Delocation and Trade Agreements in Imperfectly Competitive Markets[*]
(Preliminary)

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Abstract

We consider the purpose and design of trade agreements in imperfectly competitive environments featuring firm-delocation effects. In both the segmented-market Cournot and the integrated-market monopolistic competition settings where these effects have been identified, we show that the only rationale for a trade agreement is to remedy the inefficiency attributable to the terms-of-trade externality, the same rationale that arises in perfectly competitive markets. Furthermore, and again as in the perfectly competitive benchmark case, we show that the principle of reciprocity is efficiency enhancing, as it serves to "undo" the terms-of-trade driven inefficiency that occurs when governments pursue unilateral trade policies. Our results therefore indicate that the terms-of-trade theory of trade agreements applies to a broader set of market structures than previously thought.

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1 Introduction

A central question in the study of commercial policy is why governments form international trade agreements. Answers to this question provide the foundation from which to evaluate and interpret the design of trade agreements in light of the underlying "problems" that they exist to solve.

An established literature argues that governments have a reason to form a trade agreement when an international externality is associated with their trade-policy choices. When a country is large in world markets, it can reduce the world (offshore) price of its imported goods by raising its tariffs. The country then enjoys an improvement in its terms of trade; however, its trading partners suffer a negative terms-of-trade externality. As Johnson (1953-54) argues, when governments maximize national income and markets are perfectly competitive, the associated non-cooperative equilibrium is inefficient, and a "problem" is thereby identified. An appropriately designed trade agreement can then enhance the welfare of all governments by reducing or eliminating this inefficiency.

These arguments are extended by Bagwell and Staiger (1999) and Grossman and Helpman (1995) to allow that governments have political-economic preferences. Allowing for a wide class of government preferences, Bagwell and Staiger (1999) demonstrate that the non-cooperative equilibrium is inefficient relative to government preferences if and only if governments are motivated by the terms-of-trade consequences of their respective trade policies. Building from this finding, they then explore the form that an efficiency-enhancing trade agreement might take. They show that the principle of reciprocity (and in a multi-country setting, non-discrimination) can help to "undo" the terms-of-trade driven inefficiency and guide governments toward efficient policies.

A model with perfectly competitive markets offers a valuable benchmark for understanding the purpose of trade agreements. For many markets, however, firms possess market power. It is thus important to know whether the purpose of trade agreements might change in some fundamental sense once the model is extended to allow for the realistic possibility of imperfect competition. This extension introduces several novel issues. In particular, as is well known, imperfectly competitive markets can give rise to "profit-shifting" and "firm-delocation" effects that provide novel motives for trade policy intervention. At a minimum, this suggests that other international externalities in addition to the terms-of-trade externality may also be present in markets with imperfect competition.

In this paper, we move beyond perfectly competitive markets and extend the analysis to imperfectly competitive markets that feature the firm-delocation motive for trade policy intervention. In settings where the firm-delocation effect is present, we examine the rationale for a trade agreement, and we also consider the form that an efficiency-enhancing trade agreement might take.

Venables (1985) first identified the firm-delocation effect, according to which an import tariff or export subsidy can produce the surprising result of benefiting a country's *consumers*, by stimulating entry of domestic firms and thereby reducing domestic prices through enhanced competition. This benefit, however, comes at the expense of foreign consumers, who experience higher prices as a result of foreign-firm exit and diminished competition in the foreign market. Venables identified this effect in a model where firms produce a homogeneous good and compete in a Cournot fashion for sales in segmented markets under conditions of free entry. Venables (1987) then showed that this effect extends to a setting of free-entry monopolistic competition where markets are integrated and firms compete to sell differentiated products. In the model of monopolistic competition used by Venables, it is the savings on transport costs implied by the firm-delocation effect rather than the impacts on competition that can enhance the welfare of the intervening country. As Venables demonstrates, if the home country raises barriers to its imports or subsidizes its exports, then foreign firms can be "delocated" to the home market. Home consumers then save on trade costs in the form of a lower overall price index, at the expense of foreign consumers whose price index rises.[1]

When this novel motive for trade policy intervention is present, it might be expected that a novel rationale for a trade agreement would likewise be present. In line with this expectation, we show that new international externalities indeed arise when the firm-delocation effect is present: in addition to the terms-of-trade externality that travels through the world price, there are also local price externalities that travel through domestic and foreign local prices. The key question for our purposes, however, is whether governments internalize these international externalities in an appropriate fashion from a world-wide perspective when they make their unilateral policy choices. In both the Cournot and the monopolistic competition settings where the firm-delocation effect has been shown to arise, we address this question and establish a surprising answer: the *only* rationale for a trade agreement is to remedy the inefficiency attributable to the terms-of-trade externality, the same rationale that arises in perfectly competitive markets. Furthermore, and again as in the benchmark model with perfect competition, the principle of reciprocity is efficiency enhancing, as it serves to "undo" the terms-of-trade driven inefficiency that occurs when governments pursue unilateral trade policies.

To establish these results, we characterize the non-cooperative and efficient policy choices, and we then evaluate the precise reasons for any divergence between them. To this end, we follow Bagwell and Staiger (1999) and evaluate *politically optimal* tariffs, defined as those tariffs that would hypothetically be chosen by governments unilaterally if they did not value the pure international rent-shifting associated with the terms-of-trade movements induced by their unilateral tariff choices. We do this first for the Cournot model of firm delocation (Section 2) and then for the monopolistic competition model (Section 3). In each setting, we show that the noncooperative tariffs are inefficient and that the politically optimal tariffs are efficient. In particular, starting at the noncooperative tariffs, both countries could gain by reducing the total trade impediment on any trade flow. We thereby establish that the only rationale for a trade agreement is to remedy the higher-than-efficient tariffs that arise as a consequence of the value that governments place upon the terms-of-trade movements induced by their unilateral tariff choices.

We also show that the Cournot and monopolistic competition models exhibit an interesting

[1] More recently, the firm-delocation effect of trade policy intervention has been featured in Melitz and Ottaviano (2008) and Ossa (2009). Melitz and Ottaviano extend the analysis of this effect to a heterogeneous-firm setting. Ossa considers the rationale for trade agreements when firm-delocation effects are present. We relate our paper to Ossa's work below.

and overlooked feature: in each model, the terms-of-trade effects of import tariffs and export taxes are *asymmetric*. The asymmetry is most pronounced in the Cournot delocation model. In that model, a country can in standard fashion improve its terms of trade by levying an import tariff; however, an export tax *worsens* the terms of trade in the model, contrary to the standard case. By implication, an export subsidy *improves* a country's terms of trade in the Cournot delocation model. This features distinguishes the Cournot delocation model from other models of commercial policy. The monopolistic competition delocation model that we utilize is similar to that developed in Helpman and Krugman (1989). As Helpman and Krugman (1989) observe, in this model, a country is unable to alter its terms of trade by using an import tariff. We include export policies in our analysis as well, however, and observe that a country can generate a somewhat extreme (dollar-for-dollar) improvement in its terms of trade by applying an export tariff.

Our paper is most closely related to the recent paper of Ossa (2009). Utilizing a monopolistic competition model of firm delocation, Ossa argues that the firm-delocation effect provides a new rationale for a trade agreement, and a rationale that is especially relevant for (two-way) trade between similar countries. Ossa then goes on to offer a novel interpretation of reciprocity and non-discrimination as simple rules that can neutralize the firm-delocation effect. Our result concerning the rationale of a trade agreement in this setting is at odds with Ossa's first observation, and so it is important to explore the differences across the two papers. There are two substantive differences between the monopolistic competition model employed by Ossa and the one we utilize below. A first difference is that Ossa allows income effects on the demand for differentiated products, while our (quasi linear) specification of utility ensures that there will be no such income effects. The second difference is related to the first: due to income effects, Ossa's model becomes intractable when trade taxes imply revenue, and so Ossa assumes that trade taxes do not have revenue consequences; and importantly, this assumption requires Ossa to abstract from export (subsidy) policies in his analysis. By contrast, the revenue consequences of trade taxes are simple to handle in our quasi-linear setting, and so we can and do allow for both import tariffs and export taxes/subsidies; and as we explain below, allowing for both import and export policies is crucial for our result.[2]

If the presence of the firm-delocation effect introduces new international externalities that are transmitted through non-terms-of-trade channels, and we confirm below that it does, then how can the problem that a trade agreement must solve still boil down to providing an avenue of escape from a terms-of-trade driven Prisoners' Dilemma? Broadly speaking, the reason is this: trade agreements do not expand the set of feasible policy instruments available to governments, and so any efficiency gains generated by a trade agreement must derive from changes in the level of intervention achieved with the existing policy instruments; and as we demonstrate below, even in this more complicated environment it is the international rent-shifting/cost-shifting associated with the terms-of-trade externality – and this externality alone – that accounts for the inefficient level

[2]The GATT/WTO restricts the use of export subsidies, and in this light Ossa's (2009) finding can be interpreted as characterizing a problem that arises when export subsidies are banned. At the same time, this interpretation would fall short of delivering a fundamental rationale for a trade agreement, because it appeals to the existence of a trade agreement (on export subsidies) to explain why governments need a trade agreement.

of intervention under unilateral policy choices.

The analysis in this paper maintains the assumption that free entry eliminates profits in equilibrium even though firms are not price-takers. This allows us to focus on the firm-delocation effect, and on the novel role for trade policy intervention in the presence of this effect. An alternative role for government intervention can arise when the number of producers in each country is fixed and invariant to trade policy. In this case, there may exist profitable firms, and the pursuit of those profits – either converted into tariff revenue or shifted from one firm to another – combined with the relaxation of the assumption of price-taking behavior can provide an alternative "profit shifting" role for trade policy intervention. In a companion paper (Bagwell and Staiger, 2009), we consider this alternative by exploring models in which firms are not price takers but where the number of firms is fixed, and we again ask whether a novel role for trade agreements can be identified. For the models of profit-shifting, our main finding is again that the terms-of-trade externality continues to provide the only rationale for a trade agreement.

2 Delocation with Cournot Competition and Segmented Markets

In this section we consider a model whose underlying structure is essentially that contained in Venables (1985).[3] We refer to this model as the *Cournot delocation* model. The industry under consideration is comprised of firms who produce a homogeneous good and compete in a Cournot fashion for sales in a domestic and foreign market under conditions of free entry. The markets are segmented, and two-way trade in identical products arises as a consequence. There are transport costs between the markets, and each government may also impose a trade tax/subsidy on trade flows in and/or out of its market. This environment exhibits a firm-delocation effect that has important implications for the impacts of trade policy, as Venables first emphasized. Our main purpose here, however, is to identify and interpret the sources of inefficiency that arise when governments set their trade policies unilaterally, and thereby to explore the potential role and design of a trade agreement in this environment.

2.1 Model Setup

There are two countries (home and foreign), each endowed with a large amount of labor which is the only factor of production. In the background, a competitively supplied numeraire good is produced with labor alone according to a constant-returns-to-scale production function common across countries (1 unit of labor produces 1 unit of the numeraire). The numeraire good enters linearly into the utility of each country, is always produced and consumed in positive amounts by each country (due to the large supply of labor in each country), and is freely traded across countries, so that its price (and hence the wage of labor) is fixed and equalized (and normalized to one) everywhere in the world. This structure permits a partial equilibrium treatment of the second,

[3] The model we develop here imposes additional symmetry across countries relative to Venables (1985), but this symmetry serves only to simplify the exposition and is not necessary for our main results.

imperfectly competitive, industry that is our main focus. The home country has n_h Cournot firms in this industry, and the foreign country has n_f Cournot firms, all producing the same good at a (common) marginal cost c and fixed cost F under conditions of free entry. If the good sells in the home country at price P, then home consumers demand $D(P)$ units; likewise, if the good sells in the foreign country at price P^*, then foreign consumers demand $D^*(P^*)$ units. We assume that $D(P)$ and $D^*(P^*)$ are positive and downward sloping.

The markets are segmented, so that the home and foreign market prices P and P^* are determined by separate home and foreign market-clearing conditions, and the problem of output choice for each firm is separable across the home and foreign markets. As shown by Brander (1981), an implication of the segmented markets setting is that in general trade will occur in both directions.[4] Trade in either direction is costly in this industry, and we let φ denote the cost of transporting one unit of the good between countries (measured in units of the numeraire). We assume that each country has both import and export policies at its disposal, and we express all trade taxes in specific terms: for exports from the home country to the foreign country, t_h^* is the export tax imposed by the home country ($t_h^* < 0$ if an export subsidy) and t_f^* is the import tariff imposed by the foreign country; and for exports from the foreign country to the home country, t_f is the export tax imposed by the foreign country ($t_f < 0$ if an export subsidy) and t_h is the import tariff imposed by the home country. We maintain a focus throughout on non-prohibitive trade taxes.

For convenience we define the total trade impediments facing home and foreign imports, respectively, by

$$\begin{aligned} \tau &\equiv \varphi + t_h + t_f, \text{ and} \\ \tau^* &\equiv \varphi + t_h^* + t_f^*. \end{aligned} \tag{1}$$

In what follows, we assume the existence of positive transport costs so that $\varphi > 0$, implying that under free-trade policies ($t_h = 0,\ t_f = 0,\ t_h^* = 0,\ t_f^* = 0$) we have $\tau > 0$ and $\tau^* > 0$. In effect as will become clear, this assumption ensures that, beginning from free trade, a firm's profits are more sensitive to changes in the price it receives for its domestic sales than for its export sales. As discussed in Venables (1985), it is this feature that delivers the firm-delocation effects of trade policy exhibited by the model.

Consider next the problem faced by home firm i. For fixed n_h and n_f, home firm i must choose output destined for the home market q_h^i to maximize its home-market profit in light of the $(n_h - 1)$ other (symmetric) home firms' home-market output choices $(n_h - 1)q_h$ and the n_f (symmetric) foreign firms' home-market output choices $n_f q_f$. The industry output destined for the home market is $Q \equiv q_h^i + (n_h - 1)q_h + n_f q_f$, and Q then determines P through the home market-clearing condition

$$q_h^i + (n_h - 1)q_h + n_f q_f = D(P). \tag{2}$$

[4] For analyses of trade policies in the presence of segmented markets with an exogenously fixed number of firms, see Brander and Spencer (1984) and Dixit (1984). For an analysis of trade agreements in the segmented-market-fixed-number-of-firms setting, see Bagwell and Staiger (2009).

Home firm i must also choose output destined for the foreign market q_h^{i*} to maximize its foreign-market profit in light of the $(n_h - 1)$ other (symmetric) home firms' foreign output choices $(n_h - 1)q_h^*$ and the n_f (symmetric) foreign firms' foreign output choices $n_f q_f^*$. The industry output destined for the foreign market $Q^* \equiv q_h^{i*} + (n_h - 1)q_h^* + n_f q_f^*$ then determines P^* through the foreign market-clearing condition

$$q_h^{i*} + (n_h - 1)q_h^* + n_f q_f^* = D^*(P^*). \tag{3}$$

Using (2) and (3), we may therefore define the home and foreign market-clearing prices $P(q_h^i + (n_h - 1)q_h + n_f q_f)$ and $P^*(q_h^{i*} + (n_h - 1)q_h^* + n_f q_f^*)$, or equivalently $P(Q)$ and $P^*(Q^*)$. Notice that, owing to the segmented market assumption, P and P^* do not depend on trade taxes directly, but may depend indirectly on trade taxes to the extent that trade taxes alter respectively Q and Q^*.

We may now write home firm $i's$ home-and-foreign-market profits as

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

For each market, home firm $i's$ first-order condition equates the marginal revenue generated from a slight increase in its output in that market with its marginal cost of delivery to that market. Using (2) to derive $\frac{dP}{dQ} = \frac{1}{D'(P)}$ and using (3) to derive $\frac{dP^*}{dQ^*} = \frac{1}{D^{*\prime}(P^*)}$, these first-order conditions can be expressed as

$$\begin{aligned} q_h^i + [P(\cdot) - c]D'(P(\cdot)) \;&=\; 0, \text{ and} \\ q_h^{i*} + [P^*(\cdot) - (c + \tau^*)]D^{*\prime}(P^*(\cdot)) \;&=\; 0, \end{aligned} \tag{4}$$

where we use $P(\cdot)$ to denote $P(q_h^i + (n_h - 1)q_h + n_f q_f)$ and $P^*(\cdot)$ to denote $P^*(q_h^{i*} + (n_h - 1)q_h^* + n_f q_f^*)$ to reduce notation. These conditions define home-firm $i's$ reaction curve for the home and foreign markets, respectively.[5] Under our assumption that demand functions are downward sloping, we may observe from (4) that home firm i's markups (inclusive of trade costs) must be positive in both markets.

With analogous steps, we may write foreign firm $i's$ home-and-foreign-market profits as

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

As before, in each market, foreign firm $i's$ first-order condition equates the marginal revenue generated from a slight increase in its output in that market with its marginal cost of delivery to that

[5] We assume that the second-order conditions hold. These conditions are given by $2[-D'(P(\cdot))] > [P(\cdot) - c]D''(P(\cdot))$ and $2[-D^{*\prime}(P^*(\cdot))] > [P^*(\cdot) - (c + \tau^*)]D^{*\prime\prime}(P^*(\cdot))$, and they are sure to hold, for example, if the demand functions $D(P)$ and $D^*(P^*)$ are log concave.

market. These first-order conditions can be expressed as

$$\begin{aligned} q_f^{i*} + [P^*(\cdot) - c]D^{*\prime}(P^*(\cdot)) &= 0, \text{ and} \\ q_f^i + [P(\cdot) - (c+\tau)]D'(P(\cdot)) &= 0. \end{aligned} \tag{5}$$

These conditions define foreign-firm $i's$ reaction curve for the foreign and home markets, respectively.[6] Again, given our assumption that demand functions are downward sloping, we see from (5) that foreign firm i's markups (inclusive of trade costs) must be positive in both markets.

Finally, when all home and foreign firms are on their respective reaction curves, we have the Cournot-Nash equilibrium. After imposing symmetry across home firms ($q_h^i = q_h$ and $q_h^{i*} = q_h^*$) and across foreign firms ($q_f^i = q_f$ and $q_f^{i*} = q_f^*$), we may solve for the home-market output levels for a representative home firm and a representative foreign firm. We denote these Nash quantities in the home market by $q_h^N(n_h, n_f, \tau)$ and $q_f^N(n_h, n_f, \tau)$, respectively, with $Q^N(n_h, n_f, \tau) \equiv n_h q_h^N + n_f q_f^N$. Similarly, we may solve for the foreign-market output levels for a representative home firm and a representative foreign firm. We denote these Nash quantities in the foreign market by $q_h^{*N}(n_h, n_f, \tau^*)$ and $q_f^{*N}(n_h, n_f, \tau^*)$, respectively, with $Q^{*N}(n_h, n_f, \tau^*) \equiv n_h q_h^{*N} + n_f q_f^{*N}$. We also impose the condition

$$q_f^N P''(Q^N) + P'(Q^N) < 0 \text{ and } q_h^{*N} P^{*\prime\prime}(Q^{*N}) + P^{*\prime}(Q^{*N}) < 0, \tag{6}$$

which ensures that a firm's marginal revenue falls in a market when other firms' output increases in that market, and amounts to an assumption that reaction curves are downward sloping.[7]

For a broad family of demand functions (including linear demands), when n_h and n_f are held fixed an increase in τ reduces the sales of each foreign firm into the home market, $q_f^N(n_h, n_f, \tau)$, raises the sales of each home firm in the home market, $q_h^N(n_h, n_f, \tau)$, and reduces total sales in the home market $Q^N(n_h, n_f, \tau)$, with $P(Q^N(n_h, n_f, \tau))$ rising but by less than τ.[8] And similarly, with n_h and n_f held fixed, an increase in τ^* reduces the sales of each home firm into the foreign market, $q_h^{*N}(n_h, n_f, \tau^*)$, raises the sales of each foreign firm in the foreign market, $q_f^{*N}(n_h, n_f, \tau^*)$, and reduces total sales in the foreign market $Q^{*N}(n_h, n_f, \tau^*)$, with $P^*(Q^{*N}(n_h, n_f, \tau^*))$ rising but by less than τ^*. We henceforth assume that these properties hold.

We may now write the maximized profits of a representative home firm as

$$\begin{aligned} \Pi^h(n_h, n_f, \tau^*, \tau) = {} & [P(Q^N(n_h, n_f, \tau)) - c]q_h^N(n_h, n_f, \tau) \\ & +[P^*(Q^{*N}(n_h, n_f, \tau^*)) - (c+\tau^*)]q_h^{*N}(n_h, n_f, \tau^*) - F. \end{aligned} \tag{7}$$

[6] We again assume that the second-order conditions hold.

[7] Condition (6) clearly holds when demand is linear. More generally, condition (6) is ensured if the demand functions $D(P)$ and $D^*(P^*)$ are log concave.

[8] For the linear-demand case, see, for example, Bagwell and Staiger (2009a). We note that, for sufficiently convex demand functions, an increase in τ may induce $P(Q^N(n_h, n_f, \tau))$ to rise by more than τ, when n_h and n_f are held fixed. We abstract from such demand functions here.

And similarly, we may write the maximized profits of a representative foreign firm as

$$\begin{aligned}\Pi^f(n_h, n_f, \tau^*, \tau) &= [P^*(Q^{*N}(n_h, n_f, \tau^*)) - c]q_f^{*N}(n_h, n_f, \tau^*) \\ &\quad +[P(Q^N(n_h, n_f, \tau)) - (c+\tau)]q_f^N(n_h, n_f, \tau) - F.\end{aligned} \tag{8}$$

We assume that $\Pi^h(n_h, n_f, \tau^*, \tau)$ and $\Pi^f(n_h, n_f, \tau^*, \tau)$ are each decreasing in n_h and n_f. This assumption holds for a broad family of demand functions (including linear demands).

Under free entry, n_h and n_f adjust to ensure that the maximized profits of home and foreign firms defined in (7) and (8) respectively are equal to zero, or

$$\Pi^h(n_h, n_f, \tau^*, \tau) = 0 = \Pi^f(n_h, n_f, \tau^*, \tau), \tag{9}$$

which then defines $n_h^N(\tau^*, \tau)$ and $n_f^N(\tau^*, \tau)$. Our focus on non-prohibitive trade taxes ensures that both $n_h^N(\tau^*, \tau)$ and $n_f^N(\tau^*, \tau)$ are positive, but condition (9) ignores the fact that n_h and n_f can only take on integer values. Nevertheless, we will follow standard practice and treat $n_h^N(\tau^*, \tau)$ and $n_f^N(\tau^*, \tau)$ as continuous and differentiable functions, which is a good approximation if the number of firms is large.

We assume that $n_h^N(\tau^*, \tau)$ is increasing in τ and decreasing in τ^* while $n_f^N(\tau^*, \tau)$ is increasing in τ^* and decreasing in τ. This assumption holds if the determinant of the Jacobian matrix associated with (9) is positive; for example, it is straightforward to verify that this assumption holds when demand is linear. Intuitively, under our assumptions, an increase in τ with n_h and n_f held fixed will result in positive profits for home firms and negative profits for foreign firms. The equilibrium zero-profit condition in (9) can then be restored if foreign firms exit (n_f^N falls) and home firms enter (n_h^N rises). Similarly, an increase in τ^* with n_h and n_f held fixed will result in positive profits for foreign firms and negative profits for home firms, and the equilibrium zero-profit condition in (9) can then be re-established if home firms exit (n_h^N falls) and foreign firms enter (n_f^N rises). As we will illustrate shortly, the changes in n_h^N and n_f^N induced by changes in tariffs underlie the firm-delocation effects of trade policy intervention featured in this model.

Finally, using $n_h^N(\tau^*, \tau)$ and $n_f^N(\tau^*, \tau)$, we may write the home and foreign market prices respectively as

$$\begin{aligned}\tilde{P}^N(\tau^*, \tau) &\equiv P(Q^N(n_h^N(\tau^*, \tau), n_f^N(\tau^*, \tau), \tau)), \text{ and} \\ \tilde{P}^{*N}(\tau^*, \tau) &\equiv P^*(Q^{*N}(n_h^N(\tau^*, \tau), n_f^N(\tau^*, \tau), \tau^*)).\end{aligned} \tag{10}$$

Similarly, we may write the home and foreign market sales of a representative home and foreign firm as

$$\begin{aligned}\tilde{q}_h^N(\tau^*,\tau) &\equiv q_h^N(n_h^N(\tau^*,\tau),n_f^N(\tau^*,\tau),\tau), \\ \tilde{q}_f^N(\tau^*,\tau) &\equiv q_f^N(n_h^N(\tau^*,\tau),n_f^N(\tau^*,\tau),\tau), \\ \tilde{q}_h^{*N}(\tau^*,\tau) &\equiv q_h^{*N}(n_h^N(\tau^*,\tau),n_f^N(\tau^*,\tau),\tau^*), \text{ and} \\ \tilde{q}_f^{*N}(\tau^*,\tau) &\equiv q_f^{*N}(n_h^N(\tau^*,\tau),n_f^N(\tau^*,\tau),\tau^*).\end{aligned} \tag{11}$$

According to (10) and (11), all Nash equilibrium prices and quantities can be expressed as functions of the total trade impediments τ^* and τ.

2.2 The Firm-Delocation Effect

At this point, we evaluate the impacts of tariffs on the Nash local prices $\tilde{P}^N(\tau^*,\tau)$ and $\tilde{P}^{*N}(\tau^*,\tau)$, and thereby further highlight the importance of the firm-delocation effect. To this end, we substitute (4) into (7) and (5) into (8) to rewrite (9) as

$$\begin{aligned}[P(\cdot)-c]^2[-D'(P(\cdot))]+[P^*(\cdot)-(c+\tau^*)]^2[-D^{*\prime}(P^*(\cdot))]-F &= 0, \text{ and} \\ [P^*(\cdot)-c]^2[-D^{*\prime}(P^*(\cdot))]+[P(\cdot)-(c+\tau)]^2[-D'(P(\cdot))]-F &= 0,\end{aligned} \tag{12}$$

where with a slight abuse of notation we now use $P(\cdot)$ to denote $P(Q^N(n_h,n_f,\tau))$ and $P^*(\cdot)$ to denote $P^*(Q^{*N}(n_h,n_f,\tau^*))$. The top equation in (12) traces out a locus of home and foreign prices (P and P^*) that, for any τ^*, is consistent with the home-firm zero-profit condition; similarly, the bottom equation of (12) traces out a locus of home and foreign prices that, for any τ, is consistent with the foreign-firm zero-profit condition. Different values of n_h and n_f trace out the locus of (P,P^*) combinations described by each of the two equations in (12), and the equilibrium values $n_h^N(\tau^*,\tau)$ and $n_f^N(\tau^*,\tau)$ – and hence $\tilde{P}^N(\tau^*,\tau)$ and $\tilde{P}^{*N}(\tau^*,\tau)$ – are determined where the two loci cross and hence the two equations in (12) are satisfied.

Differentiating each equation in (12) with respect to P and P^* and solving for $\frac{dP}{dP^*}|_{\Pi^h=0}$ and $\frac{dP}{dP^*}|_{\Pi^f=0}$, it is straightforward to establish that each locus of (P,P^*) combinations is negatively sloped under the second-order conditions. Moreover, using (6), it can be shown that at the equilibrium point the foreign-firm zero-profit condition is steeper than the home-firm zero-profit condition (i.e., $\frac{dP}{dP^*}|_{\Pi^f=0} < \frac{dP}{dP^*}|_{\Pi^h=0} < 0$) as long as $\tau > 0$ and $\tau^* > 0$, which is guaranteed beginning from free-trade policies ($t_h=0$, $t_f=0$, $t_h^*=0$, $t_f^*=0$) under our assumption of positive transport costs ($\varphi > 0$).

Starting with an initial set of policies, such as the free-trade policies, at which $\tau > 0$ and $\tau^* > 0$, consider now the impact of a small increase in τ, triggered by an increase in either t_h or t_f. Figure 1 illustrates. With P on the vertical axis and P^* on the horizontal axis, the solid lines labelled $\Pi_0^h=0$ and $\Pi_0^f=0$ depict, respectively, the home-firm and foreign-firm zero profit loci described by (12) under the initial policies. As discussed above, with positive transport costs, the two loci cross as depicted in the figure, with the $\Pi_0^f=0$ locus cutting the $\Pi_0^h=0$ locus from above, and the point at which they cross corresponds to an initial equilibrium price combination denoted in the figure by $\tilde{P}_0^N$ and $\tilde{P}_0^{*N}$. As can be confirmed from (12), a small increase in τ triggered by an increase in either t_h or t_f leaves the $\Pi^h = 0$ locus unaffected, but it shifts out the $\Pi^f = 0$ locus.[9] In Figure 1, this new locus is depicted by the dashed line and labeled $\Pi_1^f = 0$, and the new equilibrium prices are denoted by $\tilde{P}_1^N$ and $\tilde{P}_1^{*N}$.

Recall that, with n_h and n_f held fixed, $P(Q^N(n_h, n_f, \tau))$ rises when τ is increased but by less than the rise in τ, while $P^*(Q^{*N}(n_h, n_f, \tau^*))$ is unaffected. To restore zero-profits for both home and foreign firms, there must be entry of home firms (n_h must rise) and exit of foreign firms (n_f must fall); and as Figure 1 illustrates, the competitive effects of this entry and exit must be sufficient to ensure that $\tilde{P}^N(\tau^*, \tau)$ ultimately *falls* and $\tilde{P}^{*N}(\tau^*, \tau)$ ultimately *rises*. In other words, a small increase in τ results in a pro-competitive (entry) effect which reduces the price in the home market and an anti-competitive (exit) effect which raises the price in the foreign market. A corresponding analysis establishes that a small increase in τ^*, triggered by an increase in either t_h^* or t_f^*, will decrease $\tilde{P}^{*N}(\tau^*, \tau)$ and increase $\tilde{P}^N(\tau^*, \tau)$.

These surprising price impacts of tariff intervention are the hallmark of the firm-delocation effect. As Venables (1985) emphasizes, these impacts arise when trade costs are positive, since a firm then has greater sales in its domestic market than abroad, all else equal, and so adjustments in the domestic price bear the primary burden for restoring zero profits following any trade policy intervention. As Venables (1985) establishes, the firm-delocation effect gives rise to a novel motive for trade policy intervention: an import tariff or export subsidy can benefit a country's *consumers*, by stimulating entry of domestic firms and thereby reducing domestic prices through enhanced competition; this benefit, however, comes at the expense of foreign consumers, who experience higher prices as a result of foreign-firm exit and diminished competition in the foreign market. We next introduce a complete representation of welfare, so that we may explore the implications of the firm-delocation effect for optimal unilateral trade policy choices and the nature of trade agreements.

2.3 Representation of Welfare

To proceed, we now develop expressions for the welfare of each country. We begin with the home welfare function. Because the free-entry condition (9) ensures that oligopoly profits are zero, we can write home welfare as the sum of consumer surplus and net trade tax revenue, or

$$CS(\tilde{P}^N) + t_h n_f^N \tilde{q}_f^N + t_h^* n_h^N \tilde{q}_h^{*N},$$

where we note that $n_f^N \tilde{q}_f^N$ corresponds to home-country imports and $n_h^N \tilde{q}_h^{*N}$ corresponds to home-country exports. To refine the expression for home welfare, we next introduce a number of further price definitions.

First, at the Cournot-Nash equilibrium, let us denote the world price for exports to the home

[9] This follows from the second-order conditions.

market by

$$\tilde{P}^{wN}(t_h, \tau^*, \tau) = \tilde{P}^N(\tau^*, \tau) - t_h \tag{13}$$

and the world price for exports to the foreign market by

$$\tilde{P}^{*wN}(t_f^*, \tau^*, \tau) = \tilde{P}^{*N}(\tau^*, \tau) - t_f^*. \tag{14}$$

We also define $\tilde{R}^N(\tau^*, \tau) = \tilde{P}^{*wN}(t_f^*, \tau^*, \tau) - \varphi - t_h^*$ as the price received by the home firm for foreign sales (the segmentation of markets implies that in general $\tilde{R}^N \neq \tilde{P}^N$), and similarly $\tilde{R}^{*N}(\tau^*, \tau) = \tilde{P}^{wN}(t_h, \tau^*, \tau) - \varphi - t_f$ as the price received by the foreign firm for home-country sales (the segmentation of markets implies that in general $\tilde{R}^{*N} \neq \tilde{P}^{*N}$). Notice using (1) that $\tilde{P}^N - \tilde{R}^{*N} = \tau$ and $\tilde{P}^{*N} - \tilde{R}^N = \tau^*$. We may thus regard the equilibrium numbers of firms defined in (9) and hence the Cournot-Nash quantities defined in (11) as functions of local price differences.

With these observations in place, we now represent home-country imports M and exports E respectively as

$$\begin{aligned} M(\tilde{P}^{*N} - \tilde{R}^N, \tilde{P}^N - \tilde{R}^{*N}) &= n_f^N(\tilde{P}^{*N} - \tilde{R}^N, \tilde{P}^N - \tilde{R}^{*N})\tilde{q}_f^N(\tilde{P}^{*N} - \tilde{R}^N, \tilde{P}^N - \tilde{R}^{*N}), \text{ and} \\ E(\tilde{P}^{*N} - \tilde{R}^N, \tilde{P}^N - \tilde{R}^{*N}) &= n_h^N(\tilde{P}^{*N} - \tilde{R}^N, \tilde{P}^N - \tilde{R}^{*N})\tilde{q}_h^{*N}(\tilde{P}^{*N} - \tilde{R}^N, \tilde{P}^N - \tilde{R}^{*N}), \end{aligned}$$

allowing home country welfare to be expressed as a direct function of prices:

$$\begin{aligned} W(\tilde{P}^N, \tilde{R}^N, \tilde{P}^{wN}, \tilde{P}^{*N}, \tilde{R}^{*N}, \tilde{P}^{*wN}) &= CS(\tilde{P}^N) \\ &+[\tilde{P}^N - \tilde{P}^{wN}]M(\tilde{P}^{*N} - \tilde{R}^N, \tilde{P}^N - \tilde{R}^{*N}) \\ &+[\tilde{P}^{*wN} - \tilde{R}^N - \varphi]E(\tilde{P}^{*N} - \tilde{R}^N, \tilde{P}^N - \tilde{R}^{*N}). \end{aligned} \tag{15}$$

Next consider the foreign welfare function. Foreign welfare is given by the sum of consumer surplus and net trade tax revenue, or

$$CS^*(\tilde{P}^{*N}) + t_f n_f^N \tilde{q}_f^N + t_f^* n_h^N \tilde{q}_h^{*N}.$$

We may therefore represent foreign country welfare by

$$\begin{aligned} W^*(\tilde{P}^{*N}, \tilde{R}^{*N}, \tilde{P}^{*wN}, \tilde{P}^N, \tilde{R}^N, \tilde{P}^{wN}) &= CS^*(\tilde{P}^{*N}) \\ &+[\tilde{P}^{wN} - \tilde{R}^{*N} - \varphi]M(\tilde{P}^{*N} - \tilde{R}^N, \tilde{P}^N - \tilde{R}^{*N}) \\ &+[\tilde{P}^{*N} - \tilde{P}^{*wN}]E(\tilde{P}^{*N} - \tilde{R}^N, \tilde{P}^N - \tilde{R}^{*N}). \end{aligned} \tag{16}$$

Hence, by (15) and (16), we may express the welfare of each country as a function of home and foreign local prices and the terms of trade (as reflected in the two world prices).

Notice an interesting feature of the Cournot delocation model: the terms-of-trade effects of import tariffs and export taxes are *asymmetric*. To see this, consider first the impact of an increase in the home import tariff t_h on the world prices $\tilde{P}^{wN}$ and $\tilde{P}^{*wN}$. Using the definitions of the world prices given in (13) and (14), we have $\frac{d\tilde{P}^{wN}}{dt_h} = \frac{\partial \tilde{P}^{wN}}{\partial t_h} + \frac{\partial \tilde{P}^{wN}}{\partial \tau} = \frac{\partial \tilde{P}^{N}}{\partial \tau} - 1 < 0$ and $\frac{d\tilde{P}^{*wN}}{dt_h} = \frac{\partial \tilde{P}^{*wN}}{\partial \tau} = \frac{\partial \tilde{P}^{*N}}{\partial \tau} > 0$, and hence the home import tariff improves the home terms of trade by lowering the world price of home imports and raising the world price of home exports. An analogous statement holds for the foreign import tariff. The terms-of-trade effect of an import tariff in the Cournot delocation model is thus the standard effect expected from competitive models for a country that is large in world markets, and this provides a second motive (in addition to firm delocation) for import tariffs in the model: international cost-shifting.[10]

Now consider the impact of an increase in the home export tax t_h^* on the world prices $\tilde{P}^{wN}$ and $\tilde{P}^{*wN}$. In this case we have $\frac{d\tilde{P}^{wN}}{dt_h^*} = \frac{\partial \tilde{P}^{wN}}{\partial \tau^*} = \frac{\partial \tilde{P}^{N}}{\partial \tau^*} > 0$ and $\frac{d\tilde{P}^{*wN}}{dt_h^*} = \frac{\partial \tilde{P}^{*wN}}{\partial \tau^*} = \frac{\partial \tilde{P}^{*N}}{\partial \tau^*} < 0$, and hence, contrary to the standard effect in competitive models, the home export tax *worsens* the home terms of trade by raising the world price of home imports and lowering the world price of home exports. Again an analogous statement holds for the foreign export tax. Intuitively, a home export tax worsens the home terms-of-trade because of the domestic exit and foreign entry that the export tax induces: as noted above in section 2.2, the anti-competitive effect of the domestic exit induced by the home export tax is sufficient to raise the price for sales in the home market, which must be paid for home imports; and the pro-competitive effect of the induced foreign entry is sufficient to lower the price for sales in the foreign market, which home firms receive for their exports.

The terms-of-trade effect of an export tax in the Cournot delocation model is thus *opposite* the standard effect expected from competitive models for a country that is large in world markets. By implication, an export subsidy *improves* a country's terms of trade, and this provides a second motive (in addition to firm delocation) for export subsidies in the model, namely, international cost-shifting.[11]

At this point it is useful to pause and compare the expressions for welfare in (15) and (16) with the expressions that arise in a perfectly competitive (integrated markets) benchmark setting. Under conditions of perfect competition in this single-good setting, each country's welfare can be expressed as a function of its local price (P or P^*) and the world price (P^w), so that home country welfare can be written as $W(P, P^w)$ and foreign country welfare can be written as $W^*(P^*, P^w)$.[12]

Compared to the perfectly competitive benchmark, the presence of segmented markets is one reason for the proliferation of prices in the expressions for welfare in (15) and (16). When markets are segmented, identical products may trade in two directions. If the configuration of tariffs (or transport costs) is different along one direction of trade than the other, then the associated world prices may differ as well. Thus, we may have that $\tilde{P}^{wN} \neq \tilde{P}^{*wN}$. The segmentation of markets also implies that in general the price that a firm receives for a unit destined for export may differ from the price that it receives when the unit is sold locally. In other words, when markets are segmented, we generally have that $\tilde{R}^{N} \neq \tilde{P}^{N}$ and $\tilde{R}^{*N} \neq \tilde{P}^{*N}$. But the home and foreign welfare expressions in

[10] Specifically, some of the tariff revenue is being collected from foreigners.

[11] Specifically, foreigners are paying for some of the subsidy to domestic exporters.

[12] See Bagwell and Staiger (1999, 2001, 2002) on the general validity of this structure and its importance for trade agreements.

(15) and (16) reveal a further and crucial distinction between the perfectly competitive benchmark and the setting we consider here: in the present setting, each country's welfare depends not only upon its own local prices and the world prices, but also on the local prices that prevail in the markets of its trading partner. This is because it is the difference between local prices at home and abroad that determines Nash equilibrium trade volumes and therefore trade tax revenues.

Hence, as (15) and (16) confirm, there is a new international externality present for each government as compared to the competitive benchmark setting: for the home government, in addition to the terms-of-trade externalities that travel through $\tilde{P}^{wN}$ and $\tilde{P}^{*wN}$, there are also (foreign) local price externalities that run through $\tilde{R}^{*N}$ and $\tilde{P}^{*N}$; and similarly, for the foreign government, in addition to the terms-of-trade externalities that travel through $\tilde{P}^{wN}$ and $\tilde{P}^{*wN}$, there are also (home-country) local price externalities that run through $\tilde{R}^{N}$ and $\tilde{P}^{N}$. This indicates a more complex international policy environment than exists under the competitive benchmark, and it raises the possibility that the task of a trade agreement may be more complicated in this environment as a result. Nevertheless, the fundamental question for our purposes here is whether governments would make unilateral policy choices that internalize these international externalities – whatever form these externalities might take – in an appropriate fashion from a world-wide perspective, and if not, why not. To answer this question, we need to examine the non-cooperative and efficient policy choices in detail and evaluate the precise reasons for any divergence between them.

2.4 Nash Policies and Inefficiency

We next characterize the Nash policy choices, which we interpret to be those policies that governments would choose in the absence of a trade agreement. Using (15) and the fact that $\frac{d\tau}{dt_h} = 1 = \frac{d\tau^*}{dt_h^*}$ by (1), the first-order conditions that define the optimal unilateral policy choices for the home country are given by[13]

$$W_{\tilde{P}^N}\frac{\partial \tilde{P}^N}{\partial \tau} + W_{\tilde{R}^N}\frac{\partial \tilde{R}^N}{\partial \tau} + W_{\tilde{P}^{wN}}\frac{d\tilde{P}^{wN}}{dt_h} + W_{\tilde{P}^{*N}}\frac{\partial \tilde{P}^{*N}}{\partial \tau} + W_{\tilde{R}^{*N}}\frac{\partial \tilde{R}^{*N}}{\partial \tau} + W_{\tilde{P}^{*wN}}\frac{\partial \tilde{P}^{*wN}}{d\tau} = 0, \quad (17)$$

$$W_{\tilde{P}^N}\frac{\partial \tilde{P}^N}{\partial \tau^*} + W_{\tilde{R}^N}\frac{\partial \tilde{R}^N}{\partial \tau^*} + W_{\tilde{P}^{wN}}\frac{\partial\tilde{P}^{wN}}{\partial \tau^*} + W_{\tilde{P}^{*N}}\frac{\partial \tilde{P}^{*N}}{\partial \tau^*} + W_{\tilde{R}^{*N}}\frac{\partial \tilde{R}^{*N}}{\partial \tau^*} + W_{\tilde{P}^{*wN}}\frac{\partial \tilde{P}^{*wN}}{\partial \tau^*} = 0. \quad (18)$$

Similarly, using (16) and the fact that $\frac{d\tau^*}{dt_f^*} = 1 = \frac{d\tau}{dt_f}$ by (1), the first-order conditions that define the optimal unilateral policy choices for the foreign country are given by[14]

$$W^*_{\tilde{P}^{*N}}\frac{\partial \tilde{P}^{*N}}{\partial \tau^*} + W^*_{\tilde{R}^{*N}}\frac{\partial \tilde{R}^{*N}}{\partial \tau^*} + W^*_{\tilde{P}^{*wN}}\frac{d\tilde{P}^{*wN}}{dt_f^*} + W^*_{\tilde{P}^{N}}\frac{\partial \tilde{P}^{N}}{\partial \tau^*} + W^*_{\tilde{R}^{N}}\frac{\partial \tilde{R}^{N}}{\partial \tau^*} + W^*_{\tilde{P}^{wN}}\frac{\partial \tilde{P}^{wN}}{\partial \tau^*} = 0, \quad (19)$$

$$W^*_{\tilde{P}^{*N}}\frac{\partial \tilde{P}^{*N}}{\partial \tau} + W^*_{\tilde{R}^{*N}}\frac{\partial \tilde{R}^{*N}}{\partial \tau} + W^*_{\tilde{P}^{*wN}}\frac{\partial\tilde{P}^{*wN}}{\partial \tau} + W^*_{\tilde{P}^{N}}\frac{\partial \tilde{P}^{N}}{\partial \tau} + W^*_{\tilde{R}^{N}}\frac{\partial \tilde{R}^{N}}{\partial \tau} + W^*_{\tilde{P}^{wN}}\frac{\partial \tilde{P}^{wN}}{\partial \tau} = 0. \quad (20)$$

[13] We assume that second-order conditions are met.

[14] Again we assume that second-order conditions are met.

The Nash policies, which we denote by t_h^N, t_h^{*N}, t_f^{*N} and t_f^N, are defined by the solution to these four first-order conditions.

Beginning from free trade and under our assumption of positive transport costs, it can be shown that each country gains when it imposes a small import tariff and/or a small export subsidy.[15] Intuitively, as we have observed, there are two reinforcing motives in the model that drive governments to restrict imports with import tariffs and to promote exports with export subsidies: a firm-delocation motive, whereby each government seeks to reduce the prices faced by consumers in its local market; and a terms-of-trade motive, whereby each government can shift some of the costs of its intervention on to foreigners. In light of these motives, it might seem natural to expect that the Nash policies characterized by (17) through (20) would then involve each country taxing its imports and subsidizing its exports. In Bagwell and Staiger (2009a), however, we focus on the case of linear demand and identify a further consideration: a *tariff-complementarity effect* exists for any country between its import and export tariffs. Intuitively, when a country raises its import tariff, the resulting firm-delocation effect generates entry and thus expanded export volume. From the perspective of trade tax revenue, this makes an export subsidy less attractive and an export tax more attractive. For the linear-demand case, we show in Bagwell and Staiger (2009a) that the tariff-complementarity effect is sufficiently strong to ensure that the Nash equilibrium entails a positive import tariff and an export tax. More generally, while it can be expected that the Nash import policy is an import tariff in this model, the sign of the Nash export policy is difficult to pin down without imposing additional assumptions on the model. In what follows, we therefore make no assumptions on the signs (taxes or subsidies) of Nash policies.

In any event, we now confirm the inefficiency of the Nash policy choices. As a preliminary step, we characterize efficient policy choices. An efficient or joint-welfare maximizing agreement would maximize the sum of W and W^*. Notice from (15) and (16), though, that the world prices ($\tilde{P}^{wN}$ and $\tilde{P}^{*wN}$) cancel from this summation: the world price affects the distribution of rents across countries, but does not in itself affect efficiency. This observation provides one simple way of understanding why tariff policies that are motivated by terms-of-trade effects lead to inefficiencies. But we may still ask whether any other sources of inefficiency are present. To this end, we express joint welfare as

$$\begin{aligned} J(\tilde{P}^N, \tilde{R}^N, \tilde{P}^{*N}, \tilde{R}^{*N}) &\equiv W(\tilde{P}^N, \tilde{R}^N, \tilde{P}^{wN}, \tilde{P}^{*N}, \tilde{R}^{*N}, \tilde{P}^{*wN}) + W^*(\tilde{P}^{*N}, \tilde{R}^{*N}, \tilde{P}^{*wN}, \tilde{P}^N, \tilde{R}^N, \tilde{P}^{wN}) \\ &= CS(\tilde{P}^N) + [\tilde{P}^N - \tilde{R}^{*N} - \varphi] M(\tilde{P}^{*N} - \tilde{R}^N, \tilde{P}^N - \tilde{R}^{*N}) + \\ &\quad [\tilde{P}^{*N} - \tilde{R}^N - \varphi] E(\tilde{P}^{*N} - \tilde{R}^N, \tilde{P}^N - \tilde{R}^{*N}) + CS^*(\tilde{P}^{*N}). \end{aligned}$$

Using the expression for joint welfare above, and noting that $\tilde{P}^N$, $\tilde{R}^N$, $\tilde{P}^{*N}$ and $\tilde{R}^{*N}$ are each functions of τ and τ^* only – and hence only functions of the total tariffs $t_h^* + t_f^*$ and $t_h + t_f$ – it follows that there are only two independent conditions that define efficient choices of t_h, t_h^*, t_f and

[15] See Venables (1985) for a demonstration of this point. Venables does not, however, characterize the Nash equilibrium policies, which we discuss next.

t_f^*, and they are given by

$$[W_{\tilde{P}^N}+W^*_{\tilde{P}^N}]\frac{\partial \tilde{P}^N}{\partial \tau}+[W_{\tilde{R}^N}+W^*_{\tilde{R}^N}]\frac{\partial \tilde{R}^N}{\partial \tau}+[W_{\tilde{P}^{*N}}+W^*_{\tilde{P}^{*N}}]\frac{\partial \tilde{P}^{*N}}{\partial \tau}+[W_{\tilde{R}^{*N}}+W^*_{\tilde{R}^{*N}}]\frac{\partial \tilde{R}^{*N}}{\partial \tau}=0; \quad (21)$$

$$[W_{\tilde{P}^N}+W^*_{\tilde{P}^N}]\frac{\partial \tilde{P}^N}{\partial \tau^*}+[W_{\tilde{R}^N}+W^*_{\tilde{R}^N}]\frac{\partial \tilde{R}^N}{\partial \tau^*}+[W_{\tilde{P}^{*N}}+W^*_{\tilde{P}^{*N}}]\frac{\partial \tilde{P}^{*N}}{\partial \tau^*}+[W_{\tilde{R}^{*N}}+W^*_{\tilde{R}^{*N}}]\frac{\partial \tilde{R}^{*N}}{\partial \tau^*}=0. \quad (22)$$

For the case of linear demands, it can be shown that efficiency requires $t_h^*+t_f^*=0$ and $t_h+t_f=0$, despite the Cournot environment (see Bagwell and Staiger, 2009a). With general demands, efficient trade policy intervention may entail either net trade restrictions or net trade promotion.

We now formally establish that the Nash policy choices are inefficient. Adding the Nash conditions (17) and (20) together, using (15) and (16) to confirm that $W_{\tilde{P}^{*wN}}=E=-W^*_{\tilde{P}^{*wN}}$ and $W^*_{\tilde{P}^{wN}}=M=-W_{\tilde{P}^{wN}}$, and noting that $\frac{d\tilde{P}^{wN}}{dt_h}=\frac{\partial \tilde{P}^{wN}}{\partial \tau}-1$ yields

$$[W_{\tilde{P}^N}+W^*_{\tilde{P}^N}]\frac{\partial \tilde{P}^N}{\partial \tau}+[W_{\tilde{R}^N}+W^*_{\tilde{R}^N}]\frac{\partial \tilde{R}^N}{\partial \tau}+[W_{\tilde{P}^{*N}}+W^*_{\tilde{P}^{*N}}]\frac{\partial \tilde{P}^{*N}}{\partial \tau}+[W_{\tilde{R}^{*N}}+W^*_{\tilde{R}^{*N}}]\frac{\partial \tilde{R}^{*N}}{\partial \tau}=-M^N, \quad (23)$$

where we use M^N to denote the Nash home-country import volume. Similarly, adding the Nash conditions (18) and (19) together, and noting that $\frac{d\tilde{P}^{*wN}}{dt_f^*}=\frac{\partial \tilde{P}^{*wN}}{\partial \tau^*}-1$ yields

$$[W_{\tilde{P}^N}+W^*_{\tilde{P}^N}]\frac{\partial \tilde{P}^N}{\partial \tau^*}+[W_{\tilde{R}^N}+W^*_{\tilde{R}^N}]\frac{\partial \tilde{R}^N}{\partial \tau^*}+[W_{\tilde{P}^{*N}}+W^*_{\tilde{P}^{*N}}]\frac{\partial \tilde{P}^{*N}}{\partial \tau^*}+[W_{\tilde{R}^{*N}}+W^*_{\tilde{R}^{*N}}]\frac{\partial \tilde{R}^{*N}}{\partial \tau^*}=-E^N, \quad (24)$$

where we use E^N to denote the Nash home-country export volume. Comparing (23) with the efficiency condition (21), and under the assumption that the second-order conditions for joint-welfare maximization hold, it is apparent that for any τ^* the level of τ implied by the Nash tariff condition (23) is inefficiently high. Similarly, comparing (24) with the efficiency condition (22), it is apparent that for any τ the level of τ^* implied by the Nash tariff condition (24) is inefficiently high. Thus, in this environment the Nash policy choices result in trade barriers that are too high.[16]

2.5 Politically Optimal Policies and Efficiency

To determine the *reason* for the inefficiency of the Nash tariff choices, we now follow Bagwell and Staiger (1999, 2001) and define *politically optimal* tariffs as those tariffs that would hypothetically be chosen by governments unilaterally if they did not value the pure international rent-shifting associated with the terms-of-trade movements induced by their unilateral tariff choices. Specifically, we suppose that the home government acts as if $W_{\tilde{P}^{wN}}\equiv 0$ and $W_{\tilde{P}^{*wN}}\equiv 0$ when choosing its politically optimal tariff, while the foreign government acts as if $W^*_{\tilde{P}^{*wN}}\equiv 0$ and $W^*_{\tilde{P}^{wN}}\equiv 0$ when choosing its politically optimal tariff. We therefore define politically optimal tariffs as those tariffs

[16] In particular, beginning from the Nash equilibrium tariff levels, a reduction in τ will increase joint welfare and thereby move countries toward the international efficiency frontier. A similar interpretation applies for (24) and (22) and the Nash level of τ^*.

that satisfy the following four conditions:

$$\begin{aligned}
W_{\tilde{P}^N}\frac{\partial \tilde{P}^N}{\partial \tau}+W_{\tilde{R}^N}\frac{\partial \tilde{R}^N}{\partial \tau}+W_{\tilde{P}^{*N}}\frac{\partial \tilde{P}^{*N}}{\partial \tau}+W_{\tilde{R}^{*N}}\frac{\partial \tilde{R}^{*N}}{\partial \tau} &= 0, \\
W_{\tilde{P}^N}\frac{\partial \tilde{P}^N}{\partial \tau^*}+W_{\tilde{R}^N}\frac{\partial \tilde{R}^N}{\partial \tau^*}+W_{\tilde{P}^{*N}}\frac{\partial \tilde{P}^{*N}}{\partial \tau^*}+W_{\tilde{R}^{*N}}\frac{\partial \tilde{R}^{*N}}{\partial \tau^*} &= 0, \\
W^*_{\tilde{P}^{*N}}\frac{\partial \tilde{P}^{*N}}{\partial \tau^*}+W^*_{\tilde{R}^{*N}}\frac{\partial \tilde{R}^{*N}}{\partial \tau^*}+W^*_{\tilde{P}^N}\frac{\partial \tilde{P}^N}{\partial \tau^*}+W^*_{\tilde{R}^N}\frac{\partial \tilde{R}^N}{\partial \tau^*} &= 0, \text{ and} \\
W^*_{\tilde{P}^{*N}}\frac{\partial \tilde{P}^{*N}}{\partial \tau}+W^*_{\tilde{R}^{*N}}\frac{\partial \tilde{R}^{*N}}{\partial \tau}+W^*_{\tilde{P}^N}\frac{\partial \tilde{P}^N}{\partial \tau}+W^*_{\tilde{R}^N}\frac{\partial \tilde{R}^N}{\partial \tau} &= 0.
\end{aligned} \tag{25}$$

With politically optimal tariffs defined in this way, we may ask whether politically optimal tariffs are efficient, and thereby explore whether the Nash inefficiencies identified above can be given a terms-of-trade interpretation, according to which the fundamental problem faced by governments in designing their trade agreement is to find a way to eliminate terms-of-trade manipulation.

With regard to the nature of the thought experiment envisioned in the politically optimal tariffs, there is an important distinction between the perfectly competitive environment considered in Bagwell and Staiger (1999, 2001) and the imperfectly competitive setting that we analyze here.[17] In the perfectly competitive setting, domestic welfare can be written as $W(P, P^w)$ as we have observed, and the politically optimal tariff for the domestic government then satisfies $W_P \frac{dP}{dt} = 0$. Thus, in the case of perfect competition, it is immaterial whether the thought experiment associated with politically optimal tariffs is interpreted to mean that the government acts "as if" $W_{P^w} \equiv 0$ or rather that the government acts "as if" $\frac{dP^w}{dt} \equiv 0$, because either way we have $W_{P^w}\frac{dP^w}{dt} \equiv 0$.[18] Notice that, under the second interpretation, politically optimal tariffs are the tariffs that governments would choose unilaterally if they were "small" in world markets.

In the presence of imperfectly competitive firms, however, this second interpretation is not valid. To see why, consider the home country, and recall that the home welfare function now includes $\tilde{P}^{*N}$ and $\tilde{R}^{*N}$. And observe as well that the relationship $\tilde{P}^{*wN}(t_f^*, \tau^*, \tau) = \tilde{P}^{*N}(\tau^*, \tau) - t_f^*$ implies $\frac{d\tilde{P}^{*N}}{dt_h} = \frac{d\tilde{P}^{*wN}}{dt_h}$, while the relationship $\tilde{R}^{*N}(\tau^*, \tau) = \tilde{P}^{wN}(t_h, \tau^*, \tau) - \varphi - t_f$ implies $\frac{d\tilde{R}^{*N}}{dt_h} = \frac{d\tilde{P}^{wN}}{dt_h}$. Consequently, if the home government were to act "as if" $\frac{d\tilde{P}^{*wN}}{dt_h} \equiv 0$ and $\frac{d\tilde{P}^{wN}}{dt_h} \equiv 0$, it would then by necessity also act "as if" $\frac{d\tilde{P}^{*N}}{dt_h} \equiv 0$ and $\frac{d\tilde{R}^{*N}}{dt_h} \equiv 0$, and so its unilaterally chosen import tariff would satisfy $W_{\tilde{P}^N}\frac{\partial \tilde{P}^N}{\partial \tau} + W_{\tilde{R}^N}\frac{\partial \tilde{R}^N}{\partial \tau} = 0$, which differs from the expression for the politically optimal home import tariff in the first condition of (25). An analogous statement applies for the other home policy instrument and for each policy instrument of the foreign government. In effect, in the presence of imperfect competition, it no longer makes sense to think of a hypothetical situation in which governments act as if they were small in world markets, because their firms are not small.

We now proceed to offer a formal evaluation of the efficiency properties of politically optimal tariffs as defined by (25). This is easily done: the first and fourth conditions in (25), when summed

[17] This distinction is shared as well with the fixed-number-of-firms imperfectly competitive environment considered in Bagwell and Staiger (2009).

[18] Bagwell and Staiger (1999, footnote 11) stress the first of these interpretations in their formal analysis, but both interpretations are valid in the competitive markets setting.

together, imply the efficiency condition (21); and the second and third conditions in (25), when summed together, imply the efficiency condition (22). Politically optimal tariffs are thus efficient. Put differently, if governments could be induced not to value the pure international rent-shifting associated with the terms-of-trade movements caused by their unilateral tariff choices, then they would set efficient tariffs. Evidently, the firm-delocation motive for trade-policy intervention provides no independent source of international inefficiency in the Cournot delocation model.

It is interesting to compare the Nash and politically optimal trade policies, so that we may understand the nature of the import and export policy commitments that government must make if they are to move from the Nash to the political optimum in the Cournot delocation model. A complete comparison is difficult to undertake without further structure, however. With the restriction of linear demand, we show in Bagwell and Staiger (2009a) that the politically optimal policy is free trade. As we note above, for the linear-demand case, we also show in Bagwell and Staiger (2009a) that the Nash import policy is an import tariff and the Nash export policy is an export tax. As we observe above, it is also true that, beginning from free trade, each government has a unilateral incentive to subsidize its exports. For the linear-demand case, we thus argue in Bagwell and Staiger (2009a) that the efficient political optimum (free trade) requires that governments be restrained from imposing import tariffs and export subsidies, despite the fact that the unilateral incentive to subsidize exports does not arise in the model until import tariffs are restrained to sufficiently low levels.

A final point worth emphasizing is the important role played by both import and export policies in establishing the efficiency of the political optimum. If, for example, governments were assumed only to have import tariffs (t_h for the home country and t_f^* for the foreign country) at their disposal, then it is still the case that efficiency would be defined as in (21) and (22) above, owing to the redundancy of the export instruments t_h^* and t_f in terms of their impacts on the total trade taxes τ and τ^*, and hence on $\tilde{P}^N$, $\tilde{R}^N$, $\tilde{P}^{*N}$ and $\tilde{R}^{*N}$. The efficient total trade taxes would then be achieved entirely through t_h and t_f^*. But as can be seen from the conditions for the political optimum in (25), the politically optimal setting of t_h and t_f^* alone could not in general achieve efficiency.

Therefore, the efficiency of the political optimum – and hence the ability to interpret the problem that a trade agreement can solve as a terms-of-trade problem – hinges importantly on the assumption that governments have sufficient trade-tax instruments at their disposal. If they did not, then other non-terms-of-trade problems might also be addressed by a trade agreement (in this setting, just as more generally). But viewed in this way, it is also clear what the associated non-terms-of-trade problem would be: a trade agreement could help substitute for missing trade policy instruments (e.g., export policies) which, if available, would then convert the role of a trade agreement back to the standard terms-of-trade driven Prisoners' Dilemma.[19]

We summarize the results of this section with:[20]

[19] We emphasize that what is required for the efficiency of the political optimum in this setting is that each country has a complete set of trade tax instruments, in the sense that each government has available the use of an import tariff and an export tax/subsidy, *not* that each country has a complete set of (trade and domestic) tax instruments with which to achieve the first best.

[20] In reality, political economy concerns are an important reason for trade policy intervention. According to the

Proposition 1 *In the Cournot delocation model, the Nash trade policies are inefficient, and the inefficiency arises only because governments value the pure international rent-shifting associated with the terms-of-trade movements induced by their unilateral tariff choices.*

2.6 Reciprocity

An important implication of Proposition 1 is that, for the Cournot delocation model, just as in the competitive benchmark model, a trade agreement that is founded on the principle of reciprocity can guide governments from their inefficient unilateral policies to the efficiency frontier. To establish this implication, we follow Bagwell and Staiger (1999, 2001) and define tariff changes that conform to *reciprocity* as those that bring about equal changes in the volume of each country's imports and exports when valued at existing world prices.

Working within the general equilibrium interpretation of the model described at the beginning of section 2.1, taking account of trade in the numeraire good, and letting a superscript "0" denote original trade tax levels and a superscript "1" denote new trade tax levels, it is direct to establish that tariff changes conforming to reciprocity must satisfy[21]

$$\begin{aligned}&[\tilde{P}^{wN}(t_h^0,\tau^{*0},\tau^0)-\tilde{P}^{wN}(t_h^1,\tau^{*1},\tau^1)]M(\tau^{*1},\tau^1)\\&=[\tilde{P}^{*wN}(t_f^{*0},\tau^{*0},\tau^0)-\tilde{P}^{*wN}(t_f^{*1},\tau^{*1},\tau^1)]E(\tau^{*1},\tau^1).\end{aligned} \tag{26}$$

According to (26), tariff changes that conform to reciprocity imply either that (i) world prices are left unchanged as a result of the tariff changes, so that $\tilde{P}^{wN}(t_h^0,\tau^{*0},\tau^0)=\tilde{P}^{wN}(t_h^1,\tau^{*1},\tau^1)$ and $\tilde{P}^{*wN}(t_f^{*0},\tau^{*0},\tau^0)=\tilde{P}^{*wN}(t_f^{*1},\tau^{*1},\tau^1)$, or (ii) world prices are altered in a net-trade-tax-revenue neutral fashion. Either way, it is clear that there can be no pure international rent shifting across countries as a result of tariff changes that conform to reciprocity. Moreover, notice that under (ii) there exists an alternative set of tariff changes which would preserve τ^{*1} and τ^1 and hence $M(\tau^{*1},\tau^1)$ and $E(\tau^{*1},\tau^1)$ but satisfy $\tilde{P}^{wN}(t_h^0,\tau^{*0},\tau^0)=\tilde{P}^{wN}(t_h^1,\tau^{*1},\tau^1)$ and $\tilde{P}^{*wN}(t_f^{*0},\tau^{*0},\tau^0)=\tilde{P}^{*wN}(t_f^{*1},\tau^{*1},\tau^1)$, and which would therefore continue to satisfy reciprocity and leave each country indifferent between the original tariff changes and this alternative.[22] As a consequence, we can

terms-of-trade theory, adding these concerns does not alter the basic reason for a trade agreement (see Bagwell and Staiger, 1999, for a statement of this result in the competitive benchmark setting, and Bagwell and Staiger, 2009, for an extension of this result to a setting of imperfect competition with fixed numbers of firms). In the free-entry setting that we consider in this paper, however, it is not immediately clear how to introduce political economy considerations, because those considerations typically lead governments to place extra weight on producer surplus as they make their trade policy choices, and in our free-entry setting equilibrium producer surplus is always driven to zero. For this reason, we leave the introduction of political economy concerns in this kind of setting to future work.

[21] The steps to derive (26) employ the balanced trade condition that must hold at the original and the new world prices, and are identical to those described in note 19 of Bagwell and Staiger (2001).

[22] This can be confirmed as follows. Consider the home country. Beginning from a set of trade tax changes that alter world prices but satisfy (26), observe first that there exists an alternative set of new trade taxes, denoted by the superscript "1′," for which $\tau^{*1'}=\tau^{*1}$ and $\tau^{1'}=\tau^1$ and hence $M(\tau^{*1'},\tau^{1'})=M(\tau^{*1},\tau^1)$ and $E(\tau^{*1'},\tau^{1'})=E(\tau^{*1},\tau^1)$ but where $\tilde{P}^{wN}(t_h^{1'},\tau^{*1'},\tau^{1'})=\tilde{P}^{wN}(t_h^0,\tau^{*0},\tau^0)$ and $\tilde{P}^{*wN}(t_f^{*1'},\tau^{*1'},\tau^{1'})=\tilde{P}^{*wN}(t_f^{*0},\tau^{*0},\tau^0)$, and that under these alternative new trade taxes the reciprocity condition (26) is still met. It remains to confirm that the net trade tax revenue collected by the home country is the same under either set of new trade taxes. To conserve notation, we now suppress tariff arguments and let a superscript "0" on a price denote that price as a function of original trade tax levels,

henceforth and without loss of generality equate tariff changes that conform to reciprocity in this setting with tariff changes that leave each world price unaltered.

We are now prepared to interpret and evaluate the principle of reciprocity within the Cournot delocation model. We do so in two steps.[23]

First, beginning from the Nash equilibrium, we wish to evaluate the impacts on home and foreign welfare of small changes in trade policies that reduce the total trade impediments τ and τ^* while satisfying reciprocity. We refer to such trade policy changes as *reciprocal trade liberalization.* Notice that with the four trade taxes t_h, t_h^*, t_f and t_f^*, the magnitude of the changes in τ and τ^* can be chosen independently while adjusting t_h and t_f^* to maintain $d\tilde{P}^{wN} = 0 = d\tilde{P}^{*wN}$ and thereby satisfy reciprocity (the changes in τ and τ^* imply changes in M and E while the changes in t_h and t_f^* imply changes in the volume of numeraire trade which assures reciprocity). Therefore, the reciprocal trade liberalization we consider amounts to a small reduction in τ ($d\tau < 0$), and a small reduction in τ^* ($d\tau^* < 0$) whose relative magnitude is given by $\frac{d\tau^*}{d\tau} > 0$, all induced by changes in the four underlying trade taxes which conform to reciprocity and hence satisfy $d\tilde{P}^{wN} = 0 = d\tilde{P}^{*wN}$.

As there is no implied change in either world price, the impact of a small amount of reciprocal trade liberalization on home-country welfare is given by

$$
\begin{aligned}
-\{[W_{\tilde{P}^N}\frac{\partial \tilde{P}^N}{\partial \tau} + W_{\tilde{R}^N}\frac{\partial \tilde{R}^N}{\partial \tau} + W_{\tilde{P}^{*N}}\frac{\partial \tilde{P}^{*N}}{\partial \tau} + W_{\tilde{R}^{*N}}\frac{\partial \tilde{R}^{*N}}{\partial \tau}] \\
+ [W_{\tilde{P}^N}\frac{\partial \tilde{P}^N}{\partial \tau^*} + W_{\tilde{R}^N}\frac{\partial \tilde{R}^N}{\partial \tau^*} + W_{\tilde{P}^{*N}}\frac{\partial \tilde{P}^{*N}}{\partial \tau^*} + W_{\tilde{R}^{*N}}\frac{\partial \tilde{R}^{*N}}{\partial \tau^*}] \cdot \frac{d\tau^*}{d\tau}\},
\end{aligned}
$$

while the impact on foreign-country welfare is given by

$$
\begin{aligned}
-\{[W^*_{\tilde{P}^{*N}}\frac{\partial \tilde{P}^{*N}}{\partial \tau^*} + W^*_{\tilde{R}^{*N}}\frac{\partial \tilde{R}^{*N}}{\partial \tau^*} + W^*_{\tilde{P}^N}\frac{\partial \tilde{P}^N}{\partial \tau^*} + W^*_{\tilde{R}^N}\frac{\partial \tilde{R}^N}{\partial \tau^*}] \cdot \frac{d\tau^*}{d\tau} \\
+ [W^*_{\tilde{P}^{*N}}\frac{\partial \tilde{P}^{*N}}{\partial \tau} + W^*_{\tilde{R}^{*N}}\frac{\partial \tilde{R}^{*N}}{\partial \tau} + W^*_{\tilde{P}^N}\frac{\partial \tilde{P}^N}{\partial \tau} + W^*_{\tilde{R}^N}\frac{\partial \tilde{R}^N}{\partial \tau}]\}.
\end{aligned}
$$

Evaluated at the Nash equilibrium defined by (17)-(20), the above two expressions reduce respectively to

$$
\begin{aligned}
&\{[-M^N \cdot (\frac{\partial \tilde{P}^N}{\partial \tau} - 1) + E^N \frac{\partial \tilde{P}^{*N}}{\partial \tau}] + [-M^N \frac{\partial \tilde{P}^N}{\partial \tau^*} + E^N \frac{\partial \tilde{P}^{*N}}{\partial \tau^*}] \cdot \frac{d\tau^*}{d\tau}\}, \text{ and} \qquad (27) \\
&\{[-E^N \cdot (\frac{\partial \tilde{P}^{*N}}{\partial \tau^*} - 1) + M^N \frac{\partial \tilde{P}^N}{\partial \tau^*}] \cdot \frac{d\tau^*}{d\tau} + [-E^N \frac{\partial \tilde{P}^{*N}}{\partial \tau} + M^N \frac{\partial \tilde{P}^N}{\partial \tau}]\}.
\end{aligned}
$$

and let a superscript "1" on a price denote that price as a function of new trade tax levels, and let a superscript "1′" on a price denote that price as a function of alternative new trade tax levels. Now observe that home net revenue under the new tariffs is given by $[\tilde{P}^{N1} - \tilde{P}^{wN1}]M(\tau^{*1}, \tau^1) + [\tilde{P}^{*wN1} - \tilde{R}^{N1} - \varphi]E(\tau^{*1}, \tau^1)$, while under the alternative set of new tariffs it is given by $[\tilde{P}^{N1} - \tilde{P}^{wN0}]M(\tau^{*1}, \tau^1) + [\tilde{P}^{*wN0} - \tilde{R}^{N1} - \varphi]E(\tau^{*1}, \tau^1)$, and hence home-country net revenue under the two sets of new trade taxes will be the same if and only if $[\tilde{P}^{wN0} - \tilde{P}^{wN1}]M(\tau^{*1}, \tau^1) = [\tilde{P}^{*wN0} - \tilde{P}^{*wN1}]E(\tau^{*1}, \tau^1)$. But this condition is guaranteed by the reciprocity condition (26). An analogous argument holds for the foreign country.

[23] These two steps consider in sequence the two ways in which the principle of reciprocity finds representation in the GATT/WTO. See Bagwell and Staiger (1999, 2001, 2002) for more on the role of reciprocity in the GATT/WTO.

We wish to explore whether each country gains from at least a small amount of reciprocal trade liberalization. This amounts to asking whether each expression in (27) is positive. The first term in each expression records how each country feels about the small reduction in the total impediment to its import trade. This term is positive because of the firm-delocation effect: an increase in the total impediment to import trade in one country leads to a lower price in that country's market and a higher price in the market of the other country (e.g., for the home country's import trade, we have $\frac{\partial \tilde{P}^N}{\partial \tau} < 0 < \frac{\partial \tilde{P}^{*N}}{\partial \tau}$). Correspondingly, since reciprocity neutralizes any world-price movements, (17) and (19) imply that each country would desire a reduced total impediment to its import trade at the Nash equilibrium if this could be achieved without world-price movements. This desire in turn reflects the standard terms-of-trade impacts of import tariffs in the model. The second term in each expression records how each country feels about the small reduction in the total impediment to its export trade. Due again to the firm-delocation effect, this term is *negative.* Accordingly, since reciprocity neutralizes any world-price movements, (18) and (20) imply that each country would desire an *increase* in the total impediment to its export trade at the Nash equilibrium if this could be achieved without world-price movements. This desire reflects the *non-standard* terms-of-trade impacts of export subsidies in the model.

Hence, if reciprocal trade liberalization is to benefit both countries in the Cournot delocation model, the benefit each country enjoys from the reduction in the total trade impediment in its import sector must outweigh the cost that each suffers from the reduced total trade impediment in its export sector. This suggests that the magnitudes of $d\tau$ and $d\tau^*$ must be carefully balanced. For example, it is easy to see that reciprocal trade liberalization that is too heavily weighted toward either $d\tau$ or $d\tau^*$ cannot benefit both countries.[24] This is a novel consideration, and it can be traced to the non-standard terms-of-trade effect of export subsidies in the Cournot delocation model: as we have emphasized above, the standard terms-of-trade effects of export taxes are symmetric with import tariffs, and when those effects are present each country benefits from reciprocal reductions in trade barriers in both its import and export sectors (see Bagwell and Staiger, 2001). In the Cournot delocation model, though, governments must be careful to choose the magnitude of $\frac{d\tau^*}{d\tau}$ so that the benefits of reduced trade impediments in the import sector outweigh the costs of reduced trade impediments in the export sector for each country.

Nevertheless, it is direct to show using (27) that there is a non-empty range for $\frac{d\tau^*}{d\tau}$ – and hence for the relative magnitudes of the reductions in τ and τ^* – within which, beginning from the Nash equilibrium, reciprocal trade liberalization must offer strict benefits to each country. We may therefore conclude that, beginning from the Nash equilibrium, both countries can gain from at least a small amount of reciprocal trade liberalization in the Cournot delocation model.

[24] Consider reciprocal trade liberalization that satisfies $d\tau < 0 = d\tau^*$. With each world price fixed under reciprocity, it is direct to see from (19) and (20) that, beginning from the Nash equilibrium, the foreign country must lose from reciprocal trade liberalization that takes this form, as (27) indicates. It is also illuminating to see why this must be so. To satisfy the fixed-world-price conditions implied by reciprocity in this case, we must have $d\tilde{P}^{wN} = 0 = \frac{\partial \tilde{P}^N}{\partial \tau} d\tau - dt_h$ and $d\tilde{P}^{*wN} = 0 = \frac{\partial \tilde{P}^{*N}}{\partial \tau} d\tau - dt_f^*$, which with $d\tau < 0 = d\tau^*$ implies $dt_h > 0$ and $dt_f^* < 0$ and also $dt_f < 0$ and $dt_h^* > 0$. This means that the foreign country faces more restrictive import and export policies from its trading partner as a result of these changes, and it is for this reason that it is hurt by reciprocal trade liberalization in this case.

Our second step is to consider the impact of reciprocity when it is applied in response to the reintroduction of trade barriers. In particular, we now establish that, if countries negotiate to the political optimum, then neither country has an interest in unilaterally raising its import tariff or export subsidy if it is understood that such an act would be met with a reciprocal action from its trading partner.

To confirm this observation, consider the impact on home-country welfare if, beginning from the political optimum defined by (25), the home country were to raise slightly its import tariff (increase t_h), and in response to this the foreign country were to respond in a reciprocal fashion with its import and export taxes so as to prevent the world prices from changing. Denoting these reciprocal foreign responses by $\frac{dt_f}{dt_h}|_{rec}$ and $\frac{dt_f^*}{dt_h}|_{rec}$, the impact on home-country welfare is given by

$$\begin{aligned}\{[W_{\tilde{P}^N}\frac{\partial \tilde{P}^N}{\partial \tau} + W_{\tilde{R}^N}\frac{\partial \tilde{R}^N}{\partial \tau} + W_{\tilde{P}^{*N}}\frac{\partial \tilde{P}^{*N}}{\partial \tau} + W_{\tilde{R}^{*N}}\frac{\partial \tilde{R}^{*N}}{\partial \tau}] \cdot (1 + \frac{dt_f}{dt_h}|_{rec}) \\ + [W_{\tilde{P}^N}\frac{\partial \tilde{P}^N}{\partial \tau^*} + W_{\tilde{R}^N}\frac{\partial \tilde{R}^N}{\partial \tau^*} + W_{\tilde{P}^{*N}}\frac{\partial \tilde{P}^{*N}}{\partial \tau^*} + W_{\tilde{R}^{*N}}\frac{\partial \tilde{R}^{*N}}{\partial \tau^*}] \cdot \frac{dt_f^*}{dt_h}|_{rec}\},\end{aligned}$$

which evaluated at the political optimum is zero by (25). Similarly, if the home country were to raise slightly its export subsidy (reduce t_h^{*N}), and in response to this the foreign country were to respond in a reciprocal fashion with its import and export taxes so as to prevent the world prices from changing (with these responses denoted by $\frac{dt_f}{dt_h^*}|_{rec}$ and $\frac{dt_f^*}{dt_h^*}|_{rec}$), the impact on home-country welfare is given by

$$\begin{aligned}-\{[W_{\tilde{P}^N}\frac{\partial \tilde{P}^N}{\partial \tau} + W_{\tilde{R}^N}\frac{\partial \tilde{R}^N}{\partial \tau} + W_{\tilde{P}^{*N}}\frac{\partial \tilde{P}^{*N}}{\partial \tau} + W_{\tilde{R}^{*N}}\frac{\partial \tilde{R}^{*N}}{\partial \tau}] \cdot \frac{dt_f}{dt_h^*}|_{rec} \\ + [W_{\tilde{P}^N}\frac{\partial \tilde{P}^N}{\partial \tau^*} + W_{\tilde{R}^N}\frac{\partial \tilde{R}^N}{\partial \tau^*} + W_{\tilde{P}^{*N}}\frac{\partial \tilde{P}^{*N}}{\partial \tau^*} + W_{\tilde{R}^{*N}}\frac{\partial \tilde{R}^{*N}}{\partial \tau^*}] \cdot (1 + \frac{dt_f^*}{dt_h^*}|_{rec})\},\end{aligned}$$

which again evaluated at the political optimum is zero by (25). Exactly the same arguments apply to each of the policies of the foreign country.

Hence, the terms-of-trade Prisoners' Dilemma problem that characterizes the Nash inefficiency in the Cournot delocation model – like the competitive benchmark model – provides a foundation for understanding why a trade agreement that is founded on the principle of reciprocity can guide governments from their inefficient unilateral policies to the efficiency frontier. We summarize with:

Corollary 1 *In the Cournot delocation model, the principle of reciprocity serves to "undo" the terms-of-trade driven inefficiency that occurs when governments pursue unilateral trade policies.*

3 Delocation with Monopolistic Competition

In this section we consider a variant of the model in Venables (1987), where the variant that we analyze is similar to that developed in Helpman and Krugman (1989). Here, markets are integrated, monopolistically competitive firms use a single factor of production to produce differentiated varieties according to an increasing-returns technology, consumer demand for differentiated products takes a CES form, and there is free entry of firms in both home and foreign countries. As before, a freely-traded homogeneous "outside" good is produced with the same factor of production according to a constant-returns technology. The outside good enters linearly into utility and is always produced and consumed in each country in positive amounts. These assumptions have the effect of tying down marginal costs of differentiated-goods production in both countries and eliminating income effects on the demand for differentiated products as well. We allow for the presence of "iceberg" transport costs on the trade in differentiated products between countries, and indeed it is now the savings on transport costs implied by the firm-delocation effects of trade policy intervention – rather than the impacts on competition as in the Cournot model of the previous section – that can enhance the welfare of the intervening country in this setting. Finally, and importantly, in addition to the import policies considered in Helpman and Krugman (1989), we permit governments to pursue export policies as well.

By construction, this model has some very special features As emphasized by Helpman and Krugman (1989), the model displays no terms-of-trade impacts of import tariffs. On the other hand, as we will show, terms-of-trade impacts of export policies *are* present in the model, and in contrast to the Cournot delocation model they are of the conventional kind although somewhat extreme. Be that as it may, our main purpose is again to identify and interpret the sources of inefficiency that arise when governments set their trade policies unilaterally, and to thereby explore the potential role and design of a trade agreement in this environment.

3.1 Model Setup

There are two countries (home and foreign), each endowed with a large amount of labor (L and L^*, respectively), which is the only factor of production. Consumer utility in the home and foreign country is given, respectively, by

$$\begin{aligned} U &= \theta^{-1}(C_D)^{\theta} + C_Y, \quad \text{and} \\ U^* &= \theta^{-1}(C_D^*)^{\theta} + C_Y^*, \end{aligned} \tag{28}$$

where C_D is an index of consumption of a basket of differentiated goods, which for the moment we treat as a single (composite) good referred to as good D, C_Y is consumption of a homogenous good Y, '$*$' denotes a foreign-country variable, and $\theta \in (0,1)$ is a parameter of the utility function. Good Y is produced with labor alone according to a constant-returns-to-scale production function common across countries (1 unit of labor produces 1 unit of good Y). Good Y is always produced in each country (due to the large supply of labor in each country) and freely traded across countries, so that its price (and hence the wage of labor) is fixed and equalized everywhere in the world. We treat good Y as the numeraire and thus normalize its price to 1.

Notice from the utility function U that the marginal utility of consuming another unit of good

Y is 1, while the marginal utility of consuming another unit of good D is $(C_D)^{\theta-1}$, and analogously for the utility function U^*. Utility maximization in each country requires that quantities demanded are chosen so that the ratio of marginal utilities for goods D and Y is set equal to the ratio of prices for goods D and Y. Recalling that the price of good Y is normalized to 1, and letting P denote the price of good D faced by consumers in the home country and P^* the price of good D faced by consumers in the foreign country, utility maximization then implies

$$\begin{aligned} C_D &= P^{-\epsilon}, \text{ and} \\ C_D^* &= (P^*)^{-\epsilon}, \end{aligned} \tag{29}$$

where $\epsilon = \frac{1}{1-\theta} > 1$ is the elasticity of (home or foreign country) demand for good D. The indirect utility functions of the two countries may then be written as

$$\begin{aligned} V(P, I) &= (\epsilon\theta)^{-1} P^{-\epsilon\theta} + I, \quad \text{and} \\ V^*(P^*, I^*) &= (\epsilon\theta)^{-1} (P^*)^{-\epsilon\theta} + I^*, \end{aligned} \tag{30}$$

where I denotes home-country income and I^* denotes foreign income, each measured in units of the numeraire good Y.

As mentioned above, the quantity C_D is an index of home-country consumption of differentiated goods. This index is assumed to take a CES form and hence exhibits "love of variety." Specifically, we assume that

$$C_D = [\sum_i (c^i)^\alpha]^{\frac{1}{\alpha}},$$

where c^i is home-country consumption of variety i of the differentiated good and α is a preference parameter with $\alpha \in (0, 1)$. Note that all varieties i enter symmetrically into this index. It can be shown (see Dixit and Stiglitz, 1977) that the associated home-country price index is

$$P = [\sum_i (p^i)^{\frac{\alpha}{\alpha-1}}]^{\frac{\alpha-1}{\alpha}}, \tag{31}$$

where p^i is the price for variety i paid by home-country consumers. Analogously, for the foreign country, we have

$$C_D^* = [\sum_i (c^{*i})^\alpha]^{\frac{1}{\alpha}},$$

and associated foreign-country price index

$$P^* = [\sum_i (p^{*i})^{\frac{\alpha}{\alpha-1}}]^{\frac{\alpha-1}{\alpha}}, \tag{32}$$

where p^{*i} is the price for variety i paid by foreign-country consumers.

The home-country demand for an individual variety i of the differentiated good then takes the form

$$c^i = C_D \cdot \left(\frac{p^i}{P}\right)^{-\sigma}, \tag{33}$$

where $\sigma = \frac{1}{1-\alpha} > 1$. Plugging into (33) the expression for C_D in (29) and simplifying yields

$$c^i = (p^i)^{-\sigma} P^{\sigma-\epsilon} \equiv c^i(p^i, P). \tag{34}$$

We assume that $\sigma > \epsilon$, which is to say we assume that the elasticity of substitution between varieties within the differentiated product sector (σ) is greater than the overall price elasticity (ϵ). An analogous expression may be derived for the foreign-country demand for an individual variety i of the differentiated good:

$$c^{*i} = (p^{*i})^{-\sigma} (P^*)^{\sigma-\epsilon} \equiv c^{*i}(p^{*i}, P^*). \tag{35}$$

Notice that, due to the existence of the outside good Y and the way that it enters into the utility functions in (28), there are no income effects on the demand for differentiated products, as (34) and (35) confirm. This property provides a key simplification that will become very useful once trade policies are introduced below, because with this property the revenue consequences of trade policy intervention have no bearing on the equilibrium conditions in the differentiated products industry (a feature also shared by the Cournot delocation model of the previous section).

Technology for producing individual varieties is the same across varieties and available everywhere in the world: any individual variety i can be produced with a fixed cost of labor F and a constant marginal cost in terms of labor λ (recall that the wage of labor is fixed at 1 everywhere in the world). In light of the fixed cost of production, no variety will be produced by more than one firm or in more than one location, and each firm will be the monopoly supplier of its variety.

If a home-country firm wishes to sell to foreign consumers, we assume that it must confront the following trade costs: an "iceberg" transport cost $\phi > 0$ according to which a fraction ϕ of the good is used up in shipment; an ad valorem export tax imposed by the home government at rate τ_h^* (an export subsidy if $\tau_h^* < 0$); and an ad valorem import tariff imposed by the foreign government at rate τ_f^*. We denote (1 plus) the total ad valorem trade impediment on home exports to the foreign market by ι^*, where[25]

$$\iota^* \equiv 1 + \phi + \tau_h^* + \tau_f^*. \tag{36}$$

We assume that markets are integrated and focus throughout on non-prohibitive trade costs, so that the wedge between the home market price for a home produced variety i and the price at which that variety sells in the foreign market is given by $p_h^{*i} = \iota^* p_h^i$, where p_h^i denotes the home-market price of a home-produced good and p_h^{*i} denotes the foreign-market price of a home-produced good.[26]

[25] As reflected in (36), all trade impediments are expressed in ad valorem terms relative to the factory-gate price $\hat{p}$ (as characterized below). Hence, we assume that the foreign importer buys from the factory at price $\hat{p}$, then pays the export tax $\tau_h^* \hat{p}$ and the import tax $\tau_f^* \hat{p}$ and transport costs $\phi \hat{p}$.

[26] It is convenient to follow Helpman and Krugman (1989, Ch. 7) in the modeling of iceberg transport costs, although their approach differs slightly from the conventional modeling of iceberg transport costs introduced by

Similarly, if a foreign firm wishes to sell to home-country consumers, we assume that it must confront the following trade costs: the iceberg transport cost ϕ according to which a fraction ϕ of the good is used up in shipment; an ad valorem export tax imposed by the foreign government at rate τ_f (an export subsidy if $\tau_f < 0$); and an ad valorem import tariff imposed by the home government at rate τ_h. We denote (1 plus) the total ad valorem trade impediment on foreign exports to the home-country market by ι, where[27]

$$\iota \equiv 1 + \phi + \tau_h + \tau_f. \tag{37}$$

Again, because we assume that markets are integrated and trade costs are non-prohibitive, the wedge between the foreign market price for a foreign produced variety i and the price at which that variety sells in the home market is given by $p_f^i = \iota p_f^{*i}$, where p_f^{*i} denotes the foreign-market price of a foreign-produced good and p_f^i denotes the home-market price of a foreign-produced good.

We may now write down the profits for a home firm producing variety i who sets a price p_h^i:

$$\pi^i = (p_h^i - \lambda) \cdot [c^i(p_h^i, P) + (1+\phi)c^{*i}(p_h^{*i}, P^*)] - F.$$

When choosing a price for its single variety i, the firm is assumed to take the price indexes P and P^* as fixed. Using $p_h^{*i} = \iota^* p_h^i$ and the particular functional forms of $c^i(p_h^i, P)$ and $c^{*i}(p_h^{*i}, P^*)$ given in (34) and (35) respectively, it may then be shown that equating marginal revenue to marginal cost and thereby maximizing profits implies the price choice

$$p_h^i = \frac{\sigma}{\sigma - 1}\lambda \equiv \hat{p} \tag{38}$$

for a home firm producing any variety i. We now record the foreign-market price of a (representative) home-produced variety:

$$p_h^{*i} = \iota^* \hat{p} \equiv p_h^*(\iota^*). \tag{39}$$

Similarly, the profits for a foreign firm producing variety i who sets a price p_f^{*i} are given by

$$\pi^{*i} = (p_f^{*i} - \lambda) \cdot [c^{*i}(p_f^{*i}, P^*) + (1+\phi)c^i(p_f^i, P)] - F.$$

Again when choosing a price for its single variety i, the firm is assumed to take the price indexes P and P^* as fixed. Using $p_f^i = \iota p_f^{*i}$ and the particular functional forms of $c^i(p_f^i, P)$ and $c^{*i}(p_f^{*i}, P^*)$ given in (34) and (35) respectively, it may then be shown that equating marginal revenue to marginal

Samuelson (1954). According to the formulation used by Helpman and Krugman, a fraction ϕ of the amount of an export good that is *delivered to the foreign port* is used up in transit, while the conventional assumption following Samuelson is that a fraction ϕ of the amount of an export good that *leaves the factory gate* actually arrives at the foreign port. Implicit in our modeling of iceberg transport costs and tariffs is that international shipping services are freely traded.

[27] As reflected in (37), we again express all trade impediments in ad valorem terms relative to the factory-gate price $\hat{p}$. Hence, we assume that the home importer buys from the factory at price $\hat{p}$ (as characterized below), then pays the export tax $\tau_f\hat{p}$ and the import tax $\tau_h\hat{p}$ and transport costs $\phi\hat{p}$.

cost and thereby maximizing profits implies the price choice

$$p_f^{*i} = \frac{\sigma}{\sigma - 1}\lambda \equiv \hat{p} \tag{40}$$

for a foreign firm producing any variety i. We may now also record the domestic-market price of a (representative) foreign-produced variety:

$$p_f^i = \iota\hat{p} \equiv p_f(\iota). \tag{41}$$

Hence, using (31) and (32) in combination with (38)-(41), if there are n_h home firms producing differentiated varieties and n_f foreign firms, then the home and foreign price indexes are given respectively by

$$\begin{aligned} P &= [n_h \cdot \hat{p}^{\frac{\alpha}{\alpha-1}} + n_f \cdot p_f^{\frac{\alpha}{\alpha-1}}]^{\frac{\alpha-1}{\alpha}} \equiv P(n_h, n_f, p_f), \text{ and} \\ P^* &= [n_f \cdot \hat{p}^{\frac{\alpha}{\alpha-1}} + n_h \cdot p_h^{*\frac{\alpha}{\alpha-1}}]^{\frac{\alpha-1}{\alpha}} \equiv P^*(n_h, n_f, p_h^*), \end{aligned} \tag{42}$$

where for notational simplicity we suppress the dependence of p_f on ι and p_h^* on ι^* in what follows. Finally, free entry implies that n_h and n_f adjust to ensure

$$\begin{aligned} c(\hat{p}, P(n_h, n_f, p_f)) + (1+\phi)c^*(p_h^*, P^*(n_h, n_f, p_h^*)) &= \frac{F}{(\hat{p}-\lambda)} \\ c^*(\hat{p}, P^*(n_h, n_f, p_h^*)) + (1+\phi)c(p_f, P(n_h, n_f, p_f)) &= \frac{F}{(\hat{p}-\lambda)}, \end{aligned} \tag{43}$$

where we now utilize the symmetric structure of the model and remove the superscript i's from the home- and foreign-country demands for an individual variety. These two zero-maximized-profit conditions determine $n_h(p_f, p_h^*)$ and $n_f(p_f, p_h^*)$.[28] Plugging these expressions into the expressions for P and P^* in (42) then yields $P(p_f, p_h^*)$ and $P^*(p_f, p_h^*)$. As in the previous section, our focus on non-prohibitive trade taxes ensures that both $n_h(p_f, p_h^*)$ and $n_f(p_f, p_h^*)$ are positive, but condition (43) ignores the fact that n_h and n_f can only take on integer values. We treat $n_h(p_f, p_h^*)$ and $n_f(p_f, p_h^*)$ as continuous and differentiable functions in what follows (as is standard), which is a good approximation if the number of firms is large.

Notice from (42) that, for fixed n_h and n_f, each country's price index rises with the level of trade impediments faced by its importers and is independent of the level of trade impediments that its exporters face. On the other hand, beginning from a level of trade impediments that is positive, it is also clear from (42) that a reduction in n_f matched by an equal increase in n_h would reduce the domestic price index P and raise the foreign price index P^*.

From these initial observations, and with positive transport costs ($\phi > 0$) but all trade taxes set initially to zero, consider then the impact on home and foreign price indexes of introducing a

[28]We are not concerned with impacts of changes in transport costs, and so we suppress dependence on ϕ here and throughout.

positive home import tariff τ_h. With n_h and n_f initially held fixed, (42) implies that p_h^* and P^* are unchanged while P and thus $c(\hat{p}, P(n_h, n_f, p_f))$ rise; furthermore, calculations confirm that the rise in P is less than the rise in p_f and that $c(p_f, P(n_h, n_f, p_f))$ falls. It then follows that, holding fixed n_h and n_f, a positive home import tariff τ_h increases the left-hand-side of the top condition in (43) while decreasing the left-hand-side of the bottom condition in (43), implying positive profits for home firms and negative profits for foreign firms. As a result, there must be entry of home firms (a rise in n_h) and exit of foreign firms (a drop in n_f), and to restore zero profits for home and foreign firms the rise in n_h and drop in n_f must lead ultimately to a *rise* in P^* and a *drop* in P.[29]

We may therefore conclude that with positive transport costs, the imposition of a domestic import tariff $\tau_h > 0$ *raises* P^* and *reduces* P, i.e., $\frac{dP^*}{d\tau_h} = \frac{\partial P^*}{\partial p_f}\frac{dp_f}{d\tau_h} > 0 > \frac{dP}{d\tau_h} = \frac{\partial P}{\partial p_f}\frac{dp_f}{d\tau_h}$. This is the essence of the firm-delocation effect associated with import protection in the monopolistic competition model: by raising barriers to imports, foreign firms can be "delocated" to the home market, where home consumers then save on trade costs in the form of a lower overall price index, at the expense of foreign consumers whose price index rises.[30] Moreover, it is immediate from (42) and (43) that a rise in the foreign export subsidy (a fall in τ_f beginning from free trade) has an impact on P and P^* which is exactly the opposite from the impact of a rise in τ_h just described, i.e., $\frac{dP^*}{d\tau_f} = \frac{\partial P^*}{\partial p_f}\frac{dp_f}{d\tau_f} > 0 > \frac{dP}{d\tau_f} = \frac{\partial P}{\partial p_f}\frac{dp_f}{d\tau_f}$. Hence, by employing an export subsidy $\tau_f < 0$, the foreign government can reduce P^* and raise P and thereby engineer a savings in trade costs for its consumers. Finally, the same statements apply to the foreign import tariff $(\tau_f^* > 0)$ and the home export subsidy $(\tau_h^* < 0)$, i.e., $\frac{dP}{d\tau_f^*} = \frac{\partial P}{\partial p_h^*}\frac{dp_h^*}{d\tau_f^*} > 0 > \frac{dP^*}{d\tau_f^*} = \frac{\partial P^*}{\partial p_h^*}\frac{dp_h^*}{d\tau_f^*}$ and $\frac{dP}{d\tau_h^*} = \frac{\partial P}{\partial p_h^*}\frac{dp_h^*}{d\tau_h^*} > 0 > \frac{dP^*}{d\tau_h^*} = \frac{\partial P^*}{\partial p_h^*}\frac{dp_h^*}{d\tau_h^*}$.

[29] More formally, we may start with any initial set of policies, such as the free-trade policies, at which trade taxes $\tau_h + \tau_f$ and $\tau_h^* + \tau_f^*$ are nonnegative, and then consider a slight increase in ι triggered, for example, by a slight increase in τ_h. Following Helpman and Krugman (1989, Chapter 7), we consider a graph with $P^{*\sigma-\epsilon}$ on the y axis and $P^{\sigma-\varepsilon}$ on the x axis. At the initial policies, calculations confirm that the home-firm and foreign-firm zero profit loci are downward sloping and that the zero profit locus for a home firm is steeper than that for a foreign firm. A slight increase in ι shifts the foreign iso-profit locus upward, requiring a higher value for $P^{*\sigma-\epsilon}$ and thus P^* and a lower value for $P^{\sigma-\epsilon}$ and thus P. From here, we may use (42) to confirm that the increase in ι induces a higher value for n_h and a lower value for n_f. If the initial policies are at or near free trade, calculations also confirm that a lower value for $n_h + n_f$ is induced. Intuitively, following an increase in ι, the restoration of the home and foreign zero-profit conditions in (43) requires that P and P^* move in opposite direction, because if both increase then the profits of home firms will continue to be positive, while if both decrease then the profits of foreign firms will continue to be negative. But with preferences identical across countries and $\phi > 0$, local sales contribute relatively more to the profits of each country's firms than do export sales, ruling out the possibility that zero profits could be restored for both home and foreign firms with a rise in P and a fall in P^*. The only remaining possibility is then that P^* must rise and P must fall.

[30] The delocation effect of trade protection in a monopolistically competitive environment was first identified in Venables (1987), but it is closely related to the home-market effect identified in Krugman (1980). The delocation effect for Cournot firms in Venables (1985) is analogous but, as we have described in the previous section, in the Cournot case the entry/exit of firms alters firm-level prices through competitive effects, whereas in the current monopolistically competitive setting firm-level prices are unchanged by entry/exit but the price index is nonetheless altered through changes in the numbers of home- and foreign- produced varieties.

3.2 Representation of Welfare

The impacts of trade taxes on the price indexes P and P^* that we have just described capture the firm-delocation effects associated with trade policy in this setting, but these effects are not by themselves enough to determine the welfare impacts of trade policy, as (30) indicates. We must also determine how trade taxes effect income in each country (I and I^*).

To this end, note that our assumption that labor is the only factor of production and that the wage is fixed at 1, in combination with free entry ensuring that profits are zero, implies that income in each country is given by the labor force in the country plus the country's net trade tax revenue. Therefore, denoting home imports (foreign exports) by M and home exports (foreign imports) by E and noting that

$$\begin{aligned} M &= n_f(p_f, p_h^*)c(p_f, P(p_f, p_h^*)) \equiv M(p_f, p_h^*), \quad \text{and} \\ E &= n_h(p_f, p_h^*)c^*(p_h^*, P^*(p_f, p_h^*)) \equiv E(p_f, p_h^*), \end{aligned}$$

we may then express home and foreign income as[31]

$$\begin{aligned} I &= L + \tau_h^*\hat{p}E(p_f, p_h^*) + \tau_h\hat{p}M(p_f, p_h^*), \quad \text{and} \\ I^* &= L^* + \tau_f\hat{p}M(p_f, p_h^*) + \tau_f^*\hat{p}E(p_f, p_h^*). \end{aligned}$$

We next define the world price for exports to the foreign market by $p^{*w} = (1+\tau_h^*)\hat{p} \equiv p^{*w}(\tau_h^*)$, implying that $\tau_h^*\hat{p} = p^{*w} - \hat{p}$. Using $p_h^* = (1+\phi+\tau_h^*+\tau_f^*)\hat{p}$, it then follows also that $\tau_f^*\hat{p} = p_h^* - \phi\hat{p} - p^{*w}$. And similarly, we define the world price for exports to the domestic market by $p^w = (1+\tau_f)\hat{p} \equiv p^w(\tau_f)$, implying that $\tau_f\hat{p} = p^w - \hat{p}$. Using $p_f = (1+\phi+\tau_f+\tau_h)\hat{p}$, it then follows also that $\tau_h\hat{p} = p_f - \phi\hat{p} - p^w$.

With these pricing relationships, and recalling from (38) that $\hat{p}$ is simply a function of parameters of the model, we may rewrite the expressions for income as

$$\begin{aligned} I &= L + [p^{*w} - \hat{p}]E(p_f, p_h^*) + [p_f - \phi\hat{p} - p^w]M(p_f, p_h^*) \equiv I(p_h^*, p_f, p^w, p^{*w}), \quad \text{and} \\ I^* &= L^* + [p^w - \hat{p}]M(p_f, p_h^*) + [p_h^* - \phi\hat{p} - p^{*w}]E(p_f, p_h^*) \equiv I^*(p_h^*, p_f, p^w, p^{*w}). \end{aligned}$$

Finally, using these expressions for I and I^*, we may write the indirect utility functions of the two countries as direct functions of prices:

$$\begin{aligned} V(p_h^*, p_f, p^w, p^{*w}) &= (\epsilon\theta)^{-1}P(p_f, p_h^*)^{-\epsilon\theta} + I(p_h^*, p_f, p^w, p^{*w}), \quad \text{and} \\ V^*(p_h^*, p_f, p^w, p^{*w}) &= (\epsilon\theta)^{-1}P^*(p_f, p_h^*)^{-\epsilon\theta} + I^*(p_h^*, p_f, p^w, p^{*w}). \end{aligned} \tag{44}$$

Compared to the welfare expressions in (30), the expressions in (44) are particularly informative

[31] Recall that our modeling of iceberg transport costs assumes that international shipping services are freely traded, which is why trade taxes are applied only to the delivered quantities of traded differentiated goods, and not also to the fraction of the good used up in transport (the "shipping services"). See also note 26.

for helping to identify the channels through which international externalities associated with trade policy choices are transmitted in this environment.

Consider first the world prices p^{*w} and p^w. When the domestic country raises its tax on exports τ_h^*, the world price of its exports $p^{*w}(\tau_h^*)$ is increased, and as (44) indicates this impacts (negatively) the welfare of the foreign country. Similarly, when the foreign country raises its tax on exports τ_f, the world price of its exports $p^w(\tau_f)$ is increased, and as (44) indicates this impacts (negatively) the welfare of the domestic country. These international policy externalities are identical to the terms-of-trade externalities that arise in a competitive setting (see Bagwell and Staiger, 1999, 2001). On the other hand, notice that each country's import tariff (τ_h for the home country, τ_f^* for the foreign country) has *no* impact on either world price, and so the use of import tariffs in this environment does not entail international externalities that travel through world prices. This is a very special feature of the model under study, and as Helpman and Krugman (1989, Ch. 7) explain, it arises here because marginal cost (λ) is tied down by free trade in the numeraire good Y and because the CES demand specification ensures that firms in the differentiated product sector do not alter their price markup over marginal cost in response to ad valorem trade taxes. Of course, this same feature implies that each country *can* alter the world price with its export tax (as we have observed), and can do so in a rather extreme fashion (100% pass-through of export taxes to consumers abroad), precisely because firms in the differentiated product sector do not alter their price markup over marginal cost in response to ad valorem trade taxes.[32]

In a perfectly competitive setting, these terms-of-trade externalities would constitute the only channel through which the policy choices of one country could impact the welfare of the other country (in the sense that, as discussed in the previous section, within a perfectly competitive environment the welfare of the domestic and foreign governments under general conditions can be written in the form $W(p, p^w)$ and $W^*(p^*, p^w)$). But as the welfare expressions in (44) confirm, in the current setting things are more complicated. In particular, home welfare now depends directly on the price of home produced varieties in the foreign market, $p_h^*(\iota^*)$; and similarly, foreign welfare now depends directly on the price of foreign produced varieties in the home market, $p_f(\iota)$.

This indicates a more complex international policy environment than in the case of perfectly competitive markets, and it raises the possibility that the task of a trade agreement may be more complicated in this environment as a result. Nevertheless, as we indicated previously, the fundamental question for our purposes is whether governments would make unilateral policy choices that internalize these international externalities – whatever form these externalities might take – in an appropriate fashion from a world-wide perspective, and if not, why not. To answer this question, we need to examine the non-cooperative and efficient policy choices in detail and evaluate the precise reasons for any divergence between them. We turn to this task in the next two subsections.

[32] Notice too that the world-price consequences of export taxes in the current model are *opposite* to those in the Cournot delocation model of the previous section. In that setting, entry and exit alters world prices through competitive effects in each of the segmented markets, and as we have described in the previous section the entry and exit implications of a country's export tax cause its terms-of-trade to worsen rather than improve. In the current setting, by contrast, entry and exit itself has no impact on world prices.

3.3 Nash Policies and Inefficiency

We next characterize the Nash policy choices, which we take to be the optimal policies that the governments would choose unilaterally in the absence of a trade agreement. We begin by characterizing the domestic government's best-response import and export policies. Recalling that p^{*w} depends only on τ_h^* and that p^w is independent of τ_h and τ_h^*, and noting from (36), (37), (39) and (41) that p_h^* is independent of τ_h while p_f is independent of τ_h^*, the first-order conditions that jointly define the domestic government's best-response import and export policies are given by:

$$
\begin{aligned}
V_{p_f}\frac{dp_f}{d\tau_h} &= 0, \text{ and} \\
V_{p_h^*}\frac{dp_h^*}{d\tau_h^*} + V_{p^{*w}}\frac{dp^{*w}}{d\tau_h^*} &= 0.
\end{aligned}
\tag{45}
$$

Before turning to characterize the foreign government's best-response policies, it is helpful to delve further into the first-order conditions that define the domestic government's best-response policy choices, in order to better understand the forces at work in this setting. Using the expression for domestic welfare given in (44), and noting that $\frac{dp^{*w}}{d\tau_h^*} = \hat{p}$ and that $\frac{dp_h^*}{d\tau_h^*} = \hat{p} = \frac{dp_f}{d\tau_h}$, the first-order conditions in (45) can be written in the more explicit form

$$
\begin{aligned}
-C_D\frac{\partial P}{\partial p_f} + M + \hat{p}[\tau_h^*\frac{\partial E}{\partial p_f} + \tau_h\frac{\partial M}{\partial p_f}] &= 0, \text{ and} \\
-C_D\frac{\partial P}{\partial p_h^*} + E + \hat{p}[\tau_h^*\frac{\partial E}{\partial p_h^*} + \tau_h\frac{\partial M}{\partial p_h^*}] &= 0.
\end{aligned}
\tag{46}
$$

As indicated earlier, the firm-delocation effect arises in the presence of positive transport costs, and it is embodied in the properties that $\frac{dP}{d\tau_h} = \frac{\partial P}{\partial p_f}\frac{dp_f}{d\tau_h} < 0$ and $\frac{dP}{d\tau_h^*} = \frac{\partial P}{\partial p_h^*}\frac{dp_h^*}{d\tau_h^*} > 0$, which with $\frac{dp_h^*}{d\tau_h^*} = \hat{p} = \frac{dp_f}{d\tau_h}$ then implies $\frac{\partial P}{\partial p_f} < 0$ and $\frac{\partial P}{\partial p_h^*} > 0$. Given any foreign trade policies which – together with the level of transport costs ϕ – imply positive total trade costs, the firm-delocation effect is thus present, and the left-hand-side of the top condition in (46) is then positive when evaluated at domestic free trade policies $\tau_h^* = 0 = \tau_h$, indicating that $\tau_h > 0$ would then be required to satisfy this condition. As a consequence of the firm-delocation motive for import policy, it is thus natural to expect that the best-response import policy is an import tariff.

By contrast, the sign of the left-hand-side of the bottom expression in (46) when evaluated at $\tau_h^* = 0 = \tau_h$ is not clear. Intuitively, there are two opposing motives for export policy in the model: the first term is negative as a result of the firm-delocation effect, and this pushes toward an export subsidy ($\tau_h^* < 0$) as the domestic best-response export policy; but added to this is a second term (E) which is positive and reflects terms-of-trade considerations, and this pushes toward an export tax ($\tau_h^* > 0$) as the domestic best response export policy. Hence, whether the domestic best-response export policy is an export subsidy or an import tariff depends on the relative strengths of the firm-delocation and terms-of-trade motives for export policy intervention.

Returning now to our main task, with analogous steps we can write the first-order conditions that jointly define the foreign government's best-response import and export policies as

$$V^*_{p^*_h}\frac{dp^*_h}{d\tau^*_f}=0,\ \text{and} \tag{47}$$
$$V^*_{p_f}\frac{dp_f}{d\tau_f}+V^*_{p^w}\frac{\partial p^w}{\partial \tau_f}=0.$$

The Nash policy choices, which we denote by τ^N_h, τ^{*N}_h, τ^{*N}_f and τ^N_f, are given by the joint solutions to (45) and (47).

To evaluate the efficiency properties of the Nash tariff choices, we first need to characterize the trade policy choices that would be internationally efficient in this environment. Consider, then, the efficient policies. These are the choices of τ^*_h, τ^*_f, τ_f and τ_h that maximize $V+V^*$. We note that

$$I(\cdot)+I^*(\cdot)=L+L^*+[p^*_h-\phi\hat{p}-\hat{p}]E(p_f,p^*_h)+[p_f-\phi\hat{p}-\hat{p}]M(p_f,p^*_h)\equiv K(p^*_h,p_f),$$

and so the world prices p^w and p^{*w} drop out of the sum of domestic and foreign incomes, permitting this sum to be expressed as $K(p^*_h,p_f)$. But this in turn implies that joint welfare may be expressed as

$$\begin{aligned} V(\cdot)+V^*(\cdot) &= (\epsilon\theta)^{-1}[P((p_f,p^*_h))]^{-\epsilon\theta}+(\epsilon\theta)^{-1}[P^*((p_f,p^*_h))]^{-\epsilon\theta}+K(p^*_h,p_f) \\ &\equiv G(p^*_h,p_f). \end{aligned} \tag{48}$$

As can be seen, changes in the world prices induced by trade taxes play no role in determining the efficient setting of trade tax policies, because these changes correspond to pure international rent shifting.

Using the expression for joint welfare in (48), recalling that p^*_h depends only on ι^* while p_f depends only on ι, and using (36) and (37) to confirm that $\frac{d\iota^*}{d\tau^*_h}=1=\frac{d\iota^*}{d\tau^*_f}$ and $\frac{d\iota}{d\tau_h}=1=\frac{d\iota}{d\tau_f}$, it follows that there are only two independent conditions that define efficient choices of τ^*_h, τ^*_f, τ_f and τ_h, and they may be expressed as:

$$[V_{p^*_h}+V^*_{p^*_h}]\frac{dp^*_h}{d\iota^*}=0,\quad \text{and} \tag{49}$$

$$[V_{p_f}+V^*_{p_f}]\frac{dp_f}{d\iota}=0. \tag{50}$$

To understand the nature of efficient trade policy intervention in this setting, consider efficiency condition (49). Proceeding along similar lines to those described above, the left-hand-side of this condition, when evaluated at free trade policies $\tau^*_h+\tau^*_f=0=\tau_f+\tau_h$ and once the symmetry across countries is exploited, may be written in the more explicit form

$$[C_D(\frac{1-\alpha}{\alpha})\hat{p}(\frac{n}{2}\cdot\hat{p}^{\frac{\alpha}{\alpha-1}}+\frac{n}{2}\cdot p_h^{*\frac{\alpha}{\alpha-1}})^{\frac{-1}{\alpha}}]\cdot[(\hat{p}^{\frac{\alpha}{\alpha-1}}+p_h^{*\frac{\alpha}{\alpha-1}})\cdot(\frac{\partial n_h}{\partial p^*_h}+\frac{\partial n_f}{\partial p^*_h})], \tag{51}$$

where $\frac{n}{2} \equiv n_h = n_f$. The expression in (51) is the product of two bracketed terms. The first bracketed term is positive, and the second bracketed term is negative (see footnote 29). Hence, the left-hand-side of the condition in (49) is negative when evaluated at global free trade policies $\tau_h^* + \tau_f^* = 0 = \tau_f + \tau_h$, indicating that $\tau_h^* + \tau_f^* < 0$ would then be required to satisfy this condition. An analogous conclusion can be drawn with regard to efficiency condition (50) and the implication that $\tau_f + \tau_h < 0$ is required to satisfy this condition. Therefore, efficiency in this setting requires that trade be subsidized.[33]

We may now confirm that the Nash tariff choices are indeed inefficient. This can be seen by adding the bottom Nash condition in (45) to the top Nash condition in (47) and the top Nash condition in (45) to the bottom Nash condition in (47) to obtain

$$[V_{p_h^*} + V^*_{p_h^*}]\frac{dp_h^*}{d\iota^*} = -E\frac{dp^{*w}}{d\tau_h^*}, \quad \text{and} \tag{52}$$

$$[V_{p_f} + V^*_{p_f}]\frac{dp_f}{d\iota} = -M\frac{dp^w}{d\tau_f}, \tag{53}$$

where in writing (52) and (53) we have used the fact that $\frac{dp_h^*}{d\tau_h^*} = \frac{dp_h^*}{d\tau_f^*} = \frac{dp_h^*}{d\iota^*}$ and $\frac{dp_f}{d\tau_h} = \frac{dp_f}{d\tau_f} = \frac{dp_f}{d\iota}$, and that (44) implies $V_{p^{*w}} = E$ and $V^*_{p^w} = M$. The terms $E\frac{dp^{*w}}{d\tau_h^*}$ and $M\frac{dp^w}{d\tau_f}$ are positive, and so (52) and (53) imply that both $[V_{p_h^*} + V^*_{p_h^*}]\frac{dp_h^*}{d\iota^*}$ and $[V_{p_f} + V^*_{p_f}]\frac{dp_f}{d\iota}$ must be negative when evaluated at Nash tariff choices. But then (49) implies that ι^* – and hence the sum of the Nash tariffs on home exports to foreign – is above that required for efficiency for any given ι, while (50) implies that ι – and hence the sum of the Nash tariffs on home imports from foreign – is above that required for efficiency for any given ι^*.[34]

3.4 Politically Optimal Policies and Efficiency

To determine the reason for the inefficiency of the Nash tariff choices, we again follow Bagwell and Staiger (1999, 2001) and define politically optimal tariffs as those tariffs that would hypothetically be chosen by governments unilaterally if they did not value the pure international rent-shifting associated with the terms-of-trade movements induced by their unilateral tariff choices. Specifically, we suppose that the home government acts as if $V_{p^w} \equiv 0$ and $V_{p^{*w}} \equiv 0$ when choosing its politically optimal tariff, while the foreign government acts as if $V^*_{p^w} \equiv 0$ and $V^*_{p^{*w}} \equiv 0$. Of course, we have already noted that in the special environment we consider here, the home government has no ability to alter p^{*w} with its tariff choices while the foreign government has no ability to alter p^w with its tariff choices, but for completeness and consistency with our earlier discussions we assume that

[33] The reason that it is efficient to subsidize to trade is that monopolistically competitive producers set prices above marginal cost, and so efficiency is served by subsidizing consumption of the differentiated goods, something that an import subsidy in each country can - in a second-best fashion - achieve (see Helpman and Krugman, 1989, Ch. 7 for a related discussion).

[34] In particular, beginning from the Nash equilibrium tariff levels, a reduction in ι^* will increase joint welfare and move countries toward the international efficiency frontier. A similar interpretation applies for (53) and (50) and the Nash level of ι.

governments do not value any world price movements in the political optimum.

Accordingly, politically optimal tariffs are defined by

$$V_{p_h^*}\frac{dp_h^*}{d\iota^*} = 0, \qquad (54)$$
$$V_{p_f}\frac{dp_f}{d\iota} = 0; \quad \text{and}$$

$$V^*_{p_h^*}\frac{dp_h^*}{d\iota^*} = 0, \qquad (55)$$
$$V^*_{p_f}\frac{dp_f}{d\iota} = 0.$$

But it is now immediate that the top conditions of (54) and (55) together imply (49), while the bottom conditions of (54) and (55) together imply (50). Hence, politically optimal tariffs are efficient: if governments could be induced not to value the pure international rent-shifting associated with the terms-of-trade movements induced by their tariff choices, they would set efficient tariffs and there would be nothing left for a trade agreement to do. Evidently, as in the Cournot delocation model of the previous section, the firm-delocation motive for trade-policy intervention provides no independent source of international inefficiency in the monopolistic competition model of firm delocation.

Again it is interesting to compare the conditions for politically optimal trade policies (54) and (55) with the Nash conditions (45) and (47). Notice first that the Nash import tariffs for each country are defined by the same conditions as the conditions that define their politically optimal import tariffs. This follows from the special feature of this model which, as we have noted, ensures that import tariffs have no terms-of-trade effects. On the other hand, as we have observed, export taxes do have terms-of-trade effects in this setting, and these effects account for the difference between the Nash export policy conditions and the politically optimal export policy conditions. In particular, as a comparison of the bottom condition in (45) with the top condition in (54) confirms, by not valuing the terms-of-trade consequences of its export policy ($V_{p^{*w}}\frac{dp^{*w}}{d\tau_h^*} > 0$), the home government is induced by its politically optimal condition to select a lower value of τ_h^* than it would were its selection determined by its Nash condition. An analogous statement applies to the export policy of the foreign government.

Intuitively, in the Nash equilibrium governments use import tariffs in this model for the sole purpose of delocating firms from the markets of their trading partners to their own market and thereby lowering their own price index; an additional impact arises as the trade volume of the firms that remain located in their trading partners is reduced; and as we have already noted, there is no terms of trade impact of import tariffs in the model. But governments also use export policies, and here there is an offsetting incentive: an export subsidy could similarly help to delocate firms; but an export tax is warranted for terms-of-trade purposes in this model; and this terms-of-trade motive keeps export subsidies lower than they would otherwise be. Notice, though, that an export subsidy *could* be set so as to neutralize delocation that might otherwise occur as a result of the import tariff of a trading partner, and it could also be set so as to neutralize any trade volume reduction for surviving firms that might have been caused by the trading partner's import tariff. When a country does not value the terms-of-trade consequences of its export policies, it is induced to increase its export subsidies to exactly these neutralizing levels, and as a consequence the associated politically optimal policy choices are efficient.

Notice again the importance of export policies for this result. If governments were assumed only to have import tariffs (τ_h for the domestic government, τ_f^* for the foreign government), then it is still the case that efficiency would be defined as in (49) and (50) above, owing to the redundancy of the instruments τ_h and τ_f and the instruments τ_f^* and τ_h^* in terms of their impacts on p_h^* and p_f. But as can be seen from the conditions for the political optimum (54) and (55), the politically optimal setting of τ_h and τ_f^* alone could not achieve efficiency; indeed, given that there are no terms-of-trade consequences associated with the setting of import tariffs in this model, the politically optimal setting of τ_h and τ_f^* corresponds to Nash choices. Hence, if export policies are ruled out in this model, the Nash import tariff choices are inefficient, despite the fact that import tariffs have no terms-of-trade consequences in the model; as a result, there is then a non-terms-of-trade problem for a trade agreement to solve. But viewed in this way, it is also now clear what the non-terms-of-trade problem is: a trade agreement can here help substitute for missing trade policy instruments (export policies) which, if available, would then convert the role of a trade agreement back to the standard terms-of-trade driven Prisoners' Dilemma.

Therefore, as before, the efficiency of the political optimum – and hence the ability to interpret the problem that a trade agreement can solve as a terms-of-trade problem – hinges importantly on the assumption that governments have sufficient trade-tax instruments at their disposal. If they did not, then other non-terms-of-trade problems might also be addressed by a trade agreement (in this setting, just as more generally).[35]

We summarize the results of this section with

Proposition 2 *In the monopolistic competition model of firm delocation, the Nash trade policies are inefficient, and the inefficiency arises only because governments value the pure international rent-shifting associated with the terms-of-trade movements induced by their unilateral tariff choices.*

In a recent paper, Ossa (2009) uses a monopolistic competition model of firm delocation and attempts to provide new answers relative to the terms-of-trade theory to two central questions in the economics of trade agreements: first, what is the purpose of a trade agreement?; and second, what is the role played by reciprocity and non-discrimination? Regarding the first question, Ossa observes that the firm-delocation externality can provide a separate reason for a trade agreement that is independent of the terms-of-trade externality. Regarding the second question, Ossa then

[35] As with Proposition 1, we emphasize here that what is required for the efficiency of the political optimum in this setting is that each country has a complete set of trade tax instruments, in the sense that each government has available the use of an import tariff and an export tax/subsidy, *not* that each country has a complete set of (trade and domestic) tax instruments with which to achieve the first best.

offers a novel interpretation of reciprocity and non-discrimination as simple rules that can neutralize the firm-delocation externality. The result stated in Proposition 2 above is at odds with Ossa's first observation, and so it is important to explore the differences across the two papers.

There are two substantive differences between the model employed by Ossa (2009) and the one we develop in this section. A first difference is that Ossa follows Venables (1987) and adopts a specification of utility that allows income effects on the demand for differentiated products, while we follow Helpman and Krugman (1989) and adopt the (quasi linear) specification of utility in (28) that ensures that there will be no such income effects. So along this dimension, Ossa's model is more general than the model we work with in this section. The second difference is related to the first: due to income effects, Ossa's model is difficult to work with when trade taxes imply revenue, and so Ossa assumes for simplicity that trade taxes do not have revenue consequences. Importantly, this assumption requires Ossa to abstract from export policies in his analysis, and focus only on the use of import tariffs. By contrast, the revenue consequences of trade taxes are simple to handle in our quasi-linear setting, because they are soaked up by consumption of the numeraire good, and so we can and do allow for both import tariffs and export taxes; and as we have emphasized above, allowing for a full set of trade policies is crucial for our result.

3.5 Reciprocity

As with the Cournot model of the previous section, an important implication of Proposition 2 is that, for the monopolistically competitive firm delocation model, just as in the competitive benchmark model, a trade agreement that is founded on the principle of reciprocity can guide governments from their inefficient unilateral policies to the efficiency frontier. To establish this, we again follow Bagwell and Staiger (2001) and define tariff changes that conform to reciprocity as those that bring about equal changes in the volume of each country's imports and exports when valued at existing world prices.

Again taking account of trade in the numeraire good, and letting a superscript "0" denote original trade tax levels and a superscript "1" denote new trade tax levels, it is direct to establish that tariff changes conforming to reciprocity must satisfy[36]

$$\begin{aligned}&[p^w(\tau_f^0) - p^w(\tau_f^1)]M(p_f^1, p_h^{*1}) \\ &= [p^{*w}(\tau_h^{*0}) - p^{*w}(\tau_h^{*1})]E(p_f^1, p_h^{*1}).\end{aligned} \tag{56}$$

As was the case in the previous section, it is clear that there can be no pure international rent shifting across countries as a result of tariff changes that conform to reciprocity: according to (56), such tariff changes imply either that (i) world prices are left unchanged as a result of the tariff changes, so that $p^w(\tau_f^0) = p^w(\tau_f^1)$ and $p^{*w}(\tau_h^{*0}) = p^{*w}(\tau_h^{*1})$, or (ii) world prices are altered in a net-trade–tax-revenue neutral fashion.

[36] Once again the steps to derive (56) employ the balanced trade condition that must hold at the original and the new world prices, and are identical to those described in note 19 of Bagwell and Staiger (2001).

We are now prepared to interpret and evaluate the principle of reciprocity in the monopolistic competition model of firm delocation. As in the previous section, we proceed in two steps.

As a first step, it is straightforward to establish that, starting at the Nash equilibrium, the home and foreign countries must both gain from a small adjustment in trade taxes that reduces total trade barriers (ι and ι^*, and hence by (39) and (41), p_f and p_h^*) and satisfies reciprocity. Consider first a reduction in ι and ι^* that is engineered with a small reduction in the home and foreign import tariffs τ_h and τ_f^*. As we have observed, the special features of this model imply that import tariffs have no impacts on world prices, and so by (56) *any* reductions in τ_h and τ_f^* will conform to reciprocity in this model.[37] But then, evaluated at the Nash conditions given by (45) and (47), the impact on home and foreign welfare of a small (reciprocal) reduction in τ_h and τ_f^* is given respectively by

$$\begin{aligned} -\{V_{p_f}\frac{dp_f}{d\tau_h}+V_{p_h^*}\frac{dp_h^*}{d\tau_f^*}\} &= -\{V_{p_f}\frac{dp_f}{d\tau_h}+V_{p_h^*}\frac{dp_h^*}{d\tau_h^*}\} = -V_{p_h^*}\frac{dp_h^*}{d\tau_h^*} = E^N\frac{dp^{*w}}{d\tau_h^*} > 0, \quad \text{and} \\ -\{V^*_{p_h^*}\frac{dp_h^*}{d\tau_f^*}+V^*_{p_f}\frac{dp_f}{d\tau_h}\} &= -\{V^*_{p_h^*}\frac{dp_h^*}{d\tau_f^*}+V^*_{p_f}\frac{dp_f}{d\tau_f}\} = -V^*_{p_f}\frac{dp_f}{d\tau_f} = M^N\frac{dp^{w}}{d\tau_f} > 0. \end{aligned}$$

With analogous arguments, it can be shown that both countries gain from a small reduction in ι and ι^* that is engineered with reciprocal reductions in the home and foreign export taxes τ_h^* and τ_f from their Nash levels. In particular, it follows from (56) that the reduction in τ_f that is required to satisfy reciprocity in response to a small reduction in τ_h^*, which we denote by $\frac{d\tau_f}{d\tau_h^*}|_{rec}$, is defined by

$$\frac{d\tau_f}{d\tau_h^*}|_{rec} = \frac{E^0}{M^0}, \tag{57}$$

where M^0 and E^0 denote the initial levels of home-country imports and exports, respectively.[38] But then, evaluated at the Nash conditions given by (45) and (47) and using (57), the impact on home and foreign welfare of a small reciprocal reduction in τ_h^* and τ_f is given respectively by

$$\begin{aligned} -\{V_{p_f}\frac{dp_f}{d\tau_f}\frac{d\tau_f}{d\tau_h^*}|_{rec}+V_{p_h^*}\frac{dp_h^*}{d\tau_h^*}+V_{p^{*w}}\frac{dp^{*w}}{d\tau_h^*}+V_{p^w}\frac{dp^w}{d\tau_f}\frac{d\tau_f}{d\tau_h^*}|_{rec}\} &= E^N\frac{dp^w}{d\tau_f} > 0, \quad \text{and} \\ -\{V^*_{p_h^*}\frac{dp_h^*}{d\tau_h^*}+V^*_{p_f}\frac{dp_f}{d\tau_f}\frac{d\tau_f}{d\tau_h^*}|_{rec}+V^*_{p^{*w}}\frac{dp^{*w}}{d\tau_h^*}+V^*_{p^w}\frac{dp^w}{d\tau_f}\frac{d\tau_f}{d\tau_h^*}|_{rec}\} &= E^N\frac{dp^{*w}}{d\tau_h^*} > 0. \end{aligned}$$

Our second step is to consider the impact of reciprocity when it is applied in response to the reintroduction of trade barriers. Specifically, we now establish that, if countries negotiate to the political optimum, then neither country has an interest in unilaterally raising its import tariff or export tax if it is understood that such an act would be met with a reciprocal action from its trading

[37] Intuitively, this simply reflects the fact that in this model each country is "small" with regard to its import tariff, and for a small country a change in its trade policy must lead to equal changes in the volume of its imports and exports by the condition that trade must remain balanced at the (fixed) world prices.

[38] The expression in (57) may be derived in the same way as (56) by considering small tariff changes and dropping second-order terms, and using $\frac{dp^w}{d\tau_f} = \hat{p} = \frac{dp^{*w}}{d\tau_h^*}$.

partner. To confirm this observation, let us begin at the politically optimal policies defined by (54) and (55). Clearly, neither country has any incentive to raise its import tariff above its politically optimal level, because as (45) and (47) confirm the condition that defines the politically optimal level of each country's import tariff is the same as that which defines its Nash level (and as we have observed, no policy response from the trading partner is warranted to maintain reciprocity in this case). Consider next export policies. If the home country were to raise τ_h^* beginning from the political optimum, and the foreign government were to reciprocate according to $\frac{d\tau_f}{d\tau_h^*}|_{rec}$, the impact on home-country welfare would be given by

$$V_{p_f}\frac{dp_f}{d\tau_f}\frac{d\tau_f}{d\tau_h^*}|_{rec}+V_{p_h^*}\frac{dp_h^*}{d\tau_h^*}+V_{p^{*w}}\frac{dp^{*w}}{d\tau_h^*}+V_{p^w}\frac{dp^w}{d\tau_f}\frac{d\tau_f}{d\tau_h^*}|_{rec}=V_{p_f}\frac{dp_f}{d\tau_f}\frac{d\tau_f}{d\tau_h^*}|_{rec}+V_{p_h^*}\frac{dp_h^*}{d\tau_h^*}=0,$$

where the first equality uses (57) and the fact that $\frac{dp^{*w}}{d\tau_h^*}=\hat{p}=\frac{dp^w}{d\tau_f}$, and the second equality follows according to the conditions for the home-country's politically optimal tariff choices given in (54). An exactly analogous argument holds for the foreign country's incentive to raise τ_f in the face of a reciprocal response from the home country.

Hence, the terms-of-trade Prisoners' Dilemma problem that characterizes the Nash inefficiency in the monopolistically competitive delocation model – like the Cournot delocation model of the previous section and like the competitive benchmark model – provides a foundation for understanding why a trade agreement that is founded on the principle of reciprocity can guide governments from their inefficient unilateral policies to the efficiency frontier. We summarize this discussion as follows:

Corollary 2 *In the monopolistic competition model of firm delocation, the principle of reciprocity serves to "undo" the terms-of-trade driven inefficiency that occurs when governments pursue unilateral trade policies.*

Finally, it is worth emphasizing that, unlike the Cournot delocation model, the monopolistic competition model of firm delocation presented in this section shares with the broader terms-of-trade theory the prediction that trade agreements should encourage rather than discourage the use of export subsidies. Evidently, a prediction that a trade agreement should restrict export subsidies with a ceiling rather than a floor arises naturally when the terms-of-trade consequences of export subsidies are reversed from the standard case, and this reversal occurs in the Cournot delocation model but not in the monopolistic competition model of firm delocation.

4 Conclusion

When markets are imperfectly competitive, profit-shifting and firm-delocation effects can give rise to novel motives for trade policy intervention. In light of the various ways that trade policies may influence welfare, it might be expected that new rationales for trade agreements would arise once imperfectly competitive markets are allowed. In this paper, we feature the firm-delocation motive for trade policy intervention and argue that the basic rationale for a trade agreement is, in fact, the same rationale that arises in perfectly competitive markets. In both the Cournot and monopolistically competitive models of firm delocation, the *only* rationale for a trade agreement is to remedy the inefficiency attributable to the terms-of-trade externality. Furthermore, and again as in the benchmark model with perfect competition, we show that the principle of reciprocity is efficiency enhancing, as it serves to "undo" the terms-of-trade driven inefficiency that occurs when governments pursue unilateral trade policies.

Our analysis thus suggests that the broad implications of the terms-of-trade approach to trade agreements are quite general, as they apply not just to perfectly competitive but also to a wide range of imperfectly competitive markets. This suggestion is further supported in our companion paper (Bagwell and Staiger, 2009), which draws analogous conclusions in an imperfectly competitive setting where the number of firms is fixed and profit-shifting effects are featured. With this suggestion we do not mean to imply that extending the analysis of trade agreements to imperfectly competitive markets is unimportant. On the contrary, as Ossa (2009) emphasizes, such work is critical for extending the applicability of the trade agreements literature to better reflect the realities of international trading patterns. In addition, novel insights emerge once we move outside of the setting of perfect competition; for example, as we argue in Bagwell and Staiger (2009a), the novel implications of the Cournot delocation model for export policies provides a new way of understanding export subsidy agreements. Rather, our point is simply that the terms-of-trade approach to trade agreements remains valid in imperfectly competitive settings as the foundation from which to evaluate and interpret the design of trade agreements in light of the underlying problems that they exist to solve.

Finally, in all of the settings that we consider the international externalities share an important trait: they all travel through prices, and are hence pecuniary in nature. Of increasing urgency in the world economy are problems – such as global warming – that feature international externalities that take a non-pecuniary form. An important task for future research is to characterize the form that an efficiency-enhancing agreement might take when the underlying problems stem from non-pecuniary externalities.[39]

[39] An additional feature which is common to all of the settings we consider is that international prices and the quantities traded are determined by market-clearing mechanisms between (possibly non-competitive) suppliers and consumers. Antras and Staiger (2008) show that, when trade reflects specialized products whose international prices are determined through bilateral bargaining between sellers and buyers rather than market clearing mechanisms, the role of a trade agreement must expand beyond providing an avenue of escape from a terms-of-trade driven Prisoners' Dilemma if governments are to achieve the international efficiency frontier.

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Figure 1
Firm Delocation in the Cournot Model