How Economic Interests Explain the Pattern of Subsidy Restrictions

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Abstract

This paper proposes a theory of subsidy bans that aligns well with their negotiating history across major sectors. A challenge for standard trade agreement theories is explaining why countries would cooperate to ban trading partner's export-promoting subsidies, which improve the terms of trade of imports. Trade negotiation records suggest a rationale to explore formally: concerns over lost sales of import-competing firms dominate other concerns as markets integrate. The challenge for building this motive into theory is that government preferences implying subsidy bans also imply that nations would not open markets through tariff cuts in the first place. To resolve this challenge, I consider governments who pursue tariff cuts in negotiations as a second-best approach for shifting rents to exporters. Given any motive to promote exporters, countries negotiate tariff cuts so large that they seek price increases in import sectors. Sufficient desire to prevent further price decreases in import sectors then motivates enforcement of subsidy bans. The subsidy bans are desirable only after sufficient trade frictions have been removed, so the theory aligns well with the history that consensus subsidy restrictions were achieved first in manufacturing, then in agriculture, and not yet in services.

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1 Introduction

Concern over trading partner's subsidies has been a defining characteristic of U.S. trade policy for decades: U.S. concern about European subsidies in the 1970s drove the initial multilateral forms of subsidy cooperation, the Subsidies Code in the Tokyo Round and then the current Agreement on Subsidies and Countervailing Measures (SCM) that still prevails in the World Trade Organization (WTO) today (see e.g. Wouters and Coppens, 2010 for the history). More recently, Chinese subsidies have been a widely accepted source of frustration in U.S.-China relations (see e.g. Bown and Hillman, 2019). So two key features of subsidy conflict and cooperation are (1) major powers strongly prefer the deterrence or removal on subsidies on their imports from each other, and (2) there has been scope for multilateral cooperation in subsidies, whereby all countries prefer restrictions on subsidies while importers and exporters.

Subsidy cooperation is well understood in some economic contexts, but not well for the defining features of subsidy cooperation just mentioned. Textbook undergraduate international trade (e.g. Krugman, Obstfeld, and Melitz 2014) explains well the desire to limit subsidies of import-competing domestic production (which worsens terms of trade of exporters) and the desire to limit subsidies between national champions competing for the rest-of-world market (which reduces rents achieved from sales in imperfect competition), following Brander and Spencer (1985). The former motive aligns well with actual subsidy conflicts in the early days of the GATT (see, Staiger and Sykes, 2013) and the latter motive undoubtedly contributed to SCM agreement, as Section 2 will explain. But neither of these textbook motives for subsidy cooperation aligns well with the two driving features of subsidy cooperation and conflict in the last 50 years. Neither is an explanation for why the U.S. would want foreign subsidies removed from its imports from E.U. or China over the last 50 years. The Brander and Spencer model of competing exporters cannot explain multilateral subsidy cooperation because world welfare actually improves from the subsidy war between the exporters (see, e.g., Bagwell and Staiger, 2012b), so the model's ability to explain subsidy restrictions relies critically on the importers who benefit from cheaper products not being present in the two negotiating countries. Recent trade policy work still argues then that the WTO subsidy rules remain "something of a puzzle" (see, e.g., Bown et al. 2022, fn 12).

This paper provides the first static theory of political economy such that all governments would want to limit export subsidies. I focus on trade between two large countries such that we are not assuming away the importing consumers who benefit from cheaper products, which is relevant in considering U.S. trade with the E.U. or China. A seemingly straightforward political economic explanation is that subsidy restrictions are desirable if the import-competing

sectors are more politically powerfully than consumers. Indeed, earlier work articulates this explanation informally (Grossman and Horn, 2013, Grossman and Mavroidis, 2001). This explanation also aligns well with the WTO's negotiating history, which largely focuses on incumbent firms protecting sales within their own markets, as detailed in section 2 of this paper. However, formally modelling this possibility is not straightforward. The major challenge is that political power that motivates subsidies would also prevent countries from reducing trade barriers to open markets in the first place.

The main contribution of the paper is to provide a formal articulation of how at a cooperative trade equilibrium, countries would want to restrict subsidies. In leading theories of trade cooperation with perfect competition plus political economy (Bagwell and Staiger 1999, 2006) or imperfect competition (Bagwell and Staiger, 2012b), countries cooperate in policy spaces such that there is no first-order effect of changes in local prices of tradables when deviating from the agreement. At the cooperative equilibrium in such theories, countries would not want to discourage trading partners' subsidies to achieve terms-of-trade gains, and this result holds regardless of the political power of importers. The current paper builds instead on the theory in DeRemer (2022), which considers how countries negotiate reciprocally over tariffs if there are frictions in using export subsidies and domestic subsidies, while governments still seek to distribute rents to exporters through tariff cuts. As a result, governments negotiate tariff cuts to the point where they would want to increase prices for import-competing industries. In such trade agreement outcomes, countries would want to prohibit subsidies if the political power of importers is sufficiently strong. I show this result can hold both in a setting with perfect competition with political power for importers and exporters. I also consider a framework with monopolistic competition and countries negotiating to free trade, similar to Ossa (2011), and whether governments would restrict entry subsidies.[1]

A second contribution is that the paper derives how foreign export subsidies are disliked at cooperative tariff levels but welcomed around noncooperative policies. This result is consistent with the broad pattern we have observed around cooperation over subsidized exports, first occurring with manufacturing, then agriculture, then more recently with discussions over

[1] One technical note: the paper focuses on what would commonly be considered the theory of export subsidies, but the results in principle could apply to domestic policies that ultimately serve to subsidize exports. One problem in thinking about subsidy restrictions is that allowing states to choose domestic policies that subsidize exports is that states can do so freely and correct any domestic distortions with these subsidizes. Still a reasonable possibility is states have limited ability to use domestic policies that promote exports and then also use trade negotiations to further promote exporters. Nonetheless, striking this balance in theory is difficult, so the paper focuses on the theory of subsidies on exports and no domestic subsidies. A second possibility is to focus on fixed costs subsidies while restricting marginal cost subsidies, as in Section 3. Naturally, there has been some discomfort in assuming away subsidy restrictions in a paper about explaining subsidy restrictions, but the approaches in this paper are the cleanest way to explain the real world.

services subsidies starting with the recent white paper of the European Commission (2020).

The paper contributes to a literature explaining restrictions on export subsidies by fitting the key facts about subsidy conflict and cooperation that historically motivated the WTO subsidy rules. A theory that aligns with this specific historical motive of protecting import-competing firms from subsidies is important. Other theories may be relevant in explaining subsidy cooperation in certain contexts but do not align with the WTO SCM negotiating history.

The most closely related strand of literature relies on market structures such that export subsidies unusually increase the terms of trade at a cooperative free trade outcome, a result known as a Metzler paradox. This work includes Bagwell and Staiger (2012a), considering a linear Cournot model; and Bagwell and Lee (2020), considering linear demand and firm heterogeneity. Though these papers contribute to plausible long-run benefits for subsidy restrictions without political economy motives, I raise a few points why a political economy theory is still worthwhile. First, subsidy restrictions are not negotiated by individual industry and there is no clear evidence that Metzler paradoxes or the market structures are common features of all industries. Second, the reading of subsidy restrictions in Section 2 suggests a clear motive of protection of sales of incumbent firms, so the long-run firm-delocation costs of subsidies affecting consumers rather than producers is distant from the main motive for the WTO subsidy rules.

Another strand of related literature focuses on motives of subsidy restrictions distinct from my focus on the WTO negotiating history. The political commitment motives for trade agreements (Maggi and Rodriguez Clare, 1998, 2007), contrasts with the international externality motive for trade agreements, as they focus on governments who sign agreements to tie their hands from political pressures. Commitment motives can explain restrictions on domestic subsidies (Brou and Ruta, 2013) and export subsidies (Potipiti and Suwanprasert, 2022) but the key features to explain here from the WTO SCM history do not align well with the commitment theory. The U.S. conflict with Europe or China in subsidies also does not transparently rely on either party wanting to tie their hands from political pressure in imposing subsidies.

Other literature focuses on distinct issues of institutional design in the multilateral trading system. One strand focuses on why the WTO would outright ban subsidies to import-competing firms rather than alternative institutional approaches like non-violation complaints, using models of imperfect information and mechanism design (Lee 2016; Bouet et al. 2021). This is a distinct issue from my focus on bans to subsidies that promote exports. Mrazova (2021) and Beshkar and Lashkaripour (2020) focus on why governments would cut import tariffs rather than export taxes (or increase export subsidies) starting from a nonco-

operative equilibrium. This focus is distinct from mine, whereas I focus on cooperation once the decision to focus on reciprocal tariff cuts has already been made, and then I evaluate whether export bans are desirable at various levels of import tariff cooperation.

The rest of the paper proceeds as follows. Section 2 discusses the negotiating history of subsidy agreements. Section 3 discusses entry subsidies in the context of a monopolistically competitive trade agreement model, and Section 4 considers the evolution of subsidy rules in this framework. Section 5 discusses results in the context of a perfectly competitive model. Section 6 concludes and discusses the paper's broader implications, including for quantitative trade models.

2 Historical and Legal Background

This section details salient features in the evolution of multilateral discipline on subsidies and countervailing measures relevant for the theory. Broader histories can be found in Sykes (2005), WTO (2006), and Wouters and Coppens (2010). The first subsection considers the GATT's history of regulating domestic subsidies, export subsidies, and countervailing duties. The next subsection considers evidence of the motives behind the Uruguay Round negotiations (1986-1994) that led to the WTO's Agreement on Subsidies and Countervailing Measures (SCM). The final subsection considers how well the model's focus on entry subsidies matches WTO practice.

2.1 GATT Subsidy Rules

Negotiating parties for the GATT discussed subsidies but did not view them as an opportunistic policy that should be limited or eliminated. A 1946 UN Economics and Social Council meeting[2] presented the following view:

> One of the main features of the United States proposals on subsidies was that direct subsidies to producers would be permitted. The United States Delegation felt that subsidies were preferable to import restrictions or tariffs. Subsidies kept prices down and demand up. They were expansionist rather than contractionist measures.

The main provision constraining domestic policies under the GATT was the Article XXIII nonviolation complaint. The rule, first formally modeled by Bagwell and Staiger (2001a), "ensures that the level of market access commitments implied by tariff negotiations [in

[2] E/FC/T/C.II/37,UN Economics and Social Council 31 October 46 meeting.

Article II] is not eroded by subsequent changes in domestic policies" (545). A 1955 GATT working party report[3] explains that the contracting parties believed that domestic subsidy regulation of Article XXIII was sufficient to require no further strengthening of domestic policy provisions:

> The Working Party considered many proposals for strengthening the present provisions of the Agreement with respect to the use of subsidies. So far as domestic subsidies are concerned, it was agreed that a contracting party which has negotiated a concession under Article II may be assumed, for the purpose of Article XXIII, to have a reasonable expectation, failing evidence to the contrary, that the value of the concession will not be nullified or impaired by the contracting party which granted the concession by the subsequent introduction of a domestic subsidy on the product concerned.

Based on the strong endorsement of Article XXIII, this paper takes as given that the Article XXIII nonviolation complaint was functional. When evaluating the WTO subsidy rules, we ask why additional rules—subsidy limits or countervailing duties—would be necessary in addition to Article XXIII.

The GATT had a longer history of limiting export subsidies than domestic subsidies, but a crucial difference from the GATT and WTO is the consensus to limit export subsidies under the WTO. Manufacturing export subsidies were originally subject to a mere reporting requirement in Article XVI. As Irwin, Mavroidis, and Sykes (2008) detail, there was some discussion of limiting export subsidies in the original GATT, but U.S. negotiators did not consider these proposals further because they did not have authority to limit export subsidies under the 1945 Reciprocal Trade Agreements Act (RTAA), which allowed the Truman Administration to implement GATT without Congressional approval. Beginning in 1962, thirteen developed countries began to limit manufacturing export subsidies while requiring no such rules for primary products (e.g. agriculture). Such an agreement is consistent with the theory of Brander and Spencer (1985), who show that manufacturing countries collude to limit subsidies at the expense of importers of manufactured goods. Indeed, the Australian delegation, representing a primary product exporter, was displeased with the plurilateral export subsidy agreement: "The Article was weak because of the glaring and invidious comparison between weak limitations on subsidies of primary products as compared with the ban on subsidies of manufacturing goods."[4] Because existing theory is adequate to explain this 1962 subsidy agreement, the current paper does not focus on it further, and instead

[3] GATT document L/334, 1 March 1955.

[4] GATT Document SR-9/41, 3 March 1955.

focuses on explaining the consensus agreement to limit export subsidies that occurred in the WTO.[5]

Countervailing duties (CVDs) existed in the GATT, but they were more a blatant form of protection by the United States rather than an efficiency-enhancing remedy. Because the 1897 U.S. CVD law predated the GATT, it was grandfathered in, and unlike other countries, the U.S. was permitted to countervail without demonstrating that its domestic industry had been injured by the subsidized imports, up until 1980 (Wouters and Coppens 2010). The U.S. was the primary user of CVDs under the GATT, accounting for 110 of 128 CVDs reported to the GATT Secretariat between 1980 and 1991 (Sykes 2005). Because the U.S. applied most CVDs and applied them without an injury test, this paper considers CVDs to be just an example of a failure of import tariff cooperation, and the level of import tariff cooperation is exogenous in the current paper.[6] We focus instead on how countervailing duty laws can benefit governments in a cooperative agreement once sufficient import tariff cooperation has been achieved.

2.2 WTO Subsidy Negotiating History

A note from the GATT secretariat[7] at the outset of the negotiations provides insight into what problems subsidy rule negotiators believed they were solving:

> A number of problems have arisen in the case of production subsidies. The General Agreement does not limit their use, and the requirement not to prejudice the interests of other contracting parties is very vague. In particular it is unclear who has to make the determination of prejudice, how the prejudice should be assessed and whether the obligation to discuss the possibility of limiting the subsidization implies that the subsidizing contracting party must take action to limit the subsidy in question. The Agreement on Subsidies and Countervailing Measures has provided some disciplines as to the effects in the sense that signatories are obliged to seek to avoid causing, through the use of any subsidy, adverse effects to the interest of another signatory. It also established a procedure to determine the existence of adverse effects and to take a remedial action. To the extent that

[5] This historical interpretation of export subsidy bans is distinct from Mrazova (2021), who uses an early proposal for Article XVI to motivate a theory in which export subsidies are always banned.

[6] This interpretation differs from Ethier (2007), who considers countervailing duty laws to be an essential feature of the noncooperative equilibrium for all countries. His justification is that CVD laws predated the GATT. But America's frequent and arbitrary application of CVDs leads the current paper to classify CVDs as a uniquely American form of tariff protection during the GATT era rather than as a globally-adopted feature of the noncooperative equilibrium.

[7] MTN.GNG/NG10/W/4, 28 April 1987.

> these effects have arisen in the domestic market of the importing country, they have been dealt with through the use of countervailing duties. As the importing country has an efficient deterrent against these effects, the problems result rather from possible abuse of this deterrent. However, regarding adverse effects arising in the domestic market of the subsidizing country or in the third country market, the obligations under the Agreement on Subsidies and Countervailing Measures to avoid causing such effects are hardly enforceable.

The theory in this paper matches the view of the secretariat that the purpose of the subsidy rules is to prevent subsidies from having adverse effects (cross-border externalities) in each other's markets and in the markets of third countries. In contrast to Bagwell and Staiger (2006), countervailing duties are seen as playing an essential role in the agreement. Also, the text implies that the Article XXIII nonviolation complaint is no longer seen as effective at preventing "adverse effects arising in the domestic market of the subsidizing country."[8] This paper nonetheless follows Bagwell and Staiger (2001a, 2006) and assumes that Article XXIII handles adverse effects, to understand why countries would create new subsidy rules rather than improve upon Article XXIII.

2.3 Entry Subsidies and the GATT/WTO

A distinctive feature of this paper is its emphasis on problems created by subsidies that affect entry. The theory matches well with the seminal empirical countervailing duty study of Marvel and Ray (1995), who document that "many of the subsidies in question appear to have covered fixed costs." The authors interpret this stylized fact as evidence that countervailing duties are not used to address legitimate profit-shifting concerns, due to the absence of any theory of strategic motives for fixed cost subsidies. Grossman and Mavroidis (2001, 2003) argue WTO panels have failed to follow the intentions of WTO founders in regulating these subsidies, hence their title choice, "Recurring Misunderstanding of Non-Recurring Subsidies. More recently, Baylis (2009) notes the need for theory on strategic motivations for fixed cost subsidies in her survey of the countervailing duty and strategic trade policy literature.

Among the most prominent examples of fixed cost subsidies in the WTO era is the Boeing-Airbus case, in which Boeing has challenged European Union "launch aid." The EU reduces Airbus' cost of financing the development of new aircraft varieties, which cut into Boeing's market share in several markets. Naturally, there are several complications of the aircraft industry not captured by model. Boeing and Airbus are multi-product duopolists

[8] See also Roessler and Gappah (2005) for a critique of the Article XXIII nonviolation complaint and a summary of its case history.

who offshore and use complex supply chains. The model nonetheless captures the core feature of the dispute—subsidies leading to the expansion of varieties.

3 The Model with Entry Subsidies

The model builds on Section 7.3 of Helpman and Krugman (1989) by adding an export subsidy and a domestic entry subsidy. We further simplify by assuming symmetric technology, endowments, and preferences across the two large countries, Home and Foreign. The economy has two sectors: a monopolistically competitive sector of symmetric firms producing differentiated products and a quasilinear freely traded numeraire good. There are two factors: a labor factor mobile between the two sectors and a specific factor necessary for entry in the differentiated sector. The factors are owned by consumers who take prices and government policies as given and maximize utility. Firms take government policy and the consumer price index as given and maximize profits. Individual firms and consumers are too small to behave strategically.

After laying out the model, this section determines the governments' objectives as a function of Home and Foreign policy choices. The objectives allow us to derive the *cross-border externalities* of government policies. Here externalities refer to the cross-border effects of policies that a government does not internalize when it chooses policies unilaterally.

3.1 Setup

Government: The Home government chooses an ad valorem import tariff τ, an export subsidy s, and a subsidy to entry e. The Foreign government chooses a corresponding set of policies τ^*, s^*, and e^*. A negative import tariff indicates an import subsidy, and a negative export subsidy indicates an export tax, but we will primarily focus on situations when governments choose import tariffs and export subsidies. Nondistortionary transfers between government and consumers balance any budget deficit or surplus.

Government objectives assign a weight 1 to consumer surplus and a weight α to the rents accruing to the specific factor (i.e. producer surplus). Microfoundations for such government objectives come from the Grossman and Helpman (1994) model of lobbying, and Chang (2005) extends the results to a framework with monopolistic competition.[9]

[9]The additional weight on producer profits is motivated by Hufbauer and Erb (1984, p. 8) and Baldwin (1980, p. 86), who argue that producers' sense of entitlement to their domestic markets has always been central to subsidy rules. Mavroidis, Messerlin, and Wauters (2008) observe that the WTO subsidy rules are focused on producer interests.

For the existence of noncooperative and cooperative equilibria, we require $\alpha < \sigma$, where σ is the elasticity of substitution between differentiated products. If the political economy weight α were greater than σ, countries would give boundless export subsidies to their producers.

Consumption: Consumers in each country all have income large enough to ensure consumption Y of the numeraire good. The utility functions are

$$\begin{aligned} U &= \frac{1}{\theta}(D)^{\theta} + Y, \text{ and} \\ U^* &= \frac{1}{\theta}(D^*)^{\theta} + Y^*. \end{aligned} \tag{1}$$

The utility functions imply an elasticity of substitution $\varepsilon = \frac{1}{1-\theta}$ between sectors. D is a CES composite good over n_h symmetric Home products and n_f symmetric Foreign products. Imposing symmetry on the consumption of goods for each product, we have

$$\begin{aligned} D &= \left(n_h c_h^{\frac{\sigma-1}{\sigma}} + n_f c_f^{\frac{\sigma-1}{\sigma}}\right)^{\frac{\sigma}{\sigma-1}}, \text{ and} \\ D^* &= \left(n_h c_h^{*\frac{\sigma-1}{\sigma}} + n_f c_f^{*\frac{\sigma-1}{\sigma}}\right)^{\frac{\sigma}{\sigma-1}}. \end{aligned} \tag{2}$$

The elasticities of substitution satisfy $\sigma > \varepsilon > 1$. For consumption variables c, subscripts h and f denote location of origin, while the superscript "*" indicates location of consumption, so c_f is Home imports and c_h^* is Foreign imports.

Marginal Production: The good Y has a unit labor requirement and is freely traded between sectors. The differentiated products have marginal labor requirement m. To ship one unit abroad requires an iceberg trade cost, additional production of the good that "melts" in transit. The trade cost is $\phi \geq 0$.

Firm Entry: Countries each have a capital endowment K specific for entry into the differentiated sector. Some consumers own capital and some do not, ensuring a motive for capital lobbying. Governments can reduce the capital requirement with an entry subsidy. The government subsidizes entry in the differentiated sector by hiring labor to produce a public good specific to the differentiated sector. The capital requirement is given by the function $k(e)$, such that k is strictly decreasing in the government subsidy e. Firm profits accrue to the owners of the specific factor. The domestic entry subsidies e and e^* determine the number of firms n_h and n_f in each country:

$$n_h = \frac{K}{k(e)}, \text{ and } n_f = \frac{K}{k(e^*)}. \tag{3}$$

The function k can be inverted to express the cost to the government of having a given number of firms, as if governments were directly choosing the number of firms:

$$\begin{aligned} e &= k^{-1}(\frac{K}{n_h}) \equiv f(n_h), \text{ and} \\ e^* &= k^{-1}(\frac{K}{n_f}) \equiv f(n_f). \end{aligned} \tag{4}$$

A simple feasible functional form is $k(e) = \frac{K\beta}{e+\mu}$ for a scale parameter β and a shift parameter μ. Such a function $k(e)$ yields $f(n) = \beta n - \mu$ for $n \geq \frac{\mu}{\beta}$, and $\frac{\mu}{\beta}$ is the number of firms absent any entry subsidy. The model could conceivably admit a more general functional form for k, provided that the government objectives are concave in the number firms chosen.[10] We require a restriction on the shift parameter μ that ensures countries offer positive entry subsidies at all equilibria under consideration.[11] The scale parameter for $k(e)$ is subject to an additional restriction to ensure there is a cooperative equilibrium with zero tariffs. Discussion of the restriction is postponed to Section 4.1.

The structure here allows us to consider, in a simple way, government ability to influence the extensive margin of firm entry, while at the same time not allowing free entry to eliminate any lobbying motive for firms, as would be the case in a single-factor model.[12] As discussed in Section 2.3, consideration of fixed cost subsidies is empirically justified. The simplification that government effectively chooses the number of firms also has precedent in the international competition policy literature.[13] In the current paper, the approach offers tractability for studying interactions between domestic policy choices and trade policies, and such interactions have received little attention apart from Bagwell and Staiger (2001a, 2006).

[10] The elasticity of welfare with respect to firm entry, absent $f(n)$, is $\frac{\varepsilon-1}{\sigma-1}$, so at the very least we require $f(n)$ to be more convex than $n^{(\frac{\varepsilon-1}{\sigma-1})}$, and a linear cost function meets this requirement since $\frac{\varepsilon-1}{\sigma-1} < 1$.

[11] A decrease in μ lowers the number of firms with no entry subsidies. Being a constant in $f(n)$, μ has no effect on first-order conditions and second-order conditions that determine noncooperative and constrained choices of n_h and n_f.

[12] The idea that such free entry can eliminate strategic trade motives has been well understood since Horstmann and Markusen (1986).

[13] Dixit (1984), Horn and Levinsohn (2001), and Bagwell and Staiger (2002, Ch. 9) each consider a domestic competition policy (e.g. antritrust policy) that directly determines the number of domestic firms in a Cournot market. Only Bagwell and Staiger (2002, Ch. 9) consider whether there is an additional rationale for a domestic policy agreement beyond the GATT, and they conclude the answer is no.

3.2 Determining Government Objectives

To evaluate the government objectives, we find the equilibrium consumption and production taking government policies as given.

Freely mobile labor implies wages are equal across sectors, and profit maximization implies the wage equals the price of the homogeneous good. Free trade in the homogeneous good implies the prices of the homogeneous good and wages are equal across countries. The wage is defined to be the numeraire.

Utility maximization implies demand for the composite good $D = P^{-\varepsilon}$, where P is the price index for the composite good and PD is the total expenditure on differentiated products. Indirect utilities V and V^* are decreasing in own price index and increasing in income I:

$$\begin{aligned} V &= \frac{1}{\varepsilon - 1} PD + I = \frac{1}{\varepsilon - 1} P^{1-\varepsilon} + I, \text{ and} \\ V^* &= \frac{1}{\varepsilon - 1} P^* D^* + I^* = \frac{1}{\varepsilon - 1} P^{*1-\varepsilon} + I^*. \end{aligned} \tag{5}$$

The notation for prices p_h, p_f, p_h^*, and p_f^* matches the consumption variables c_h, c_f, c_h^*, and c_f^*. The price index P is standard following Dixit and Stiglitz (1977) under symmetric firms:

$$\begin{aligned} P &= \left(n_h p_h^{1-\sigma} + n_f p_f^{1-\sigma}\right)^{\frac{1}{1-\sigma}} \equiv P(n_h, n_f, p_h, p_f), \text{ and} \\ P^* &= \left(n_f p_f^{*1-\sigma} + n_h p_h^{*1-\sigma}\right)^{\frac{1}{1-\sigma}} \equiv P^*(n_h, n_f, p_h^*, p_f^*). \end{aligned} \tag{6}$$

Consumer maximization implies the total demands for individual products are

$$\begin{aligned} c_h &= p_h^{-\sigma} P^{\sigma-\varepsilon} \equiv c_h(n_h, n_f, p_f, p_h),\ c_f = p_f^{-\sigma} P^{\sigma-\varepsilon} \equiv c_f(n_h, n_f, p_f, p_h), \\ c_f^* &= p_f^{*-\sigma} P^{*\sigma-\varepsilon} \equiv c_f^*(n_h, n_f, p_h^*, p_f^*), \text{ and } c_h^* = p_h^{*-\sigma} P^{\sigma-\varepsilon}. \equiv c_h^*(n_h, n_f, p_h^*, p_f^*). \end{aligned} \tag{7}$$

Market demand x_h for a Home product is the sum of domestic demand and Foreign demand, plus the iceberg transport costs:

$$\begin{aligned} x_h &= c_h + (1+\phi) c_h^* \equiv x_h(n_h, n_f, p_h, p_f, p_h^*, p_f^*). \\ x_f &= c_f^* + (1+\phi) c_f \equiv x_f(n_h, n_f, p_h, p_f, p_h^*, p_f^*). \end{aligned} \tag{8}$$

Because markets are integrated, imports are marked up from domestic prices based on net cross-border costs:[14]

$$\begin{aligned} p_h^* &= (1+\phi+\tau^*-s)p_h \equiv p_h^*(\tau^*, s, p_h), \text{ and} \\ p_f &= (1+\phi+\tau-s^*)p_f^* \equiv p_h^*(\tau, s^*, p_f^*). \end{aligned} \tag{9}$$

Since demand functions have a constant price elasticity, profit-maximization implies a constant local price for domestic varieties p_h and p_f^*.

$$p_h = p_f^* = \frac{\sigma}{\sigma-1}m \equiv p. \tag{10}$$

The prices do not depend on tariffs, as emphasized in Ossa (2011), or on firm entry, as emphasized here. Because we have shown these local prices for domestic goods are constant with respect to policy, we will omit them from all functional notation henceforth.

World prices p_h^w and p_f^w are the prices of Home and Foreign exports between borders. They depend only on the export subsidy:

$$\begin{aligned} p_h^w &= (1-s)p_h \equiv p_h^w(s), \text{ and} \\ p_f^w &= (1-s^*)p_f^* \equiv p_f^w(s^*). \end{aligned} \tag{11}$$

The per unit markup $p - m = \frac{p}{\sigma}$ determines Home and Foreign domestic per firm profits π and total profits Π:

$$\pi_h = (\frac{p}{\sigma})x_h,\ \pi_f = (\frac{p}{\sigma})x_f, \tag{12}$$

$$\begin{aligned} \Pi_h &= n_h\pi_h \equiv \Pi_h(n_h, n_f, p_f, p_h^*), \text{ and} \\ \Pi_f &= n_f\pi_f \equiv \Pi_f(n_h, n_f, p_f, p_h^*). \end{aligned} \tag{13}$$

Home government objectives can be decomposed as follows:

- Profits (with political economy weight α) $\equiv \alpha\Pi_h$
  - Domestic profits $\equiv \alpha(\frac{p}{\sigma})n_h c_h = \alpha(\frac{c_h}{x_h})\Pi_h$

[14] The definition of the Foreign import tariff multiplying the domestic price of Home goods p_h instead of the world price of Home goods p_h^w (to be defined) follows Bagwell and Staiger (2015) but not DeRemer (2013) and Campolmi, Fadinger, and Forlati (2013). The choice of definition here leads to simpler analysis for this paper and does not materially affect results.

– Export profits $\equiv \alpha(\frac{p}{\sigma})(1+\phi)n_h c_h^* = \alpha(1-\frac{c_h}{x_h})\Pi_h$

- Consumption

  – Consumer surplus $\equiv \frac{1}{\varepsilon-1}PD$

  – Import tariff revenue $\equiv \tau p n_f c_f$

  – Export subsidy cost $\equiv -sp n_h c_h^*$

  – Entry subsidy cost $\equiv -f(n_h)$

  – Wage income $\equiv L$

A corresponding decomposition holds for Foreign. The government objectives G and G^* are then

$$\begin{aligned} G &= \alpha\Pi_h + \frac{1}{\varepsilon-1}PD + \tau p n_f c_f - sp n_h c_h^* - f(n_h) + L, \text{ and} \\ G^* &= \alpha\Pi_f + \frac{1}{\varepsilon-1}P^*D^* + \tau^* p n_h c_h^* - s^* p n_f c_f - f(n_f) + L. \end{aligned} \tag{14}$$

An important task is to separate the effects that go through prices and the number of firms. We write the Home government objective as a function of prices and firms. Note also the definition of the price indices (Equation 6) as a function of firm counts and local traded prices (once we have suppressed dependence on the constant local domestic prices), and the definition of the prices as a function of trade policies (Equations 9 and 11).

$$\begin{aligned} G(n_h, n_f, p_f, p_h^*, p_f^w, p_h^w, P, P^*) &= \frac{1}{\varepsilon-1}P^{1-\varepsilon} + n_h c_h(P)\left[\frac{\alpha p}{\sigma}\right] - f(n_h) + L \\ &\quad n_f c_f(p_{f,}P)[p_f - \phi p_f^* - p_f^w] + n_h c_h^*(p_h^*, P^*)\left[\frac{\alpha p(1+\phi)}{\sigma} + (p_h^w - p_h)\right] \end{aligned} \tag{15}$$

The world objective is as follows:

$$\begin{aligned} W(n_h, n_f, p_f, p_h^*, p_f^w, p_h^w, P, P^*) &= \frac{1}{\varepsilon-1}(P^{1-\varepsilon} + P^{*1-\varepsilon}) + \frac{\alpha p}{\sigma}\left[n_h c_h(P) + n_f c_f(P^*)\right] \\ &\quad + n_f c_f(p_f, P)\left[p_f - (1+\phi)p\right] + n_h c_h^*(p_h^*, P^*)\left[p_h^* - (1+\phi)p\right] \\ &\quad - f(n_h) - f(n_f) + 2L. \end{aligned}$$

The sum of the two objectives is justified here because we consider symmetric choices

throughout. W can be written in terms of net trade taxes, which we define as $t_f \equiv (\tau - s^*)$ for Foreign-produced goods and $t_h \equiv (\tau^* - s)$ for Home-produced goods.

3.3 Import Tariff Results

This section considers noncooperative and cooperative tariffs. We introduce an unobjectionable assumption that ensures the standard result that countries' noncooperative import tariffs are larger than their cooperative import tariffs. In constructing a theory of the WTO subsidy rules, this paper needs to be consistent with some basic empirical facts of trade policy, such as a noncooperative equilibrium with high import tariffs and a cooperative equilibrium with low import tariffs.

At the noncooperative equilibrium in trade policies, each country's import and export subsidy choice is unilaterally optimal. At the cooperative equilibrium, each country's net trade barriers are picked to maximize world welfare. The cooperative equilibrium depends only on net trade barriers because W only depends on net trade barriers.

We establish a first lemma that net trade taxes are higher at noncooperative trade policies than cooperative trade policies, so noncooperative trade policy choices result in too little trade. All lemmas are proven in Appendix A.2.

Lemma 1 *Consider countries with symmetric policies* $\bar{e}$, $\bar{\tau}^N$, *and* $\bar{s}^N$, *such that* $\frac{dG}{d\tau} = \frac{dG^*}{d\tau^*} = \frac{dG}{ds} = \frac{dG^*}{ds^*} = 0$. *For sake of comparison, consider a different pair of countries with net trade barriers* $\bar{t}^c$ *such that* $\frac{dW}{d\tau} = \frac{dW}{d\tau^*} = \frac{dW}{ds} = \frac{dW}{ds^*} = 0$. *Then* $\bar{\tau}^N$, $\bar{s}^N$, $\bar{t}^c$ *do not depend on* $\bar{e}$, $\bar{\tau}^N > 0$, *and* $\bar{t}^N > \bar{t}^C$.

The lack of dependence of the noncooperative trade policies $\bar{\tau}^N$ and $\bar{s}^N$, and fully cooperative trade barriers $\bar{t}^c$ on the level of entry subsidies (and hence the number of firms) is a consequence of CES preferences and the symmetry between countries. The policies maximizing the joint objective W involve subsidizing trade as a second-best attempt to correct the monopoly distortion, so countries would benefit when moving from noncooperative policies to policies with zero net trade taxes.[15]

Many trade policy models suffer the difficulty that cooperative trade policies could arise from either reducing import tariffs or increasing export subsidies, while we observe GATT members reducing tariffs.[16] One typical way to avoid the problem is to assume away export

[15] The joint objectives are also maximized with trade subsidies in the monopolistic competition model of Bagwell and Staiger (2015). Other trade policy models (e.g. Bagwell and Staiger 1999) allow the possibility that political preferences result in positive cooperative net trade barriers.

[16] See Maggi and Rodridguez-Clare (2005), Beshkar and Lashkaripour (2020), Mrazova (2021) for more focus on this feature of trade policy models and an approach to resolving the issue.

subsidies, but such an approach is not feasible here because we want to study the motivation for the ban on export subsidies. Instead we build on the following lemma which argues that countries will unilaterally choose export subsidies below a certain bound.

Lemma 2 *Consider arbitrary import tariff policies and entry subsidies, and export subsidy choices s and s^* satisfying $\frac{dG}{ds} = \frac{dG^*}{ds^*} = 0$ Then $s \leq \frac{\alpha}{\sigma}$ and $s^* \leq \frac{\alpha}{\sigma}$.*

The $\frac{\alpha}{\sigma}$ is the value to governments of an additional unit of firm output. When subsidies are greater than $\frac{\alpha}{\sigma}$, the increase in subsidy costs cannot possibly be worth the increase in output.[17]

Lemma 2 implies that countries would not choose export subsidies above these bounds unless either they were constrained to do so, or if choosing an export subsidy above $\frac{\alpha}{\sigma}$ allowed them to choose a more desirable import policy or entry subsidy policy against some constraint. We do not consider any such constraints in this paper, so throughout we assume $s \leq \frac{\alpha}{\sigma}$ and $s^* \leq \frac{\alpha}{\sigma}$. The assumption allows us to derive later results without concern for suboptimal subsidy choices.

Ruling out the possibility of high subsidies yields an empirically sensible result on import tariffs.

Lemma 3 *Import tariffs always cause negative cross-border externalities on their trading partners ($\frac{dG^*}{d\tau} < 0$ and $\frac{dG}{d\tau^*} < 0$). If Home and Foreign choose noncooperative import tariffs to maximize their objectives, holding other policies fixed, then the noncooperative import tariffs are higher than the cooperative import tariffs that maximize W.*

A Foreign import tariff raises the equilibrium price of Home exports in the Foreign market, and the higher price leads to lower exports for Home. Provided that export subsidies do not violate the bound suggested by Lemma 2, such that the subsidy is larger than the government's valuation of export profits, then the import tariffs always exert negative cross-border externalities. The persistent negative externalities ensure that countries' unilateral tariff choices are too high.

3.4 Foreign Firm Entry Externalities

All policies create international externalities. We focus here on the externalities of a Foreign entry subsidy policy on Home. We show that Foreign entry improves Home differ-

[17] The increase in total cost of the export subsidies consists of both an increase in the subsidy cost on the inframarginal export volume, and the additional subsidy cost on the marginal export units. The former has a negative effect on the government objective. When the subsidy is greater than $\frac{\alpha}{\sigma}$, the latter more than offsets the value to governments of the marginal unit of output. The export subsidy has no effect on the domestic market. Consequently, countries cannot unilaterally benefit from subsidies greater than $\frac{\alpha}{\sigma}$.

entiated sector consumption but worsens Home domestic and Foreign profits. Foreign entry improves Home's net trade revenue when Home uses import tariffs and export subsidies. The balance of concerns determines the effect of Foreign entry on welfare.

Foreign entry lowers the price indices of the variety-loving consumers everywhere. An elasticity of substitution σ closer to 1 implies a larger effect. We express results as log derivatives: $\frac{\widehat{y}}{\widehat{x}} \equiv \frac{d\ln y}{d\ln x} = \frac{dy}{dx}\frac{x}{y}$, the elasticity of y with respect to x.

$$\text{Consumer surplus effect} \equiv -\frac{\widehat{P}}{\widehat{n_f}} = \frac{(1-S)}{(\sigma-1)} > 0. \tag{16}$$

Here $S \equiv \frac{n_h p c_h}{n_h p c_h + n_f p_f c_f}$, Home's ratio of domestic expenditure on differentiated products to total expenditure on differentiated products. S^* is Foreign's ratio. Since consumer surplus is inversely proportional to the price indices, the increase implies an increase in Home consumer surplus from consuming differentiated products. The Foreign price index increase is $\frac{\widehat{P^*}}{\widehat{n_f}} = \frac{-S^*}{(\sigma-1)} < 0$.

Foreign entry unambiguously lowers Home total and per-firm profits, both domestically and abroad. A larger elasticity of substitution σ implies a larger business-stealing effect.

$$\text{Domestic profit effect} \equiv \frac{\widehat{\alpha(\frac{c_h}{x_h})\Pi_h}}{\widehat{n_f}} = \frac{\widehat{c_h}}{\widehat{n_f}} = \frac{\widehat{P}}{\widehat{n_f}}(\sigma-\varepsilon) = -\frac{(1-S)}{(\sigma-1)}(\sigma-\varepsilon) < 0. \tag{17}$$

$$\text{Export profit effect} \equiv \frac{\widehat{\alpha(1-\frac{c_h}{x_h})\Pi_h}}{\widehat{n_f}} = \frac{\widehat{c_h^*}}{\widehat{n_f}} = \frac{\widehat{P^*}}{\widehat{n_f}}(\sigma-\varepsilon) = -\frac{S^*}{(\sigma-1)}(\sigma-\varepsilon) < 0. \tag{18}$$

When $\tau > 0$ and $s > 0$, Foreign entry increases import tariff revenue and decreases export subsidy costs. Import tariff revenue increases because Foreign entry increases the total Home import volume (even though it decreases the imports per firm). Export subsidy costs decrease because Foreign entry decreases the Home per-firm export volume c_h^*. The export subsidy cost decrease has a positive effect on the Home objective.

$$\text{Import tariff revenue effect} \equiv \frac{\widehat{\tau p n_f c_f}}{\widehat{n_f}} = 1 + \frac{\widehat{c_f}}{\widehat{n_f}} = 1 - \frac{(\sigma-\varepsilon)}{(\sigma-1)}(1-S) > 0. \tag{19}$$

$$\text{Export subsidy cost effect} \equiv \frac{\widehat{-s p n_h c_h^*}}{\widehat{n_f}} = -\frac{\widehat{c_h^*}}{\widehat{n_f}} = \frac{(\sigma-\varepsilon)}{(\sigma-1)}(S^*) > 0. \tag{20}$$

The parts of the Home objective we have yet to consider are the domestic entry subsidy costs and labor income, but Foreign entry has no cross-border effect on these parts.

To summarize, the signs of the various effects of Foreign firm entry on the Home government's objective are:

- Domestic profits decrease $(-)$
- Export profits decrease $(-)$
- Export subsidy costs decrease $(+)$
- Import tariff revenue increases $(+)$
- Consumer surplus increases $(+)$

The balance of the various externalities determines whether Home benefits from Foreign entry. Like the cross-border trade policy effects derived in Lemma 1, the sign of the various firm entry externalities do not depend on the entry subsidies and firm counts, provided that countries are symmetric. The desired international regulation of entry subsidy depends entirely on how parameters and trade policy choices affect the reaction curves for each country. The level of the noncooperative and efficient number of firms is irrelevant for determining the balance of the various externalities. Consequently, we do not need to specify a specific functional form for the firm count cost function $f(n)$ nor do we need to solve for the noncooperative or cooperative choices of n in determining whether subsidy rules are desirable.

4 Evolution of International Subsidy Rules

To establish the desire for subsidy rules, we need to show that there is need for subsidy rules beyond the restrictions on domestic policies that existed in the GATT. Like Bagwell and Staiger (2001a, 2006), this section formally models the Article XXIII nonviolation complaint, which prevents countries from benefiting from subsidies to import-competing industries to undermine import tariff reductions. We first show that when tariffs are close to noncooperative tariff levels, the GATT rules cannot be improved by adding subsidy limits, but we then show that these GATT rules can be improved by adding subsidy limits once import tariffs are close to zero. Three characteristics that motivate subsidy limits are a high government weight on domestic profits, a high substitutability between Home and Foreign goods, and a large share of differentiated goods consumed domestically. The results link the evolution of

subsidy rules to tariff reductions.[18]

The fourth subsection shows that the desirability of subsidy constraints fails to hold when countries reduce net trade barriers by raising export subsidies instead of reducing tariffs. The result is of interest, because Bagwell and Staiger (2015) argue the principle of reciprocity guides nations to such efficient policies. Yet empirically we have not observed reciprocity applied to export subsidies to the same extent as import tariffs, so we can interpret the existence of subsidy rules as a failure of reciprocity applied to export subsidies in imperfectly competitive settings.

Establishing the benefit of subsidy rules here contrasts with the perfectly competitive environment of Bagwell and Staiger (2001a, 2006), but it does not fully model the institution, because the analysis does not initially consider countervailing duties. The fifth subsection considers how countervailing duty laws can be used as a substitute for subsidy limits, and the result contrasts with Bagwell and Staiger (2006), in whose framework countervailing duties have no role. The final subsection argues that subsidy limits can be desirable over countervailing duties in a three-country extension, when countervailing duties are difficult to coordinate.

4.1 GATT Domestic Policy Rules

This subsection formalizes the GATT domestic policy rules and the question of whether further subsidy rules can offer an improvement. We consider whether the GATT approach to international regulation of domestic policies[19] succeeds in eliminating any domestic policy externalities derived in the previous subsection. We would expect the GATT approach to eliminate at least some domestic policy externalities, since the GATT eliminates all domestic cross-border externalities in Bagwell and Staiger (2001a). We generalize their stylized model of the GATT Article XXIII nonviolation complaint. As explained in Section 2.1, such a constraint prevents countries from using domestic policies to undermine the benefits implied by tariff negotiations. The nonviolation complaint enables Home to demand a rebalancing of Foreign's policies if Foreign's domestic policy choices undermine the benefit of tariff reductions to Home. Foreign would have to grant an additional tariff cut to Home in order to abide by Article XXIII.

[18] This paper does not provide a theory explaining why countries progressed from noncooperative import tariffs in the 1940s to more cooperative levels in the 1990s, but there is already a large literature on theories of gradual tariff reductions. See Bagwell and Staiger (2002, p. 106-107) and Bagwell and Staiger (2010) for surveys.

[19] There are also other domestic policy rules in GATT that we abstract from, such as National Treatment, considered by Horn, Maggi, and Staiger (2010).

We use the following definition to model Article XXIII:[20]

Definition 4 *A Foreign policy mix* (τ^*, s^*, e^*) *is* ***market-access preserving*** *relative to baseline policies* $(\bar{\tau}, \bar{s}, \bar{e}, \bar{\tau}^*, \bar{s}^*, \bar{e}^*)$ *if and only if the new Foreign policy mix yields equal or greater Home export volume relative to the baseline policies.*

The definition must be different from Bagwell and Staiger (2001a) because theirs is not well-defined in our framework. When Bagwell and Staiger (2001a) formalize their market access constraint (p. 547), they require that Foreign policies would preserve or increase Home exports at a particular baseline world price. Their definition specifies nothing with respect to Home's policies, because Home's export volume does not depend on Home's policies apart from the world price of Home's exports, whereas in our framework the Home export volume also depends on the Home entry subsidy.[21] Foreign policies satisfying our definition do not erode Home export volume, holding the Home entry subsidy and both world prices fixed, so policies satisfying our definition satisfy their definition augmented by the requirement that the Home entry subsidy is fixed at the baseline level.

Building on our definition of market-access preserving, we have our model of the GATT.

Definition 5 *Define a* ***GATT equilibrium*** *to be a set of policies* $(\hat{\tau}, \hat{s}, \hat{e}, \hat{\tau}^*, \hat{s}^*, \hat{e}^*)$ *such that each country is choosing unilaterally optimal policies subject to the* ***market access constraint*** *defined in the program below. The Home and Foreign constraints that imply a GATT equilibrium are known as a* ***GATT Agreement****. Formally, the Foreign policies satisfy*

$$(\hat{\tau}^*, \hat{s}^*, \hat{e}^*) = \arg \max_{\tau^*, s^*, e^*} \; G^*(\hat{\tau}, \hat{s}, \hat{e}, \tau^*, s^*, e^*)$$

$$\textit{subject to } c_h^*(\hat{\tau}, \hat{s}, \hat{e}, \tau^*, s^*, e^*) \geq c_h^*(\hat{\tau}, \hat{s}, \hat{e}, \hat{\tau}^*, \hat{s}^*, \hat{e}^*)$$

The set of GATT equilibria includes potential outcomes under GATT rules. For a given equilibrium, Foreign cannot reduce Home's exports. One GATT equilibrium is at the fully

[20] The current paper considers market access rules as they have actually been applied under the GATT—as violations to commitments under import tariffs. DeRemer (2013), in contrast, considers the theoretical possibility that market access rules could involve commitments created by export tax negotiations, which have rarely been observed under the GATT. DeRemer (2013) also finds that market access should in general be measured using composite consumption indices rather than trade volumes, but the various market access measures are equivalent in the present context. The composite good for Home exports is $n_h^{\frac{\sigma}{\sigma-1}} c_h^*$. Foreign policy affects Home exports only through changes in c_h^*, so it is immaterial here whether the market access measure is c_h^*, $n_h c_h^*$, or $n_h^{\frac{\sigma}{\sigma-1}} c_h^*$. In a more general model where Foreign policy did influence Home entry, we would want to use $n_h^{\frac{\sigma}{\sigma-1}} c_h^*$ as the market access measure.

[21] The Home import tariff does not matter for Home export volume, and the Home export subsidy does not have any effect on Home export volume apart from the world price.

noncooperative trade policies. Tariff reductions under GATT are a movement between GATT equilibria.

To be consistent with reality, we need to ensure that if countries transition from one GATT equilibrium to a second GATT equilibrium with constraints requiring greater market access, then the second GATT equilibrium will have lower import tariffs then the first. In other words, countries will lower tariffs as part of granting each other greater market access. Countries could conceivably expand market access by reducing the entry subsidy and leaving tariffs fixed. In particular, we want to ensure the existence of a GATT equilibrium with zero import tariffs, because we derive results at a zero-tariff GATT equilibrium in Section 4.3. We require the following lemma:

Lemma 6 *There exists a set B of scale parameters β for the function $k(e)$, such that there exists a GATT equilibrium at zero import tariffs when $\beta \in B$.*

The entry requirement as function of the entry policy is the decreasing function $k(e)$ scaled by a parameter β. A higher β would lead to a higher marginal effect of the entry subsidy on firm entry, and a lower marginal cost curve for entry defined by $f'(n)$. With a sufficiently low marginal cost curve, the government utility from the marginal firm is sufficiently small. With sufficiently low utility from the marginal firm, governments prefer to grant market access by cutting the number of firms rather than by cutting import tariffs. The Lemma then ensures that β is sufficiently small so that the marginal firm is sufficiently valuable, so governments would grant market access by cutting tariffs to zero. For any level of market access above the Nash equilibrium level of market access, we can find a scale parameter such that governments would choose to cut import tariffs to zero when achieving that market access—the smaller the gap from the Nash level of market access, the smaller β we require. We assume throughout that $\beta \in B$, the set of scale parameters such that a zero-tariff GATT equilibrium exists.

Our stylized model of GATT perfectly enforcing Article XXIII is unrealistic, but appropriate for our purposes. As discussed in Section 2.1, the early history of the GATT provides strong support for such a model, in the sense that countries understood that Article XXIII could be used to prevent nations from undermining the market access granted by tariff cuts. Later rounds of negotiations suggest that Article XXIII was not as successful as GATT drafters originally had hoped, and the number of successful Article XXIII complaints was limited. When the Uruguay Round subsidy negotiations began in 1987, among the subsidies that were considered "hardly enforceable" were domestic subsidies to import-competing industries that Article XXIII could have addressed (GATT document W-4). The focus of the

current section, however, is on why limits on subsidies were extended to trade-promoting subsidies not limited by Article XXIII, so we take an ideal version of Article XXIII as given.

With our definition of a GATT agreement, we can consider formally whether an agreement would benefit from further subsidy restrictions.

Definition 7 *Subsidy limits $e \leq \tilde{e}$ and $e^* \leq \tilde{e}^*$ or $s \leq \tilde{s}$ and $s^* \leq \tilde{s}^*$* ***improve*** *a GATT equilibrium if Nash equilibrium government choices subject to both the market access constraints and subsidy limits yield a superior joint government outcome relative to Nash equilibrium choices subject only to the market access constraints.*

This definition only considers two possible forms of agreements, market access constraints and subsidy limits. Market access constraints alone can ensure efficiency in the two-good perfectly competitive framework of Bagwell and Staiger (2001a), who consider a generic domestic policy whose only cross-border effects travel through world prices. Subsidy limits would never improve an agreement in such an environment.[22]

We next consider whether the GATT eliminates all domestic policy externalities. Consider a GATT equilibrium. The GATT market access constraint binds, because otherwise it would not prevent countries from choosing unilateral import tariffs. Subsidy limits improve the GATT equilibrium if there exists a combination of entry subsidy decreases and tariff increases along the market access constraint such that both countries are better off. Formally, such a combination exists when $\frac{dG}{dn_f}|_{dc_h^*=0} < 0$, such that an increase in Foreign firms (dn_f) combined with a Foreign tariff decrease keeps Home exports constant ($dc_h^* = 0$).[23] Foreign's constrained maximization implies $\frac{dG^*}{dn_f}|_{dc_h^*=0} = 0$, so the change in the joint objective is $\frac{dW}{dn_f}|_{dc_h^*=0} < 0$.

In Section 3.4, we defined five cross-border externalities from Foreign firm entry. Two of these first-order effects—on Home exports and export subsidy costs—are zeroed out by the tariff change required by the to preserve Home exports in line with our model of GATT rules. Three other cross-border effects of Foreign firm entry remain:

- Domestic profits ($-$)
- Consumer surplus ($+$)

[22] The limits on contract type in the current paper differ from a literature that focuses on the efficient points that governments achieve when they act as if they do not value their ability to manipulate their terms of trade. Bagwell and Staiger (2015) determine an efficient point in a monopolistically competitive framework that involves high export subsidies and noncooperative import tariffs. Such a point is an infeasible outcome in the current paper's contracting environment, because countries would unilaterally deviate by cutting their export subsidies. Contracting over a minimum export subsidy level would allow the point to be maintained, but as DeRemer (2013) emphasizes, no such contracts have existed in the GATT/WTO.

[23] The Foreign tariff decrease that keeps Home exports constant is $-d\tau \frac{dc_h^*/d\tau}{dc_h^*/dn_f}$.

- Import tariff revenue (+)

Which of the three effects above dominate depends on the parameters and trade policies in later sections. The complexity here contrasts with Bagwell and Staiger (2001a), where all three effects are a function of the terms-of-trade, and countries prefer terms-of-trade gains by assumption.

To interpret the result, notice that the Foreign entry subsidy promotes both exports and import competition, the former trade-promoting and the latter trade-reducing. The GATT market access constraint eliminates the trade-reducing and import-competing effects of the subsidy and leaves only the trade-promoting effects. The remaining externalities are similar to the externalities of export subsidies.

Throughout this section, we will make heavy use of the following lemma:

Lemma 8 *Consider a set a constraints on Foreign defined by the vector-valued function* $X(s^*, \tau^*, n_f) = 0$*, and a matching set of constraints on Home. Adding entry subsidy limits to the set of constraints improves a GATT equilibrium subject to the set of constraints* $X = 0$ *if and only if* $\frac{dG}{dn_f}|_{dX=0} < 0$ *(where* $dX = 0$ *implies that differential changes in policy must leave* X *unchanged). Adding export subsidy limits improves the GATT equilibrium if and only if* $\frac{dG}{ds^*}|_{dX=0} < 0$*.*

To apply Lemma 8 to the GATT equilibrium with a market access constraint, we need to argue that the market access constraint binds. When market access is bound below the Nash level, then the market access constraint binds, because Home wants to raise its tariff ($\frac{dG}{d\tau} > 0$ as shown in the proof of Lemma 3). At the Nash equilibrium, the market access constraint binds by definition.

Applying Lemma 8, subsidy limits improve a GATT equilibrium subject to the market access constraint, if the sum of the domestic profit effect, the import tariff revenue effect, and the consumer surplus effect is negative.

4.2 No Subsidy Limits at Higher Tariffs

This subsection establishes that when countries choose noncooperative tariffs, subsidy limits cannot improve a GATT equilibrium. At noncooperative tariffs, in contrast to the zero-tariff case, countries must benefit from a price index decrease. Since Foreign firm entry decreases the price index and increases import tariff revenue, countries always benefit from Foreign subsidies. The theory then provides a link between the import tariff reductions

of the 1950s and 1960s under the GATT and the addition of subsidy limits on domestic export-promoting subsidies under the WTO.[24]

The noncooperative equilibrium import tariff condition $\frac{dG}{d\tau} = 0$ can be written as

$$G_P(\tau^N) = -D,$$

where G_P is the partial derivative of the Home government objective with respect to the Home price index, and the objective is defined as a function of the price index in equation (15).

This restatement of the noncooperative tariff condition reflects the tradeoff countries face when raising the import tariff. The tariff increase causes the price index to rise to the detriment of Home, and it also leads to a gain in Home's import tariff revenue on the inframarginal imports. For the noncooperative import tariff condition to hold, $G_P(\tau^N) < 0$ must hold. In contrast, when we derived parameter conditions under which countries desired subsidy rules in the previous subsection, we required the equivalent of $G_P(0) > 0$, so Home government actually prefers a price index increase. At the noncooperative import tariff, the net Foreign firm entry externality can be written as:

$$\frac{dG}{dn_f}\Big|_{\substack{dc_h^*=0 \\ \tau=\tau^*=\tau^N}} = G_P(\tau^N)\frac{dP}{dn_f} + \tau^N pc_f, \text{ and} \tag{21}$$

Since $G_P(\tau^N) < 0$ and $\tau^N pc_f, > 0$ at the Nash import tariffs, and $\frac{dP}{dn_f} < 0$ always, we must have $\frac{dG}{dn_f}\Big|_{\substack{dc_h^*=0 \\ \tau=\tau^*=\tau^N}} > 0$. An increase in Foreign firm entry can be decomposed into two effects: a decrease in the price index and an increase in import tariff revenue. At the noncooperative import tariffs, import tariffs are positive and the Home government prefers a marginal decrease in the price index, so the externality of Foreign firm entry is positive. The positive sign of the Foreign firm entry at noncooperative tariffs implies, by Lemma 8, the following proposition:

Proposition 1 *The GATT equilibrium at noncooperative tariffs cannot be improved by subsidy limits on domestic policies.*

The results here are similar to prior work on subsidy agreements at noncooperative tariffs. The Bagwell and Staiger (2006) study of subsidy rules uses a two-good perfectly competitive economy. In such an environment, Bagwell and Staiger (1999) have shown that a country sets the relative local price of its import good to its export good to be higher than it

[24]The relevance of the result does not rest on the claim that the GATT actually represented a fall from noncooperative tariffs all the way to zero import tariffs, since the respective results for zero and noncooperative import tariffs each hold for some neighborhood around the respective tariff choices.

would otherwise prefer, because the import tariff improves its terms-of-trade. With standard preferences, this terms-of-trade improvement is reflected in higher tariff revenue on the infra-marginal import volume, as in this section. When Foreign then imposes an export subsidy at the Nash equilibrium, Home benefits from both the decrease in price of the imported good, and the improvement in its terms of trade. A similar case occurs under monopolistic competition in Bagwell and Staiger (2015). In their analysis, import tariffs have no effect on the world price of an individual variety, and at Nash import tariffs, countries do not value any change in their local price. When Foreign imposes an export subsidy, there is no effect on Home welfare through the change in local price, but Home still benefits from the terms-of-trade gain. The Foreign entry subsidy effects in this paper are mechanically different from prior work, because the Foreign entry subsidy has no effect on prices of individual varieties, but as shown in DeRemer (2013), the effect is correctly interpreted as a terms-of-trade gain for Home because the world price index of Foreign exports falls. The result is similar to prior work in that the Nash tariff condition pins down the partial effect of local prices on the government objective, and the local price effect implies that countries benefit from a Foreign subsidy.

4.3 Subsidy Limits at Zero Tariffs

This subsection first establishes the possibility that subsidy limits could improve a GATT equilibrium in the simplest case when import tariffs are zero. We then establish a more general set of parameters such that subsidy limits improve the GATT equilibrium.

Consider a GATT equilibrium such that the resulting policies are zero import tariffs $\hat{\tau} = \hat{\tau}^* = 0$. Such an agreement exists (Lemma 6). If a unilateral increase in entry subsidies and decrease in import tariffs, holding the trading partner's export volume fixed, still results in a negative net cross-border externality, then constraining subsidies would improve the GATT equilibrium. The negative net cross-border externality results if the negative effect on domestic profits outweighs the positive effect on consumers (Lemma 8), given that there is no tariff revenue. We evaluate the externality on Home for the Foreign policy change:

$$\frac{dG}{dn_f}\Big|_{\substack{dc_h^*=0 \\ \tau=\tau^*=0}} = \left(\overbrace{-PD\frac{\widehat{P}}{\widehat{n_f}}}^{\text{Consumer Surplus Effect}} + \overbrace{\alpha\left(\frac{p}{\sigma}\right) n_h c_h \frac{\widehat{c_h}}{\widehat{n_f}}}^{\text{Domestic Profit Effect}} \right) \frac{1}{n_f}. \tag{22}$$

Using our results from Section 3.4, we have

$$\begin{aligned}
\frac{dG}{dn_f}|_{\substack{dc_h^*=0 \\ \tau=\tau^*=0}} &= \left(-PD\frac{\widehat{P}}{\widehat{n_f}} + \alpha\left(\frac{p}{\sigma}\right)n_h c_h \frac{\widehat{P}}{\widehat{n_f}}(\sigma-\varepsilon)\right)\frac{1}{n_f} \qquad (23)\\
&= \left(PD - \alpha\left(\frac{p}{\sigma}\right)n_h c_h(\sigma-\varepsilon)\right)\left(-\frac{\widehat{P}}{\widehat{n_f}}\right)\frac{1}{n_f}\\
&= \left[1-\alpha S(1-\frac{\varepsilon}{\sigma})\right]\left(\frac{(1-S)}{(\sigma-1)}\right)\frac{PD}{n_f}.
\end{aligned}$$

The sign of $\frac{dG}{dn_f}|_{dc_h^*=0}$ is the same as the bracketed expression. Foreign entry decreases the Home price index. The price index change leads to an increase in consumer surplus (with unit elasticity) and fall in domestic profits (with elasticity $(\sigma-\varepsilon)$). For a government maximizing national income with $\alpha = 1$, the Home price index decrease from Foreign Home entry is always desirable. If government weighs domestic profits heavily (high α), the price index decrease is undesirable:

$$\alpha > \frac{1}{S}\left(\frac{1}{1-\frac{\varepsilon}{\sigma}}\right) \Longrightarrow \frac{dG}{dn_f}|_{\substack{dc_h^*=0 \\ \tau=\tau^*=0}} < 0. \qquad (24)$$

Though S is endogenous, for symmetric policies and zero tariffs the market share depends only on parameters: $S = \frac{c_h}{c_h+(1+\phi)c_f} = \frac{1}{1+(1+\phi)^{1-\sigma}}$. We then have an expression for the existence of trade rules in terms of parameters. The first proposition then follows from (24) and Lemma 8:

Proposition 2 *For $\alpha > \frac{1+(1+\phi)^{1-\sigma}}{1-\frac{\varepsilon}{\sigma}}$ there exists a GATT equilibrium at sufficiently low import tariffs that can be improved by limits on domestic entry subsidies.*

The theory implies three considerations that can motivate a GATT equilibrium limiting entry subsidies:

1. high political economy weight on profits (high α), which raises subsidies' cross-border externality on profits,

2. high domestic share of consumption (high S and high ϕ), which increases the relative importance of domestic profits compared to consumer surplus, and

3. high substitutability between differentiated goods relative to the outside good (low $\frac{\varepsilon}{\sigma}$), which increases the effects of competition from foreign entrants.

The proposition implies subsidy limits can improve a GATT equilibrium given reasonable parameter values. If $\frac{\varepsilon}{\sigma} = \frac{1}{3}$, the ratio of elasticities of substitution between the highest and lowest categories of goods in Table IV of Broda and Weinstein (2006), and the share of differentiated consumption is 75%, then we require $\alpha > 2$, which implies governments give more weight to lobbying contributions than national welfare.

Notice there must be a political economy weight greater than 1 for there to be a negative externality from the entry subsidy.[25] The domestic share of consumption (S) and the relative substitutability of the differentiated products versus the outside good ($1-\frac{\varepsilon}{\sigma}$) both scale down the loss to producers from increased foreign competition, relative to the benefit to consumers of increased foreign variety.

On another empirical matter, observe that if countries were to simply add subsidy limits to an existing agreement, we would expect both a fall in subsidies and a rise in import tariffs to preserve the prevailing market access levels. In practice, advances in subsidy rules in the Tokyo (1973-79) and Uruguay (1986-94) Rounds of trade negotiations occurred concurrently with substantial progress in nations' commitments to provide market access. For this reason, we do not actually observe a rise in import tariffs as a consequence of subsidy rules.

4.4 Extending Results to Export Subsidies

This subsection extends the results of the previous two subsections on entry-promoting subsidies to export subsidies affecting marginal cost of production. We desire such an extension to explain why there was a consensus to limit both domestic subsidies and export subsidies in the WTO.

The effect of a Foreign export subsidy increase on Home can be written as

$$\frac{dG}{ds^*} = \left(\overbrace{PD\frac{\widehat{P}}{\widehat{p_f}}}^{\text{Consumer Surplus Effect}} - \overbrace{\alpha\left(\frac{p}{\sigma}\right) n_h c_h \frac{\widehat{c_h}}{\widehat{p_f}}}^{\text{Domestic Profit Effect}} - \overbrace{\tau p n_f c_f \left(\frac{\widehat{c_f}}{\widehat{p_f}}\right)}^{\text{Import Tariff Revenue Effect}} \right) \frac{1}{1+\phi+\tau+s^*}. \tag{25}$$

We do not require notation to indicate the effects of a GATT equilibrium because the GATT equilibrium does not constrain export subsidies. Because $\frac{dG}{ds} = 0$ at the GATT equilibrium, $\frac{dG}{ds^*} = \frac{dW}{ds^*}$, so it is sufficient to show that $\frac{dG}{ds^*} < 0$ to establish that export subsidies are inefficiently high and countries would benefit from export subsidy limits.

[25] Absent a political motive for governments to weight capital rents above wages, positive local production externalities could also lead to negative cross-border externalities from foreign entry. But such a possibility is outside the scope of this paper.

The condition for the domestic profit effect to dominate the consumer surplus here is equivalent to the condition for domestic entry subsidies at zero tariffs in Section 4.3. The conditions are equivalent because of the close relationship between Foreign price effects and Foreign firm entry effects: $(1-\sigma)\frac{\widehat{P}}{\widehat{n_f}} = \frac{\widehat{P}}{\widehat{p_f}}$ and $\frac{\widehat{c_h}}{\widehat{n_f}} = (1-\sigma)\frac{\widehat{c_h}}{\widehat{p_f}}$. Consequently, the motive for subsidy limits at zero tariffs holds for either kind of trade-promoting subsidy.

At Nash import tariffs, the import tariff revenue effect precisely offsets the domestic profit effect, and all that remains is the consumer surplus benefit for the falling Foreign price. The result that $\frac{dG}{ds^*}_{\tau=\tau^*=\tau^N} > 0$ at noncooperative import tariffs implies that international inefficiency results from too little subsidization at the noncooperative import tariffs:

$$\frac{dG}{ds^*}_{\tau=\tau^*=\tau^N} = \left(PD\frac{\widehat{P}}{\widehat{p_f}}\right)\frac{1}{1+\phi+\tau+s^*} > 0. \tag{26}$$

By Lemma 8, we can state the following:

Proposition 3 *Propositions 2 and 1 extend to export subsidies.*

Proposition 3 completes our explanation for why the rationale for subsidy limits and their evolution applies to both domestic entry subsidies and export subsidies.

4.5 The Failure of Reciprocity in Setting Export Subsidies

The paper so far has emphasized how import tariff reductions improve welfare but also lead to subsidy restriction motives. Such a policy path is consistent with empirical reality—GATT nations first bound import tariffs, then sought to constrain subsidies. Are there alternative paths of policy that could lead to different policy constraints?

We can easily show that if countries were to reduce net trade barriers by expanding export subsidies, then this policy path also can lead to net trade barriers that satisfy the trade policy efficiency conditions. Suppose countries choose export subsidies $\frac{\alpha}{\sigma}$ and choose import tariffs noncooperatively. At this level of export subsidies, countries are indifferent to changes in trade output, since the politically-weighted profit balances out the subsidy costs. Countries are choosing export subsidies as if they ignored the resulting terms-of-trade loss. We can see from the comparative static conditions in Appendix A.1.1, that (1) Foreign import tariffs have no effect on Home welfare, and (2) Foreign export subsidies shift rents in zero-sum fashion.[26] The two results imply that the border measures satisfies the trade

[26] The effect of the Foreign export subsidy on Home is $\frac{dG}{ds} = \frac{-p_h^* n_h c_h^*}{(1+\phi+\tau^*-s)}$. The effect of the Foreign export subsidy on Foreign, provided the noncooperative import tariff condition is satisfied, is $\frac{dG^*}{ds^*} = \frac{p_h^* n_h c_h^*}{(1+\phi+\tau-s^*)}$.

policy efficiency conditions. Yet since import tariffs are at noncooperative levels, applying Proposition 1 we still have no motive for subsidy constraints.

In establishing the undesirability of subsidy constraints when governments ignore the terms-of-trade effects of their policy choices, the current paper is consistent with the results of Bagwell and Staiger (2015). They show that the GATT principle of reciprocity guides countries toward the policies countries would choose when they act as if they do not value their terms of trade. The policy path assumed in the previous section—which involves reductions in import tariffs and no increases in export subsidies—is then a departure from the GATT principle of reciprocity. Empirically, the departure from the principle is transparent: for the principle to work in this setting, countries must raise export subsidies reciprocally to be consistent with the principle. In reality, we observe the policy being applied to import tariff reductions.[27] We can then interpret the WTO subsidy rules as the consequence of a departure from the principle of reciprocity in an imperfectly competitive setting.

4.6 Countervailing Duties

The previous subsections have considered how countries can improve upon GATT rules by bounding subsidies at cooperative levels. An alternative way to ensure efficient subsidies is by permitting a countervailing duty response to a subsidy. We show that if countries impose duties such that they eliminate the negative policy externalities of the subsidies, then the duties can ensure efficient subsidy choices. If α satisfies the conditions laid out in Proposition 2 so there is a problem with subsidies being too high in the absence of more rules, then countries can achieve efficient policies using countervailing duties instead of subsidy limits at the zero-tariff equilibrium. The evolution story described in the previous subsection still holds: since countries are already choosing their best response import tariffs when import tariffs chosen noncooperatively, countries obviously cannot achieve greater cooperation with countervailing duties.

To model these issues we introduce the following extension of our prior definition of the GATT equilibrium:

Definition 9 *Define a* ***GATT equilibrium with countervailing duties*** *to be a set of policies* $(\hat{\tau},\hat{s},\hat{e},\hat{\tau}^*,\hat{s}^*,\hat{e}^*)$ *such that each country is choosing unilaterally optimal policies subject to the market access constraint defined in the program below, and such that any subsidy that undermines a trading partner's domestic sales is mechanically met with an import tariff*

[27] In all work discussing the history of reciprocity in the GATT, such as Bagwell and Staiger (1999, 2002), there is no mention of reciprocity applied to export subsidy increases.

($\bar{\tau}$ for Home) that restores domestic sales volume to the baseline level. The Home and Foreign constraints that imply a GATT equilibrium are known as a ***GATT agreement with countervailing duties****. Formally, the Foreign policies satisfy*

$$(\hat{\tau}^*, \hat{s}^*, \hat{e}^*) = \arg \max_{\tau^*, s^*, e^*} \; G^*(\bar{\tau}, \hat{s}, \hat{e}, \tau^*, s^*, e^*)$$

$$\begin{aligned} \textit{subject to } c_h^*(\hat{\tau}, \hat{s}, \hat{e}, \tau^*, s^*, e^*) &\geq c_h^*(\hat{\tau}, \hat{s}, \hat{e}, \hat{\tau}^*, \hat{s}^*, \hat{e}^*) \\ \textit{and } c_h(\bar{\tau}, \hat{s}, \hat{e}, \tau^*, s^*, e^*) &= c_h(\hat{\tau}, \hat{s}, \hat{e}, \hat{\tau}^*, \hat{s}^*, \hat{e}^*) \end{aligned}$$

A set of policies is a GATT equilibrium with countervailing duties if countries would not deviate from a baseline level of subsidization given the following two constraints. First, any subsidy is met with a countervailing duty response from the trading partner that preserves the trading partner's domestic sales. Second, as in the earlier GATT equilibrium definition, imposing a domestic subsidy requires an import tariff reduction that preserves the trading partner's export volume.

The maximum level of countervailing duty implied by the definition is consistent with practice under the WTO. For an export subsidy, the countervailing duty ($\bar{\tau} - \hat{\tau}$, the tariff in excess of the baseline rate) that satisfies the second constraint above equals the amount of export subsidy beyond the baseline subsidy ($s^* - \hat{s}^*$), where the baseline export subsidy could be zero. The laws for a countervailing duty of an entry subsidy are less straightforward. But as Grossman and Mavroidis (2003) detail, one interpretation is that the countervailing duty should undo the effect of the undesirable subsidy, and such a requirement is met here.

We introduce the following formalism that parallels Section 4.1:

Definition 10 *Subsidy limits $e \leq \tilde{e}$ and $e^* \leq \tilde{e}^*$ or $s \leq \tilde{s}$ and $s^* \leq \tilde{s}^*$* ***improve*** *a GATT equilibrium with countervailing duties if Nash equilibrium government choices subject to both the market access constraints, the countervailing duties, and the subsidy limits yield a superior joint government outcome relative to Nash equilibrium choices subject only to the market access constraints and countervailing duties.*

We prove that the zero-tariff GATT equilibrium (which exists by Lemma 6) with countervailing duties cannot be improved by subsidy limits. Recall from Section 4.2 that the first-order effect of Foreign firm entry on Home welfare subject to the market access constraint is

$$\frac{dG}{dn_f}|_{dc_h^*=0} = G_P(\tau)\frac{dP}{dn_f} + \tau p c_f. \tag{27}$$

Because a countervailing duty that preserves Home domestic sales also preserves the Home price index, the $G_P \frac{dP}{dn_f}$ term above is eliminated by the combination of a differential entry subsidy increase and countervailing duty. It follows that $\frac{dG}{dn_f}|_{\substack{dc_h^*=0 \\ dP=0}} = 0$ for $\tau = 0$ and $\frac{dG}{dn_f}|_{\substack{dc_h^*=0 \\ dP=0}} > 0$ for $\tau > 0$. We can then decompose any discrete increase in Foreign entry into an integral over such differential increases in the subsidies, and conclude that the discrete increase in Foreign entry must have a nonnegative effect on Home government welfare. We then have the following proposition by Lemma 8:

Proposition 4 *A GATT equilibrium with countervailing duties at non-negative import tariffs cannot be improved by subsidy limits.*

The success of countervailing duties in theory then begs the question of why countries would ever have subsidy limits in addition to countervailing duties. The next subsection presents one explanation: the potential for subsidies to create problems for countries competing in third markets.

4.7 Third Country Competition

As we discussed in Section 2.2, a reason why countries would favor using subsidy limits over countervailing duties is competition in third countries. The case for using subsidy limits in a three-country scenario in this model depends on the difficulty of countries coordinating countervailing duty action. The baseline model can easily be extended to a third symmetric country. Here we consider a scenario where Home can impose a countervailing duty on Foreign's entry subsidy, but the third country exogenously does not impose a countervailing duty on Foreign. We denote the third country's production with subscript g and also use the superscript g to denote final destination and government choices of the third country. We already discussed in the previous subsection how at zero tariffs, there is no first-order effect of Foreign subsidization on Home, without considering the third country effects. The only effect of the Foreign subsidy on Home via the third country is through the change in the third country's price index, which affects Home's export volume and Home's export subsidy cost:

$$\begin{aligned} \frac{dG}{dn_f}|_{\substack{dc_h^*=0 \\ dc_h^g=0 \\ dP=0 \\ \tau=\tau^*=\tau^g=0}} &= G_{P^g} \frac{dP^g}{dn_f} \\ \text{where } G_{P^g} &\equiv (\frac{\alpha}{\sigma} - s) n_h \frac{dc_h^g}{dP^g}. \end{aligned}$$

We know $\frac{dc_h^g}{dP^g} > 0$ because an increase in the third-country price index is a decrease in Foreign competition and improved exports, and by Lemma 2, and we know that $s < \frac{\alpha}{\sigma}$, because countries will never subsidize exports so much that they would prefer a decrease in export volume. Consequently, $G_{P^g} > 0$, so countries benefit from an increase in the Foreign price index. Since Foreign firm entry decreases the third country's price index, we have $\frac{dP^g}{dn_f} < 0$. Intuitively, the Home government is worse off in the third market because the increased Foreign competition has an adverse effect on its exports.

The effect of Foreign entry on the third country is equal to the effect of Foreign entry on Home derived in Equation (23). The third country suffers from the entry subsidy and does not impose the countervailing duty. There is no effect on the third country's exports to Home because Home's countervailing duty preserves Home's price index.

The Lemma 8 result, that a negative externality implies countries benefit from subsidy rules, can easily be extended from two countries to the three-country setting. We have shown that both Home and the third country suffer a negative effect from Foreign firm entry. Subject to the market access and countervailing duty constraints, Foreign sets its policy so there is no first-order effect of a change in entry subsidy. By setting a subsidy limit below the Foreign level absent any such limit, Home and the third country gain a first-order benefit and the world objective improves. We then have the following proposition:

Proposition 5 *In a three-country economy, a GATT equilibrium with Home countervailing duties at zero import tariffs can be improved by subsidy limits.*

We also need to verify that by including a third country, we have not overturned our previous result that subsidy rules are undesirable at the Nash policy choices. In Appendix A.3, we derive the external effect of Foreign entry on Home in Foreign's market absent the possibility of the nonviolation complaint. This effect equals the external effect of Foreign entry on Home in the third market, where the nonviolation complaint is unavailable, so the proposition below follows:

Proposition 6 *In the three-country economy, Home's welfare cannot be improved from the Nash equilibrium by subsidy limits if* $\alpha < \frac{\varepsilon}{1-\frac{\varepsilon}{\sigma}} \frac{1}{S^N}$.

Notice this upper bound of α in Proposition 6 is greater than the lower bound of α in Proposition 2 that ensured countries desire subsidy limits (because $\varepsilon > 1$), so there does exist an interval of α such that countries would seek subsidy rules at zero import tariff levels but not at noncooperative import tariff levels. Using the parameter values from Section 4.3, the α upper bound is 8, far larger than any estimated α in the empirical literature, so the theory

is still consistent with the stylized fact that there are no subsidy rules at noncooperative tariffs.

Why are there some high α values for which Home would desire subsidy agreements at noncooperative policy in the three-country case but not in the two-country case? When Foreign subsidizes in the two-country case, the nonviolation complaint protects Home from losing any exports to Foreign, and Home has set import tariffs sufficiently high so that Home benefits from the price index decrease. In the three-country case, Home is also adversely affected by the Foreign subsidy decreasing the third country's price index. Strong political economy motives (high α) could in theory lead this third-country effect to dominate, leading to motives for subsidy limits even at noncooperative policy.

5 The Perfect Competition Model

5.1 Theory

This subsection follows Bagwell and Staiger (2001b, 2016) and DeRemer (2022). We maintain consistent notation except for some minor modification to ensure consistency with the rest of the current paper. There is an economy with goods x and y, such that Home imports x and exports y, and there is a freely traded outside numeraire good that enters into welfare quasilinearly. The political economy objectives for Home and Foreign (* superscript) are

$$\begin{aligned} W(p_x, p_y^*, p_x^w, p_y^w) &= \int_{p_x}^{\bar{p}} D(p_x^1)dp_x^1 + \gamma_M \Pi_x(p_x) + (p_x - p_x^w)M_x(p_x) \\ &\quad + \int_{p_y(p_y^*)}^{\bar{p}} D(p_y^1)dp_y^1 + \gamma_E \Pi_y(p_y(p_y^*)) - (p_y(p_y^*) - p_y^w)M_y(p_y^*), \text{ and} \\ W^*(p_x, p_y^*, p_x^w, p_y^w) &= \int_{p_x^*(p_x)}^{\bar{p}} D(p_x^1)dp_x^1 + \gamma_E^* \Pi_x^*(p_x^*(p_x)) - (p_x^*(p_x) - p_x^w)M_x(p_x) \\ &\quad + \int_{p_y^*}^{\bar{p}} D(p_y^1)dp_y^1 + \gamma_M^* \Pi_y^*(p_y^*) + (p_y^* - p_y^w)M_y(p_y^*), \end{aligned} \tag{28}$$

such that D is demand (a decreasing function), Π_x and Π_y are profits, and M_x and M_y are import demand functions. The objective includes standard political economy weights γ_M, γ_E, γ_M^*, and γ_E^* which are all greater than one. In our earlier vector notation, $M = \{-M_x, M_y, Z\}$ where Z is Home imports of the outside good, $p^l = p^{l*} = \{p_x, p_y^*, 1\}$, and $p^w = \{p_x^w, p_y^w, 1\}$, and the balanced trade condition is still $Mp^w = 0$.

For policy, Home chooses import tariff τ_x and Foreign chooses import tariff τ_y^*, and these tariffs are chosen to be nonprohibitive. We exclude export policies. There are increasing supply functions $Q_x(p) = Q_y^*(p) < Q_y(p) = Q_x^*(p)$. Under profit maximization, $\frac{d\Pi_x}{dp_x} = Q_x(p)$, and similar derivatives hold for the other profit functions. To close the model we require the no-arbitrage conditions and market clearing conditions such that

$$\begin{aligned} p_x - \tau_x &= p_x^* = p_x^w, \\ p_y^* - \tau_y^* &= p_y = p_y^w, \text{ and} \\ Q_i(p_i) + Q_i^*(p_i^*) &= D(p_i) + D(p_i^*) \text{ for } i = x, y. \end{aligned} \tag{29}$$

Notice that under these conditions, specifying either of the prices or the tariff (e.g. p_x, p_x^*, p_x^w, or τ_x) fully determines the other variables for that good. Thus we can define W as a function of $p_y(p_y^*)$ instead of p_y, and W^* as a function of $p_x^*(p_x)$ instead of p_x^*.

We verify that the model allows the application of general results from DeRemer (2022). The equations (29) ensure that higher import tariffs imply higher local prices in the import market and lower prices in the export and world markets, thus ruling out Metzler and Lerner paradoxes as required. And M_x and M_y are both decreasing in the local price of imports (since a higher price decreases demand D_i and increases supply Q_i for $i = x, y$). Import tariffs must improve the terms of trade for the nation imposing them. The terms of trade effects have the correct sign, since $\frac{dW}{dT} = 1$ and $\frac{dW^*}{dT^*} = -1$ in the quasilinear setting. Without the export policies, there is a local price externality, because Home lacks an instrument to affect p_y^* and Foreign lacks an instrument to affect p_x. We can verify

$$\frac{dW}{dp_y^*} = \frac{dp_y}{dp_y^*}(\gamma_E - 1)Q < 0, \tag{30}$$

because $\gamma_E > 1$ and

$$\frac{dp_y}{dp_y^*} = \frac{M_y'}{Q_y' - D_y'} = \frac{p_y^* \mu_y}{p_y \xi_y} < 0,$$

for import demand elasticity μ_y and export supply elasticity ξ_y. So a Foreign tariff decrease allows Home to benefit not only via a terms-of-trade gain, but also via a lower p_y^* and higher p_y, since there are higher weighted profits for Home's exporters of y. Home benefits even though there are higher consumer prices. Notice that this externality could be defined either as local price externality abroad, or (as in Bagwell and Staiger, 2016) as a domestic local price externality. The local price externality here amplifies the terms-of-trade externality, so

$\frac{dW}{d\tau_y} < 0$. Similarly for Foreign, $\frac{dW^*}{dp_x} < 0$ and $\frac{dW}{d\tau_x} < 0$. Thus, this model fits into the general framework of Section **??**.

Now we can interpret the model through the results of our previous sections. In this setting, there are only two independent local prices to target and two policies to be determined by the agreement. Thus, any more instruments such as export policies do not provide any more gains in efficiency. Because nations have both import and export policies, the unique stable and efficient policy is the political optimum. The efficiency of the political optimum here is consistent with what Bagwell and Staiger (2001b, 2016) have already shown.

For reciprocity like in DeRemer (2022), we have

$$\frac{d\tau_y^*}{d\tau_x} = \frac{\frac{dM_x}{dp_x}\frac{dp_x}{d\tau_x}p_x^w}{\frac{dM_y}{dp_y^*}\frac{dp_y^*}{d\tau_y^*}p_y^w} = \frac{M_x\frac{dp_x^w}{d\tau_x}}{M_y\frac{dp_x^w}{d\tau_y^*}} > 0 \tag{31}$$

for reciprocal tariff decreases. The stable efficient point then consists of the policies $(\hat{\tau}_x, \hat{\tau}_y^*)$ satisfying the following

$$\begin{aligned} \frac{dW}{dp_x}\frac{dp_x}{d\tau_x} + \frac{dW}{dp_y^*}\frac{dp_y^*}{d\tau_y^*}\frac{d\tau_y^*}{d\tau_x} &= 0, \text{ and} \\ \frac{dW^*}{dp_y^*}\frac{dp_y^*}{d\tau_y^*}\frac{d\tau_y^*}{d\tau_x} + \frac{dW^*}{dp_x}\frac{dp_x}{d\tau_y^*} &= 0. \end{aligned} \tag{32}$$

These policies are efficient and they obtain the same efficiency frontier as the model with both import and export policies. We have $\frac{dW}{dp_x} > 0$ and $\frac{dW^*}{dp_y^*} > 0$. We summarize the results as follows.

Remark 11 *For the perfect-competition, partial-equilibrium trade model, there are efficient policies (defined over the space of both import and export policies) such that the policies are stable with respect to reciprocal negotiations over only import policies. At these policies, both nations desire an increase in the price in their import-competing sector.*

For stability under reciprocity to be achieved, the net political gains for the export industry must be offset by domestic losses, such that Home and Foreign are each losing domestically by cutting their tariffs further. Notice then that

$$\frac{dW}{dp_x} = (\gamma_M - 1)Q + \tau_x M_x'. \tag{33}$$

Meanwhile, the Nash tariff is such that

$$\frac{dW}{dp_x}\frac{dp_x}{d\tau_x} = \frac{dp_x^w}{d\tau_x}M, \tag{34}$$

and since $\frac{dp_x}{d\tau_x} > 0 > \frac{dp_x^w}{d\tau_x}$, the tariff is set sufficiently high so that $\frac{dW}{dp_x} < 0$, because Home pursues terms-of-trade gains. If nations had import and export policies, we would instead have $\frac{dW}{dp_x} = 0$ so $\tau_x = \frac{(\gamma_M - 1)Q}{-M_x'} > 0$ for $\gamma_M > 1$, and this is the usual Bagwell and Staiger political optimum. In the current model with only import tariffs, we instead have the tariff τ_x set so low that $\frac{dW}{dp_x} > 0$, and τ_x is less than the politically optimal level.

To interpret the stable equilibrium where $\frac{dW}{dp_x} > 0$, notice that the negotiation is balancing the political economy gains for the import-competing industry, the export industry, and the consumers. At the equilibrium, the political-weighted losses to the import-competing industry from lower prices and the loss in tariff revenue must be outweighing the gains to consumers from lower prices.

Importantly, the result is consistent with the WTO prohibition of export subsidies. As Sykes (2005) details, the GATT/WTO in practice started to limit export subsidies for a subset of members in 1962 and then all members in 1995, minus a few phased-out exceptions for developing countries. What do the full instrument and limited instrument model imply about this? In the full instrument version, the export subsidy at the political optimum implies a terms-of-trade loss, so nations would ban export taxes rather than export subsidies, and this is a fairly typical result of this literature.[28] In the limited instrument version we can conclude the following:

Remark 12 *For the perfect-competition, partial-equilibrium trade model, there is a sufficiently large import parameter γ_M or sufficiently large export parameter γ_E such that nations prefer limits on export subsidies at the stable outcome with only import tariffs.*

To confirm this, notice that the externalities of a Foreign export subsidy s_x^* would be

$$\frac{dW}{ds_x^*} = \frac{dW}{dp_x}\frac{dp_x}{ds_x^*} - \frac{dp_x^w}{ds_x^*}M.$$

The second term is always positive, reflecting the terms-of-trade gains from the subsidy, while the first term is negative. $\frac{dW}{dp_x} > 0$, and this reflects the negative effects of more import competition from a subsidy increase from the stable point. The only term that depends on γ_M is $\frac{dW}{dp_x}$, so by the envelope theorem (representing the equilibrium as the constrained

[28] See Lee (2016) for a survey. Exceptions though include Bagwell and Staiger (2012a) and Bagwell and Lee (2020) in which case there is a Metzler paradox, and export subsidies can be terms-of-trade improving.

optimization solution), we have $\frac{d^2W}{ds_x^* d\gamma_M} < 0$, so for sufficiently large γ_M there is a negative externality from the subsidy. Because the stable point is efficient, $\frac{dW}{ds_x^*} < 0$ implies $\frac{dW^*}{ds_x^*} > 0$.

Similarly, looking at Foreign's policy incentives,

$$\frac{dW^*}{ds_x^*} = \frac{dW^*}{dp_x}\frac{dp_x}{ds_x^*} + \frac{dp_x^w}{ds_x^*}M$$

we can derive that $\frac{d^2W^*}{ds_x^* d\gamma_E} > 0$, and a sufficiently large γ_E ensures that Foreign would be willing to impose the export subsidy, and $\frac{dW^*}{ds_x^*} > 0$ implies $\frac{dW}{ds_x^*} < 0$ at stable and efficient policies.

To summarize, the possibility that trade agreements address local price externalities allows the possibility for a stable outcome under reciprocity such that restrictions on export policies take the form of a ban. The ban is desirable only because at the stable point, nations have liberalized so much that the loss from a local price decrease to import-competing sectors outweighs the benefits to consumers. This possibility then widens the set of models such that export subsidy restrictions can be rationalized. The export subsidy restrictions can be rationalized at stable outcomes in the limited instrument setting, while the political optimum in the full instrument setting provides no rationale for export subsidy restrictions.

5.2 An Example with Specific Functional Forms

To illustrate further, we consider specific functional forms. Following Bagwell and Staiger (2001b) and DeRemer (2022), $CS(p) = .5(1-p)^2$, the profit functions for the export goods are $p^2/2$, and the profit functions for the import-competing sectors are $p^2/4$. Balanced trade implies world prices are $p_x^w(\tau_x) = (4-3\tau_x)/7$ and $p_y^w(\tau_y^*) = (4-3\tau_y^*)/7$.

We can then solve for the equilibrium as a function of the political economy parameters. First we consider the case in which the political parameters are symmetric, so there is one parameter for export industries γ_E and one parameter for import-competing industries γ_M. In this case, the stable point is in fact the same as the symmetric efficient point in the limited-instrument setting. We can derive that the efficient import tariffs are

$$\tau_x = \tau_y^* = \frac{4(2\gamma_M + 1 - 3\gamma_E)}{59 - 9\gamma_E - 8\gamma_M}. \tag{35}$$

The level of total trade barriers and local prices are the same as in the political optimum in Bagwell and Staiger (2001b) when both import policies and export policies are available, so the same level of welfare is obtained even without the export policies. So banning export policies has no inefficiency consequences.

The plot in Figure 2 is for parameters $\gamma_M = 1.2$, $\gamma_M^* = 1.15$, $\gamma_E = 1.1$, $\gamma_E^* = 1.05$. With

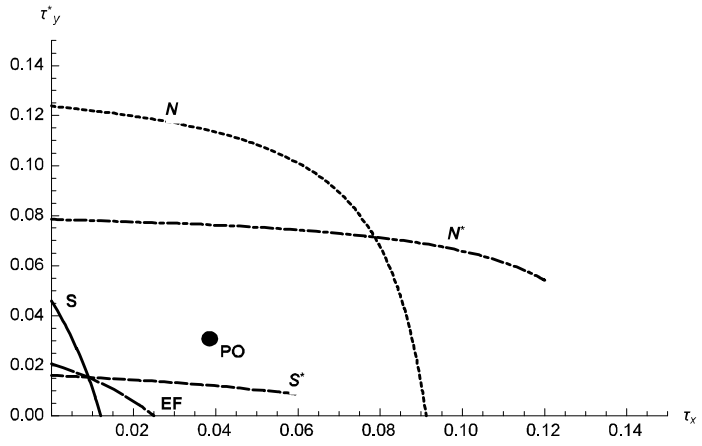

Figure 1: Asymmetric Model

these parameters, the efficient point is no longer such that we maximize the global welfare objective with $\lambda = 1$. Instead the stable point maximizes an objective with $\lambda = 1.18$ weight on Foreign. Even though the political economy forces are stronger in Home, the reciprocity concept here is neutral with respect to political economy forces, and the Home tariff is smaller than the Foreign tariff at the stable efficient point. In either case, the political optimum lies in between the stable efficient point and the Nash equilibrium, and each nation benefits from a local price increase at the stable point.

We can futher verify the set of parameters here such that nations would prefer to restrict subsidies. If focus on the parameters where free trade is optimal, $2(\gamma_M - 1) = \gamma_E - 1$, then nations would restrict subsidies at the cooperative equilibrium provided that $\gamma_E > 4/3$. This is a plausible level for a political economy parameter based on the existing empirically estimates that derive parameters as high as 2 (e.g. Ossa, 2014).

6 Conclusion

This paper provides a theory of global cooperation in subsidies along key dimensions that have previously achieved little attention in the trade policy literature despite substantial importance. U.S. frustration with subsidized imports from the EU was central to past subsidy cooperation, and frustration with subsidized imports from China is key to subsidy conflict today. Existing theory does little to address why the U.S. would want to remove the foreign subsidies to such imports, rather than solving problems with higher tariffs or higher countervailing duties. This paper explains such frustration in a manner that is true to the focus of the historically important Uruguay Round subsidy negotiations that formed

the WTO. The paper fits well with the concluding remark in the recent trade policy survey Caliendo and Parro (2022) to focus on explaining policy, in contrast to recent focus in the literature on deriving optimal policy.

This paper focuses on the simplest set of assumptions that can illustrate plausible connections between real economic features to explain actual subsidy conflict and cooperation. This approach has a rich history in international trade, e.g. perfect competition to explain how different factor endowments explains patterns of trade and distributional conflict, or homogenous firms to explain how firm-level increasing returns lead to gains from intra-industry trade, following the "dare to be silly" modelling advice from Krugman (1993). This paper similarly uses a simple restriction on domestic policies in order to explain how frictions in domestic policy setting can motivate reciprocal exchange of market access which then imply that nations eventually prefer to have subsidies restrictions.

The paper's robust motive for subsidy restrictions also suggests a form of discipline for political economy parameters in trade agreement models, starting from Ossa (2014). Trade agreement models can imply political economy parameters that can rationalize observed tariffs but there is no particular test for whether we should trust such estimates. This paper argues one such test would be to check whether such parameters that rationalize observed tariffs are also consistent with the desire to have trading partners remove subsidies on imported products.

A Appendix

A.1 Comparative Statics

This appendix section derives comparative statics for government policies. Totally log-differentiating the price index equations and the demand equations yield all the comparative statics for prices and firms:

$$\begin{bmatrix} \hat{P} \\ \hat{P}^* \end{bmatrix} = \frac{1}{1-\sigma} \begin{bmatrix} S & 1-S \\ 1-S^* & S^* \end{bmatrix} \begin{bmatrix} \hat{n}_h \\ \hat{n}_f \end{bmatrix} + \begin{bmatrix} (1-S_h)\hat{p}_f \\ (1-S_f^*)\hat{p}_h^* \end{bmatrix}, \tag{36}$$

$$\begin{aligned} \hat{x}_h &= \frac{c_h}{x_h}\hat{c}_h + (1-\frac{c_h}{x_h})\hat{c}_h^*, \\ \hat{x}_f &= (1-\frac{c_f}{x_f})\hat{c}_f + \frac{c_f}{x_f}\hat{c}_f^*, \text{ and} \end{aligned} \tag{37}$$

$$\begin{bmatrix} \hat{x}_h \\ \hat{x}_f \end{bmatrix} = (\sigma - \varepsilon) \begin{bmatrix} \frac{c_h}{x_h} & 1 - \frac{c_h}{x_h} \\ (1 - \frac{c_f}{x_f}) & \frac{c_f}{x_f} \end{bmatrix} \begin{bmatrix} \hat{P} \\ \hat{P}^* \end{bmatrix} - \sigma \begin{bmatrix} (1 - \frac{c_h}{x_h})\hat{p}_h^* \\ (1 - \frac{c_f}{x_f})\hat{p}_f \end{bmatrix}. \tag{38}$$

Here $\hat{a} = d \log a = da/a$.

The entry subsidies e and e^* singly determine the firm counts n_h and n_f, respectively. The connection between the trade policy instruments and prices is that each trade policy instrument affects only one price. Totally differentiating the traded price equations yields

$$\begin{aligned} dp_f &= p(d\tau_h + d\tau_f), \text{ and} \\ dp_h^* &= p(d\tau_h^* + d\tau_f^*). \end{aligned} \tag{39}$$

To see a connection between the effects of Foreign entry and Foreign export subsidies, notice that log changes in one have proportional effects to log changes in the other, for the Home price index, Home domestic sales, and expenditure shares: $(1-\sigma)\frac{\widehat{P}}{\widehat{n_f}} = \frac{\widehat{P}}{\widehat{p_f}}$, $(1-\sigma)\frac{\widehat{c_h}}{\widehat{n_f}} = \frac{\widehat{c_h}}{\widehat{p_f}}$, and $(1-\sigma)\frac{\widehat{p_f n_f c_f}}{\widehat{n_f}} = \frac{\widehat{p_f n_f c_f}}{\widehat{p_f}}$.

Foreign price increases always raise Home sales and lower Foreign sales:

$$\begin{aligned} \frac{\widehat{c_h}}{\widehat{p_f}} &= (\sigma - \varepsilon)(1 - S) > 0, \text{ and} \\ \frac{\widehat{c_f}}{\widehat{p_f}} &= \sigma - (\sigma - \varepsilon)(1 - S) > 1. \end{aligned} \tag{40}$$

A.1.1 Trade Policy Comparative Statics

This subsection provides comparative statics for changes in Home or Foreign government policies on Home welfare. Symmetric results hold for Foreign.

The effect of a Foreign tariff increase on Home is

$$\frac{dG}{d\tau^*} = \frac{(\frac{\alpha}{\sigma} - s) p n_h c_h^* \frac{\widehat{c_h^*}}{\widehat{p_h^*}}}{(1 + \phi + \tau^* - s)}. \tag{41}$$

The effect of an increase in Home's own export subsidy is

$$\frac{dG}{ds} = \frac{(s - \frac{\alpha}{\sigma}) p n_h c_h^* \frac{\widehat{c_h^*}}{\widehat{p_h^*}} - p_h^* n_h c_h^*}{(1 + \phi + \tau^* - s)}. \tag{42}$$

The effect of an increase in Foreign export subsidies on Home is

$$\frac{dG}{ds^*} = \frac{p_f n_f c_f - \alpha(\frac{p}{\sigma}) n_h c_h \frac{\widehat{c_h}}{\widehat{p_f}} - \tau p n_f c_f \frac{\widehat{c_f}}{\widehat{p_f}}}{(1+\phi+\tau-s^*)}. \tag{43}$$

The effect of an increase in Home's own tariff is

$$\frac{dG}{d\tau} = \frac{\alpha(\frac{p}{\sigma}) n_h c_h \frac{\widehat{c_h}}{\widehat{p_f}} + \tau p n_f c_f \frac{\widehat{c_f}}{\widehat{p_f}}}{(1+\phi+\tau-s^*)}. \tag{44}$$

The effect of an increase in trade barriers $t = \tau - s^* = \tau^* - s$ on world welfare is

$$\frac{(1+t+\phi)}{2}\frac{dW}{dt} = \alpha\frac{p}{\sigma} n \left(\left[c_h(\frac{\widehat{c_h}}{\widehat{p_f}}) + (1+\phi) c_h^*(\frac{\widehat{c_h^*}}{\widehat{p_h^*}}) \right] + t p n_h c_h^*(\frac{\widehat{c_h^*}}{\widehat{p_h^*}}) \right). \tag{45}$$

A.2 Lemma Proofs

Lemma 1 *Consider countries with symmetric policies $\bar{e}$, $\bar{\tau}^N$, and $\bar{s}^N$, such that $\frac{dG}{d\tau} = \frac{dG^*}{d\tau^*} = \frac{dG}{ds} = \frac{dG^*}{ds^*} = 0$. For sake of comparison, consider a different pair of countries with net trade barriers $\bar{t}^C$ such that $\frac{dW}{d\tau} = \frac{dW}{d\tau^*} = \frac{dW}{ds} = \frac{dW}{ds^*} = 0$. Then $\bar{\tau}^N$, $\bar{s}^N$, $\bar{t}^C$ do not depend on $\bar{e}$, $\bar{\tau}^N > 0$, and $\bar{t}^N > \bar{t}^C$.*

Proof. $\bar{\tau}^N$, $\bar{s}^N$, and $\bar{t}^c$ do not depend on $\bar{e}$ because under symmetric policies, firm counts are the same, and drop out of all the first-order conditions.

$\tau^N > 0$**:** Define $\bar{\tau}^N$ to be the Nash tariff and denote other symmetric policies similarly. $\bar{\tau}^N = -\frac{\alpha}{\sigma}\frac{c_h}{c_f}\frac{\widehat{c_h}}{\widehat{p_f}} / \frac{\widehat{c_f}}{\widehat{p_f}} > 0$, because $\frac{\widehat{c_h}}{\widehat{p_f}} > 0$ and $\frac{\widehat{c_f}}{\widehat{p_f}} < 0$ (a Foreign price increase improves Home's sales and lowers Home's imports).

$\bar{t}^N > \bar{t}^C$: Substituting the Nash policy conditions ($\frac{dG}{ds} = 0$) and ($\frac{dG}{dt} = 0$) into the externality equations we get $\frac{dG}{ds^*} > 0$ and $\frac{dG}{d\tau^*} < 0$ (see Appendix Section A.1.1), which implies countries can benefit from cooperatively reducing trade barriers from Nash policies. ■

Lemma 2 *Consider arbitrary import tariff policies and entry subsidies, and export subsidy choices s and s^* satisfying $\frac{dG}{ds} = \frac{dG^*}{ds^*} = 0$ Then $s \leq \frac{\alpha}{\sigma}$ and $s^* \leq \frac{\alpha}{\sigma}$.*

Proof. The export subsidy first-order condition (setting equation 42 to 0) implies $\bar{s} = \frac{\alpha}{\sigma} + \frac{p_h^*}{p} / \frac{\widehat{c_h^*}}{\widehat{p_h^*}}$. Since $\frac{\widehat{c_h^*}}{\widehat{p_h^*}} < 0$, $\bar{s} < \frac{\alpha}{\sigma}$. ■

Lemma 3 *Import tariffs always cause negative cross-border externalities on their trading partners ($\frac{dG^*}{d\tau} < 0$ and $\frac{dG}{d\tau^*} < 0$). If Home and Foreign choose noncooperative import tariffs to maximize their objectives, holding other policies fixed, then the noncooperative import tariffs are higher than the cooperative import tariffs that maximize W.*

Proof. The import tariff externality expression (41) implies the externality has the same sign as $s - \frac{\alpha}{\sigma}$, but Lemma **2** implies $s < \frac{\alpha}{\sigma}$, and $\frac{dG^*}{d\tau} < 0$ *and* $\frac{dG}{d\tau^*} < 0$ follows. For the Nash policies to maximize W, it must also be true that $\frac{dG}{d\tau} + \frac{dG^*}{d\tau} = 0$, so $\frac{dG}{d\tau} > 0$. $\frac{dG}{d\tau} = 0$ at the Nash tariff, and sign($\frac{dG}{d\tau}$)=sign($\alpha(\frac{p}{\sigma})c_h\frac{\widehat{c_h}}{\widehat{p_f}} + \tau p c_f \frac{\widehat{c_f}}{\widehat{p_f}}$). $\alpha(\frac{p}{\sigma})c_h\frac{\widehat{c_h}}{\widehat{p_f}} > 0$ and $pc_f\frac{\widehat{c_f}}{\widehat{p_f}} < 0$, so a lower tariff than the Nash tariff is necessary to induce a positive $\frac{dG}{d\tau}$. ■

Lemma 6: *There exists a set B of scale parameters β for the function $k(e)$, such that there exists a GATT equilibrium at zero import tariffs when $\beta \in B$.*

Proof. Define M to be a nations's total export volume, the number of firms multiplied by the per-firm export volume. Let $\bar{M} > \bar{M}^N$ be a symmetric export volume greater than the export volume at Nash policies. We show we can find a β such that there is a GATT equilibrium at zero import tariffs with export volume $\bar{M}$, and by varying $\bar{M}$, this maps out the set B of β values such that we know a zero-tariff GATT equilibrium exists. Let $\bar{\tau}, \bar{s}$,and $\bar{e}$ be the policies countries choose at the GATT equilibrium with export volume $\bar{M}$. We can scale the function $k(e)$ so that countries choose zero import tariffs. Write $k(e) = \beta_k \kappa(e)$ for some $\beta_k > 0$ yet to be determined, and κ is a function that satisfies our restrictions for k, and let κ have scale parameter β_κ. The condition for the constrained optimal choice of e can then be written as $F(\bar{\tau}, \bar{s}, \bar{e}) = \beta_k$,for some function $F(\bar{\tau}, \bar{s}, \bar{e})$, which is strictly positive because κ is positive, and both consumer welfare and total profits are increasing in the entry subsidy. The market access constraint gives us e as a function of $\bar{\tau}$ and the unilateral export condition gives us $\bar{s}(\bar{\tau}, \bar{e}(\bar{\tau}))$. If we choose $\beta_k = F(0, \bar{s}(0, \bar{e}(0)), \bar{e}(0))$, then the resulting function k has scale parameter $\beta = \beta_k\beta_\kappa$, the choices of s and e are optimal subject to the market constraint, and the policies $(0, \bar{s}(0, \bar{e}(0)), \bar{e}(0))$ determine a GATT equilibrium with zero tariffs. ■

Lemma 8: Consider a set a constraints on Foreign defined by the vector-valued function $X(s^*, \tau^*, n_f) = 0$, and a matching set of constraints on Home. Adding entry subsidy limits to the set of constraints improves a GATT equilibrium subject to the set of constraints $X = 0$ if and only if $\frac{dG}{dn_f}|_{dX=0} < 0$ (where $dX = 0$ is the constraint that differential changes in policy leave X unchanged). Adding export subsidy limits improves the GATT equilibrium if and only if $\frac{dG}{ds^*}|_{dX=0} < 0$.

Proof. At the GATT equilibrium with firms $\hat{n}_f$, $\frac{dG^*}{dn_f}|_{dX=0} = 0$. Since $\frac{dG}{dn_f}|_{dX=0} < 0$, $\frac{dW}{dn_f}|_{dX=0} < 0$. As discussed in Section 3.1, the reduced-form cost function $f(n)$ is such that G^* is concave in n_f. By concavity in n_f, there must exist $\bar{n}_f < \hat{n}_f$ in the neighborhood of $\hat{n}_f$ such that at $\bar{n}_f$, $\frac{dW}{dn_f}|_{dX=0} < 0$, $\frac{dG}{dn_f}|_{dX=0} < 0$, and $\frac{dG^*}{dn_f}|_{dX=0} > 0$. As the Foreign government objective is increasing and concave in n_f within the constraint set $n_f \leq \bar{n}_f$, the GATT equilibrium with constraint $n_f \leq \bar{n}_f$ must bind at $\bar{n}_f < \hat{n}_f$ and countries will achieve greater

welfare since $\frac{dW}{dn_f}|_{dX=0} < 0$ within the interval $(\bar{n}_f, \hat{n}_f)$. A parallel proof applies for the Home tariff choices, and a similar proof applies for the export subsidy choices. When considering the subsidy limits applied to both countries, each country suffers no first-order effect from the imposition of a differentially tighter constraint on itself, while achieving the first-order gain from the constraint on the trading partner. To establish the converse, notice that if the constrained derivative ($\frac{dG}{dn_f}|_{dX=0} < 0$ or $\frac{dG}{ds^*}|_{dX=0} < 0$) is nonnegative, then subsidy limits would either (1) not bind and have no effect or (2) bind and decrease each government's objective. ■

A.3 Inefficiency at Noncooperative Tariffs

The combined effects of Foreign firm entry, derived in Section 3.4, are

$$n_f \frac{dG}{dn_f} = p_f n_f c_f \frac{1}{\sigma - 1} + \left[\alpha(\frac{p}{\sigma}) n_h c_h \frac{\widehat{c_h}}{\widehat{n_f}} + \tau p n_f c_f \left(1 + \frac{\widehat{c_f}}{\widehat{n_f}}\right)\right] + \left[(\alpha(\frac{p}{\sigma}) n_h c_h^* - s p n_h c_h^*) \frac{\widehat{c_h^*}}{\widehat{n_f}}\right].$$

The first term is the effect on consumer surplus, the first set of brackets contains the effects in the domestic market (Home profits and tariff revenue), and the second set of brackets contains the effects in the third market (export profits and export policy costs). There are no effects in the Foreign market due to Article XXIII.

We can express the Foreign firm externality in log price changes using results from Appendix A.1:

$$n_f(\sigma-1)\frac{dG}{dn_f} = p_f n_f c_f - \left[\alpha(\frac{p}{\sigma}) n_h c_h \frac{\widehat{c_h}}{\widehat{p_f}} + \tau p n_f c_f \left(1 + \frac{\widehat{c_f}}{\widehat{p_f}}\right)\right] - \left[(\alpha(\frac{p}{\sigma}) n_h c_h^* - s p n_h c_h^*) \left(\frac{\widehat{c_h^*}}{\widehat{p_f^*}}\right)\right].$$

The first bracketed expression is comparable to the Home unilateral import policy condition, while the second is comparable to the Home unilateral export policy condition. Substituting in the noncooperative values of τ and s yields

$$\frac{dG}{dn_f} = \left(p_f n_f c_f + \left[\alpha(\frac{p}{\sigma}) n_h c_h \frac{\widehat{c_h}}{\widehat{p_f}} / \frac{\widehat{c_f}}{\widehat{p_f}}\right] + \left[p_h^* n_h c_h^* \frac{\widehat{c_h^*}}{\widehat{p_f^*}} / \frac{\widehat{c_h^*}}{\widehat{p_h^*}}\right]\right) \frac{1}{n_f(\sigma-1)}. \tag{46}$$

The first bracketed expression is negative. Home still loses domestic profits from Foreign firm entry as in the zero-tariff case of the previous section, but the losses have been scaled down by the price elasticities of import demand ($\frac{\widehat{c_f}}{\widehat{p_f}}$ and $\frac{\widehat{c_h^*}}{\widehat{p_h^*}}$) which both equal $-\sigma-(\sigma-\varepsilon)(1-\bar{S}) < -1$.

To sign $\frac{dG}{dn_f}$, first compare the consumer gain $p_f n_f c_f$ to the second bracketed expression.

For symmetric policies $p_f n_f c_f = p_h^* n_h c_h^g$. Because own price effects are stronger than cross-price effects, $-\frac{\widehat{c_h^*}}{\widehat{p_f^*}}/\frac{\widehat{c_h^*}}{\widehat{p*}} < 1$, the consumer gain dominates. Further simplifying,[29]

$$\frac{dG}{dn_f} = \left(p_f n_f c_f \varepsilon - \alpha(\frac{p}{\sigma}) n_h c_h \frac{\widehat{c_h}}{\widehat{p_f}} \right) \frac{1}{\left(-\frac{\widehat{c_f}}{\widehat{p_f}} \right) n_f (\sigma - 1)}.$$

We can sign $\frac{dG}{dn_f}$ as follows:

$$\frac{dG}{dn_f} > 0 \Longleftrightarrow \alpha < \frac{\varepsilon \sigma}{\sigma - \varepsilon} \frac{1}{\bar{S}^N}.$$

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[29] We use the symmetry result that import price elasticities for each country are the same and we calculate that $1 + \frac{\widehat{c_h^*}}{\widehat{p_f^*}}/\frac{\widehat{c_h^*}}{\widehat{p_h^*}} = \varepsilon / \left(-\frac{\widehat{c_h^*}}{\widehat{p_h^*}} \right)$.

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