{*N}(\overline{\tau}^*(\tau, k), \tau) + E^N(\overline{\tau}^*(\tau, k), \tau)\frac{\widetilde{q}_f^N}{\widetilde{q}_f^{*N}}] \\ &\quad + t_h[\frac{\partial E^{*N}}{\partial \tau^*}\frac{\widetilde{q}_f^N}{\widetilde{q}_f^{*N}} + \frac{\partial E^{*N}}{\partial \tau}] + \overline{t}_h^*(\tau, t_f^*, k)[\frac{\partial E^N}{\partial \tau^*}\frac{\widetilde{q}_f^N}{\widetilde{q}_f^{*N}} + \frac{\partial E^N}{\partial \tau}] = 0, \end{aligned} \tag{57}$$

where we utilize (56).

Suppose now that we initially place the domestic tariffs at free trade, while fixing the foreign tariffs at any non-prohibitive level consistent with positive trade costs. These policies induce a domestic free-trade price $\widetilde{P}^N(t_f^* + \phi, t_f + \phi) = k_0$. Thus, at this starting point, $t_h^* = \overline{t}_h^*(t_f + \phi, t_f^*, k_0) = 0$. Starting from here, we may ask whether the domestic government would like to raise its import tariff, t_h, while increasing its export tariff, t_h^*, a comparable amount as defined by (56) that serves to preserve the initial domestic free-trade price. The first-order condition (57) for our program, evaluated at $t_h = 0 = \overline{t}_h^*$, indicates that the domestic country would gain from such an adjustment, since it would enjoy an increase in tariff revenue with no change in consumer surplus. In particular, the gain in domestic tariff revenue and thus domestic welfare is $E^{*N}(\overline{\tau}^*(\tau, k), \tau) + E^N(\overline{\tau}^*(\tau, k), \tau)\widetilde{q}_f^N / \widetilde{q}_f^{*N} > 0$.

We may summarize the result of this variation as follows:

Proposition 5: *Suppose the domestic tariffs are initially placed at free trade, with the foreign tariffs fixed at any non-prohibitive level consistent with positive trade costs. From this starting point, suppose further that the domestic government undertakes a slight increase in its import tariff while increasing its export tariff a comparable amount as defined by (56) that serves to preserve the initial domestic free-trade price. Then the domestic country enjoys a welfare gain, since its tariff revenue increases while its consumer surplus is unaltered.*

It is interesting to compare this unilateral departure from free trade with those analyzed by Venables (1985) and in the previous section. As shown in Propositions 1 and 2, the introduction of a small import tariff and the introduction of a small export subsidy each serve to raise domestic welfare. Notice, though, that these variations entail simultaneous changes in consumer surplus and tariff revenue. By contrast, the variation that we consider in Proposition 5 entails a simultaneous increase in the import and export tariffs that preserves consumer surplus and isolates the tariff-revenue effect.[13]

This discussion suggests a way to reconcile the finding that the optimal unilateral export policy is an export subsidy with the finding that the Nash equilibrium entails an export tax. In particular, as suggested by Proposition 2, let us suppose that the domestic import tariff and all foreign tariffs are initially set at free trade, and let us then place the domestic export policy at the optimal unilateral export subsidy. From here, we can imagine a further variation in which we both raise the domestic import tariff and reduce the domestic export subsidy so as to maintain the domestic local price. If this adjustment increases tariff revenue, then we could even end up with a preferred situation for the domestic country in which import and export tariffs are positive. In the linear-demand case at least, the Nash equilibrium tariffs can be understood in this way. By considering only one policy change at a time, the variations considered by Venables (1985) and featured in Propositions 1 and 2 do not permit such simultaneous adjustments in import and export policies.

Proposition 5 highlights the potential value to a country of simultaneously making its import and export policies more restrictive.[14] This orientation suggests that a country's import and export tariffs are at least in some cases complementary with respect to their effects on tariff revenue. In turn, this line of thought provides some additional intuition for why the Nash import and export tariffs are indeed positive.

To further develop this intuition, we now formally identify a novel *tariff-complementarity effect* that arises in the Cournot delocation model of trade policy.[15] In particular, recall that

[13] The variation we consider here clearly applies for a general class of demand functions, since the result reported in Proposition 5 requires only that $\overline{\tau}^*$ is upward sloping. Also, and as Proposition 5 affirms, the result of the variation considered here holds for a wide range of possible foreign tariff specifications.

[14] In fact, the finding reported in Proposition 5 can be strengthened so as to allow for any initial domestic trade policies satisfying $t_h \leq 0$ and $t_h^* \geq 0$, suggesting that the attractiveness of raising the restrictiveness of both import and export policies in this fashion may be quite broad.

[15] The tariff-complementarity effect identified here entails a complementary relationship between a country's import and export tariffs, for the same good. This effect is thus distinct from previously identified tariff-complementarity

$TR(t_h, t_h^*, t_f, t_f^*) = t_h E^{*N}(\tau^*, \tau) + t_h^* E^N(\tau^*, \tau)$. Consider now the cross derivative of domestic tariff revenue with respect to changes in the domestic tariff instruments, t_h and t_h^*. We find that

$$\frac{\partial^2 TR}{\partial t_h \partial t_h^*} = \frac{\partial E^N}{\partial \tau} + \frac{\partial E^{*N}}{\partial \tau^*} + t_h^* \frac{\partial^2 E^N}{\partial \tau \partial \tau^*} + t_h \frac{\partial^2 E^{*N}}{\partial \tau \partial \tau^*}. \quad (58)$$

Using (27) and (30), and assuming that foreign tariffs are non-prohibitive and such that trade costs are positive, we know that $\partial E^N/\partial\tau + \partial E^{*N}/\partial\tau^* > 0$. Thus, at least in the neighborhood of domestic free trade, we have from (58) that there exists a clear tariff-complementarity effect: $\partial^2 TR/\partial t_h \partial t_h^* > 0$ when $t_h = 0 = t_h^*$.

We now summarize our finding to this point as regards the tariff-complementarity effect:

Proposition 6: *For domestic tariffs sufficiently close to free trade, the domestic import and export tariffs exert a complementary effect on domestic tariff revenue, provided that foreign tariffs are non-prohibitive and such that trade costs are positive.*

The idea behind the tariff-complementarity effect is as follows.[16] When a small export tariff, t_h^*, is introduced, tariff revenue is enjoyed on those units that are exported. If a small import tariff is then introduced as well, domestic entry occurs and so more domestic units are exported. Thus, an import tariff can increase the marginal revenue of an export tariff. Indeed, this must be the case when the export tariff begins at free trade and is then raised. Similarly, if we were to first introduce an import tariff, then import tariff revenue would be enjoyed on imported units; further, the volume of imports would only grow were an export tariff introduced as well, since the export tariff would trigger foreign entry and thus a greater volume of foreign exports. In this way, an export tariff can increase the marginal revenue of an import tariff. The described tariff-complementarity effect is general and is not limited to the linear-demand setting; however, when tariffs begin at values differing from free trade, then the marginal revenue associated with an initial tariff hike is determined in part by the effect of the hike on the volume of trade on which the initial tariff is applied. A tariff hike on the other channel can then alter marginal revenue on the initial channel by altering the rate at which the initial tariff hike affects trade volume on the initial channel. Hence, when we begin at values differing from free trade, new effects come into play that are associated with the cross derivatives of the export volume functions.[17]

The tariff-complementarity effect identified in Proposition 6 provides additional intuition for the fact that both import tariffs and export tariffs are positive in a Nash equilibrium. In effect,

effects that concern complemetary relationships between the (discriminatory) import tariffs that a country applies to different suppliers of an import good (Bagwell and Staiger, 1999b) or between the import tariffs of different countries which import a common good (Bagwell and Staiger, 1997).

[16] For domestic tariffs sufficiently close to free trade, and provided that foreign tariffs are non-prohibitive and such that trade costs are positive, we can show that domestic import and export tariffs also exert a complementary effect on domestic welfare (i.e., $\frac{\partial^2 G}{\partial t_h \partial t_h^*} > 0$). We emphasize the complementary effect that domestic tariffs exert on domestic tariff revenue, in order to further develop the intuition underlying Proposition 5.

[17] We can show that, at a point of symmetry, $\frac{\partial^2 E^n}{\partial\tau\partial\tau^*} = \frac{\partial^2 E^{*n}}{\partial\tau\partial\tau^*} < 0$. At a symmetric point with positive tariffs, therefore, we see from (58) that the sign of $\frac{\partial^2 TR}{\partial t_h \partial t_h^*}$ involves competing effects.

the joint use of import tariffs and export tariffs is attractive to governments in the linear Cournot delocation model, because a tax on trade in one direction *encourages* trade in the other direction on which the other trade tax can then collect revenue.

6 Politically Optimal Trade Policies

In the Cournot delocation model, international externalities travel from one country's trade policy to another country's welfare. As a consequence, and as noted above, Nash trade policies are inefficient. In Bagwell and Staiger (2009), we argue at a general level that unilateral trade policies would be efficient if governments were not motivated by the terms-of-trade implications of their respective trade policy selections. In this sense, the inefficiency attributable to the terms-of-trade externality is the "problem" that a trade agreement can be designed to solve. To make this point, we represent welfare in terms of local and world prices and then define the politically optimal policies as the (import and export) trade policies that governments would choose if they were not motivated by the terms-of-trade implications of their respective selections. The central finding is that the politically optimal policies are efficient.

In this section, we utilize the additional structure that the linear Cournot delocation model provides and characterize the specific trade policies that are politically optimal in this model. Given that politically optimal trade policies are known to be efficient, we know from Proposition 3 that politically optimal trade policies must impose a net trade tax of zero (i.e., $\tau = \tau^* = \phi$). Thus, if the politically optimal policies were to involve an import tariff along one channel of trade, then an offsetting export subsidy would be required along this same channel. We establish in this section that a (symmetric) political optimum exists for the linear Cournot delocation model in which global free trade is achieved (i.e., each country adopts a policy of free trade with respect to its imports *and* exports). For the linear Cournot delocation model, therefore, if countries were not motivated by the terms-of-trade implications of their policies, then it is reasonable to expect that they would achieve efficiency by adopting the specific policy vector of global free trade. After establishing this result, we then comment briefly at the end of this section on the implications of this finding for the interpretation of the WTO SCM Agreement.

6.1 Welfare Functions

Our first task is to rewrite domestic and foreign welfare as functions of local and world prices. We thus begin by defining the full set of local and world prices. Recall that the domestic and foreign local prices may be respectively expressed as $\widetilde{P}^N(\tau^*, \tau)$ and $\widetilde{P}^{*N}(\tau^*, \tau)$. We may now define the following world prices: $P^{wN}(t_h, \tau^*, \tau) \equiv \widetilde{P}^N(\tau^*, \tau) - t_h$ and $P^{*wN}(t_f^*, \tau^*, \tau) \equiv \widetilde{P}^{*N}(\tau^*, \tau) - t_f^*$. We thus define $P^{wN}(t_h, \tau^*, \tau)$ to represent the price of foreign exports on the world market (i.e., prior to the imposition of the domestic import tariff, t_h), while we define $P^{*wN}(t_f^*, \tau^*, \tau)$ to represent the price of domestic exports on the world market (i.e., prior to the imposition of the foreign import tariff, t_f^*). Finally, it is convenient to consider a unit that will be exported and to define its local price in the exporting country as the price that remains once the import tariff, export tariff and transport cost are subtracted from its local price in the importing country. Specifically, we define the following local prices

$$\begin{aligned} R^N(\tau^*,\tau) &\equiv \widetilde{P}^{*N}(\tau^*,\tau)-\tau^* = P^{*wN}(t_f^*,\tau^*,\tau)-t_h^*-\phi \\ R^{*N}(\tau^*,\tau) &\equiv \widetilde{P}^{N}(\tau^*,\tau)-\tau = P^{wN}(t_h,\tau^*,\tau)-t_f-\phi. \end{aligned}$$

We note that $R^N(\tau^*,\tau)$ may differ from $\widetilde{P}^N(\tau^*,\tau)$, since markets are segmented. Similarly, $R^{*N}(\tau^*,\tau)$ may differ from $\widetilde{P}^{*N}(\tau^*,\tau)$.[18]

We next represent firm output, entry levels, and trade volumes as functions of local prices. Let us start with the Cournot-Nash firm quantities. Using $\tau = \widetilde{P}^N(\tau^*,\tau) - R^{*N}(\tau^*,\tau)$ and $\tau^* = \widetilde{P}^{*N}(\tau^*,\tau) - R^N(\tau^*,\tau)$, and recalling that long-run Cournot-Nash firm quantities may be expressed as functions of the underlying total tariffs, we may think of the Cournot-Nash quantities of firms as functions of local prices. Thus, in the domestic market, we may express Cournot-Nash quantities as $\widetilde{q}_h^N(\widetilde{P}^{*N}-R^N,\widetilde{P}^N-R^{*N}) = \widetilde{q}_h^N(\tau^*,\tau)$ and $\widetilde{q}_f^N(\widetilde{P}^{*N}-R^N,\widetilde{P}^N-R^{*N}) = \widetilde{q}_f^N(\tau^*,\tau)$. Similarly, in the foreign market, we have the following expressions: $\widetilde{q}_h^{*N}(\widetilde{P}^{*N}-R^N,\widetilde{P}^N-R^{*N}) = \widetilde{q}_h^{*N}(\tau^*,\tau)$ and $\widetilde{q}_f^{*N}(\widetilde{P}^{*N}-R^N,\widetilde{P}^N-R^{*N}) = \widetilde{q}_f^{*N}(\tau^*,\tau)$. Of course, local prices are themselves ultimately determined by the tariff selections.

We may treat the numbers of firms and also export volumes in a similar fashion. Using (15), we may represent the numbers of firms as functions of local prices: $n_h^N(\widetilde{P}^{*N}-R^N,\widetilde{P}^N-R^{*N}) = n_h^N(\tau^*,\tau)$ and $n_f^N(\widetilde{P}^{*N}-R^N,\widetilde{P}^N-R^{*N}) = n_f^N(\tau^*,\tau)$. Likewise, using (26) and (29), we see that export volumes can also be regarded as functions of local prices: $E^N(\widetilde{P}^{*N}-R^N,\widetilde{P}^N-R^{*N}) = E^N(\tau^*,\tau)$ and $E^{*N}(\widetilde{P}^{*N}-R^N,\widetilde{P}^N-R^{*N}) = E^{*N}(\tau^*,\tau)$.

At this point, we have all of the ingredients for representing domestic and foreign welfares as functions of the local and world prices that the respective tariff selections induce. Referring to (34), we may now rewrite domestic welfare as

$$\begin{aligned} & W(\widetilde{P}^N,R^N,P^{wN},\widetilde{P}^{*N},R^{*N},P^{*wN}) \\ = \; & CS(\widetilde{P}^N)+[\widetilde{P}^N-P^{wN}]E^{*N}(\widetilde{P}^{*N}-R^N,\widetilde{P}^N-R^{*N}) \\ & +[P^{*wN}-R^N-\phi]E^N(\widetilde{P}^{*N}-R^N,\widetilde{P}^N-R^{*N}). \end{aligned} \tag{59}$$

Notice that, for any fixed set of trade policies, $W(\widetilde{P}^N,R^N,P^{wN},\widetilde{P}^{*N},R^{*N},P^{*wN}) = G(\tau^*,\tau,t_h,t_h^*)$,

[18] Using (20), we may now see that an import tariff has the traditional effect of generating an improvement in the importing country's terms-of-trade. In particular, $dP^{wN}/dt_h = \partial\widetilde{P}^N(\tau^*,\tau)/\partial\tau - 1 < 0$; thus, a higher domestic import tariff reduces the world price of the imported unit and thereby generates a terms-of-trade gain for the domestic country. At the same time, we may use (21) to see that an export tariff has a non-traditional effect on the exporting country's terms of trade. Specifically, $dP^{*wN}/dt_h^* = \partial\widetilde{P}^{*N}(\tau^*,\tau)/\partial\tau^* < 0$; thus, a higher domestic export tariff reduces the world price of the exported unit and thereby generates a terms-of-trade loss for the domestic country. An export subsidy thus generates a terms-of-trade gain for the exporting country. This novel.feature of the Cournot delocation model is attributable to the firm-delocation effect. Of course, exactly analogous results apply for the foreign country. For further discussion of the terms-of-trade effects present in the Cournot delocation model, see Bagwell and Staiger (2009).

since the local and world price variables in W are those which are induced by the tariff variables represented in G. Similarly, referring to (35), we may now rewrite foreign welfare as

$$\begin{aligned} & W^*(\widetilde{P}^N, R^N, P^{wN}, \widetilde{P}^{*N}, R^{*N}, P^{*wN}) \\ = \; & CS^*(\widetilde{P}^{*N}) + [\widetilde{P}^{*N} - P^{*wN}]E^N(\widetilde{P}^{*N} - R^N, \widetilde{P}^N - R^{*N}) \\ & + [P^{wN} - R^{*N} - \phi]E^{*N}(\widetilde{P}^{*N} - R^N, \widetilde{P}^N - R^{*N}). \end{aligned} \tag{60}$$

Just as for the domestic welfare expressions, we have that, for any fixed set of trade policies, $W^*(\widetilde{P}^N, R^N, P^{wN}, \widetilde{P}^{*N}, R^{*N}, P^{*wN}) = G^*(\tau^*, \tau, t_f^*, t_f)$.

6.2 Political Optimum

We are now prepared to characterize politically optimal trade policies. We focus first on the domestic country, who we suppose acts as if $W_{P^{wN}} \equiv 0$ and $W_{P^{*wN}} \equiv 0$ when choosing its politically optimal trade policies. The first-order condition for politically optimal domestic import policy is then

$$W_{\widetilde{P}^N} \frac{\partial \widetilde{P}^N}{\partial \tau} + W_{R^N} \frac{\partial R^N}{\partial \tau} + W_{\widetilde{P}^{*N}} \frac{\partial \widetilde{P}^{*N}}{\partial \tau} + W_{R^{*N}} \frac{\partial R^{*N}}{\partial \tau} = 0. \tag{61}$$

Likewise, the first-order condition for the politically optimal domestic export policy is

$$W_{\widetilde{P}^N} \frac{\partial \widetilde{P}^N}{\partial \tau^*} + W_{R^N} \frac{\partial R^N}{\partial \tau^*} + W_{\widetilde{P}^{*N}} \frac{\partial \widetilde{P}^{*N}}{\partial \tau^*} + W_{R^{*N}} \frac{\partial R^{*N}}{\partial \tau^*} = 0. \tag{62}$$

At this point, we have derived two conditions (i.e., (61) and (62)) with which to determine the politically optimal levels of the two domestic trade-policy selections (i.e., t_h and t_h^*). Of course, we can derive two symmetric equations for the foreign country, and these equations can be used to determine the politically optimal levels of the two foreign trade-policy selections. To keep the analysis simple, however, we will focus here on the existence and characterization of a symmetric political optimum, wherein $t_f^* = t_h$ and $t_f = t_h^*$. With the symmetry requirement imposed, our task is to characterize the values for t_h and t_h^* that satisfy (61) and (62).

In the Appendix, we use the analysis of the model developed in previous sections and establish that (61) and (62) are uniquely satisfied when $t_h = t_h^* = 0$.[19] We may thus summarize our findings in this section as follows:

Proposition 7: *There exists a unique symmetric political optimum, and in this political optimum each country practices free trade with respect to its import and export policies.*

In short, if governments were not motivated by the terms-of-trade implications of their trade policies, then they would achieve an efficient outcome; furthermore, in the linear Cournot delocation

[19] We may also verify that the second-order conditions for the political optimum are satisfied. In the Appendix, we simplify and express the first-order conditions for the politically optimal domestic import and export policies as (66) and (69). At global free trade, we may easily verify that the Jacobian matrix associated with these two first-order conditions is the same as the Jacobian matrix associated with the first-order conditions for efficient tariffs. We show above in footnote 10 that this matrix is negative definite.

model, they would in particular achieve efficiency by individually setting each import and export tariff equal to zero. Global free trade is thus the unique symmetric political optimum for this model.

An implication of this finding is that the prohibition of export subsidies contained in the WTO SCM Agreement is compatible with the political optimum in this model. This feature strengthens the ability of the linear Cournot delocation model to provide an interpretation of the treatment of export subsidies in the GATT/WTO, given that other design features of the GATT/WTO can also be interpreted as guiding governments toward efficient politically optimal outcomes (see Bagwell and Staiger, 1999a, 2009).

7 Conclusion

In this paper, we consider trade policies and agreements in the linear Cournot delocation model. We have shown that this model is capable of delivering a potential efficiency-enhancing interpretation for WTO rules on export subsidies. This distinguishes the Cournot delocation model from other formal analyses of the treatment of export subsidies in trade agreements, which as we have observed suggest that GATT/WTO efforts to reign in export subsidies may be best interpreted as an inefficient victory for exporting governments that comes at the expense of importing governments.

This raises the question whether the Cournot delocation model offers a compelling rationale for the GATT/WTO efforts to restrict the use of export subsidies. This question is not merely academic. Many GATT/WTO disputes involve export subsidies, and some of the longest-running disputes, and largest in terms of authorized retaliation, have centered on government programs that were alleged to operate as export subsidies.[20] So there is much at stake in assessing the "legitimacy" of the SCM's prohibition against export subsidies.

This question is ultimately an empirical one, since it boils down to whether the Cournot delocation model, or rather any of the other models that deliver the more skeptical view of the GATT/WTO stance on export subsidies, better captures the forces that are relevant for understanding and interpreting the GATT/WTO. As a consequence, the question cannot be answered here. But we mention several points that may be relevant in providing an eventual answer.

First, we have established our results in a linear-demand version of the Cournot delocation model. This raises the obvious question whether the efficiency-enhancing interpretation for WTO rules on export subsidies would survive with general non-linear demands. This is a subtle question, because linearity plays several roles in the model. On the one hand, in a companion paper (Bagwell and Staiger, 2009) we establish that export subsidies have non-traditional (beneficial) terms-of-trade effects for the exporting country in the Cournot delocation model even when demands are non-linear, indicating that the essential beggar-thy-neighbor features of export subsidies that argues for

[20] For example, the U.S.-EU civil aircraft dispute concerning government support for Boeing and Airbus, which includes allegations of illegal export subsidies, has spanned a period of almost 25 years, while the largest level of retaliation ever authorized in a GATT/WTO dispute concerned the U.S.-EU dispute over the U.S. FISC program, which amounted to an export subsidy.

their restraint (see note 18) is not limited to a linear-demand setting. This suggests that the main insights from the linear Cournot delocation model are likely to survive in some form with general non-linear demands. On the other hand, when demands are non-linear, global free trade may not be efficient in this setting, and so whether the prohibition of export subsidies is compatible with the efficient political optimum then remains an open question. On balance, though, the assumption of linear demands does not seem to be driving the case for restraining export subsidies on efficiency grounds that arises in the Cournot delocation model. Hence, evidence that the Cournot delocation model with general non-linear demands has empirical relevance would lend support to the view of GATT/WTO export subsidy agreements that we develop here.

Second, we have adopted the Cournot version of the firm-delocation model formalized by Venables (1985), but Venables (1987) has also formalized the firm-delocation effect in a differentiated product monopolistic competition setting, a setting that has been used recently to explore features of trade agreements in Ossa (2009) and also in Bagwell and Staiger (2009). This raises the question whether the monopolistic competition version of the firm-delocation model might also deliver an efficiency rationale for the prohibition of export subsidies. Here the answer is no. As established in Bagwell and Staiger (2009), in that model, as in other formal analyses of export subsidies and for the same reason, efficiency requires that export subsidies should, if anything, be encouraged by a trade agreement. Hence, it is the empirical relevance of the Cournot version of the delocation model that is at issue here.

And finally, we emphasize that there may of course not be just one “answer” to this question: the Cournot delocation model might offer a compelling rationale for the GATT/WTO efforts to restrict the use of export subsidies in some areas (e.g., agriculture), but not in others (e.g., civil aircraft). Viewed in this light, and together with existing theories, the Cournot delocation model and the results we have established here may simply help to provide a more nuanced and complete understanding of the treatment of export subsidies in trade agreements.

Appendix

Proof of Proposition 7: To evaluate (61), we use (59) and find that

$$\begin{aligned} W_{\widetilde{P}^N} &= -n_h^N \widetilde{q}_h^N + t_h \partial E^{*N}/\partial\tau + t_h^* \partial E^N/\partial\tau \\ W_{R^N} &= -t_h \partial E^{*N}/\partial\tau^* - t_h^* \partial E^N/\partial\tau^* - n_h^N \widetilde{q}_h^{*N} \\ W_{\widetilde{P}^{*N}} &= t_h \partial E^{*N}/\partial\tau^* + t_h^* \partial E^N/\partial\tau^* \\ W_{R^{*N}} &= -t_h \partial E^{*N}/\partial\tau - t_h^* \partial E^N/\partial\tau. \end{aligned} \tag{63}$$

Next, using our definitions for $R^N(\tau^*, \tau)$ and $R^{*N}(\tau^*, \tau)$, we see that

$$\frac{\partial R^N}{\partial\tau} = \frac{\partial \widetilde{P}^{*N}}{\partial\tau} \text{ and } \frac{\partial R^{*N}}{\partial\tau} = \frac{\partial \widetilde{P}^N}{\partial\tau} - 1. \tag{64}$$

Using (63) and (64), we may now simplify and rewrite (61) as

$$-n_h^N \{\widetilde{q}_h^N \frac{\partial \widetilde{P}^N}{\partial\tau} + \widetilde{q}_h^{*N} \frac{\partial \widetilde{P}^{*N}}{\partial\tau}\} + t_h \partial E^{*N}/\partial\tau + t_h^* \partial E^N/\partial\tau = 0 \tag{65}$$

At this point, we exploit the linear-demand structure of the model and calculate the bracketed term in (65). Using (20) and (23), we find that

$$\widetilde{q}_h^N \frac{\partial \widetilde{P}^N}{\partial\tau} + \widetilde{q}_h^{*N} \frac{\partial \widetilde{P}^{*N}}{\partial\tau} = 0.$$

Thus, in the linear Cournot delocation model, the first-order condition for the politically optimal domestic import policy can be rewritten as

$$t_h \partial E^{*N}/\partial\tau + t_h^* \partial E^N/\partial\tau = 0. \tag{66}$$

We notice that (66) is satisfied when the domestic country practices free trade with respect to its import and export policies.

Consider now (62). Using our definitions for $R^N(\tau^*, \tau)$ and $R^{*N}(\tau^*, \tau)$, we see that

$$\frac{\partial R^N}{\partial\tau^*} = \frac{\partial \widetilde{P}^{*N}}{\partial\tau^*} - 1 \text{ and } \frac{\partial R^{*N}}{\partial\tau^*} = \frac{\partial \widetilde{P}^N}{\partial\tau^*}. \tag{67}$$

Using (63) and (67), we may rewrite (62) as

$$-n_h^N \{\widetilde{q}_h^N \frac{\partial \widetilde{P}^N}{\partial\tau^*} + \widetilde{q}_h^{*N} \frac{\partial \widetilde{P}^{*N}}{\partial\tau^*} - \widetilde{q}_h^{*N}\} + t_h \partial E^{*N}/\partial\tau^* + t_h^* \partial E^N/\partial\tau^* = 0. \tag{68}$$

As above, we now exploit the linear-demand structure of the model and calculate the bracketed term in (68). Using (21) and (22), we find that

$$\widetilde{q}_h^N \frac{\partial \widetilde{P}^N}{\partial\tau^*} + \widetilde{q}_h^{*N} \frac{\partial \widetilde{P}^{*N}}{\partial\tau^*} - \widetilde{q}_h^{*N} = 0.$$

Thus, in the linear Cournot delocation model, the first-order condition for the politically optimal domestic export policy can be rewritten as

$$t_h \partial E^{*N}/\partial\tau^* + t_h^* \partial E^N/\partial\tau^* = 0. \tag{69}$$

Notice that (69) is also satisfied when the domestic country practices free trade with respect to its import and export policies.

We now see that (66) and (69) are satisfied when $t_h = t_h^* = 0$. Thus, in the linear Cournot delocation model, there exists a (symmetric) political optimum in which both countries practice free trade with respect to their import and export policies. Furthermore, at a symmetric point, we know from (32), (33) and (52), respectively, that $\partial E^N/\partial\tau = \partial E^{*N}/\partial\tau^* > 0, \partial E^N/\partial\tau^* = \partial E^{*N}/\partial\tau < 0$ and $\partial E^N/\partial\tau + \partial E^N/\partial\tau^* < 0$. This information is sufficient to tell us that global free trade is in fact the unique symmetric political optimum. Proposition 7 is thus established.

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