NBER WORKING PAPER SERIES

MULTILATERAL TRADE BARGAINING AND DOMINANT STRATEGIES

Kyle Bagwell
Robert W. Staiger

Working Paper 22842
http://www.nber.org/papers/w22842

NATIONAL BUREAU OF ECONOMIC RESEARCH
1050 Massachusetts Avenue
Cambridge, MA 02138
November 2016

We thank the NSF (Grant SES-1326940) for financial support. Bagwell thanks CASBS at Stanford for support and hospitality. The views expressed herein are those of the authors and do not necessarily reflect the views of the National Bureau of Economic Research.

At least one co-author has disclosed a financial relationship of potential relevance for this research. Further information is available online at http://www.nber.org/papers/w22842.ack

NBER working papers are circulated for discussion and comment purposes. They have not been peer-reviewed or been subject to the review by the NBER Board of Directors that accompanies official NBER publications.

© 2016 by Kyle Bagwell and Robert W. Staiger. All rights reserved. Short sections of text, not to exceed two paragraphs, may be quoted without explicit permission provided that full credit, including © notice, is given to the source.

Multilateral Trade Bargaining and Dominant Strategies
Kyle Bagwell and Robert W. Staiger
NBER Working Paper No. 22842
November 2016
JEL No. D71,F02,F13

ABSTRACT

Motivated by GATT bargaining behavior and renegotiation rules, we construct a three-country, two-good general-equilibrium model of trade and examine multilateral tariff bargaining under the constraints of non-discrimination and multilateral reciprocity. We allow for a general family of government preferences and identify bargaining outcomes that can be implemented using dominant strategy proposals for all countries. In the implementation, tariff proposals are followed by multilateral rebalancing, a sequence that is broadly consistent with observed patterns identified by Bagwell, Staiger and Yurukoglu (2016) in the bargaining records for the GATT Torquay Round. The resulting bargaining outcome is efficient relative to government preferences if and only if the initial tariff vectors position the initial world price at its "politically optimal" level. In symmetric settings, if the initial tariffs correspond to Nash tariffs, then the resulting bargaining outcome is efficient and ensures greater-than-Nash trade volumes and welfares for all countries. We also highlight relationships between our work and previous research that examines strategy-proof rationing rules in other economic settings.

Kyle Bagwell
Department of Economics
Stanford University
Landau Economics Building
579 Serra Mall
Stanford, CA 94305-6072
and NBER
kbagwell@stanford.edu

Robert W. Staiger
Department of Economics
Dartmouth College
319 Silsby
Hanover, NH 03755
and NBER
rstaiger@dartmouth.edu

1 Introduction

Since 1947, the General Agreement on Tariffs and Trade (GATT) and its successor organization, the World Trade Organization (WTO), have provided the multilateral forum for bargaining over trade policy. The GATT was formed in 1947 among 23 original signatory countries and sponsored eight multilateral rounds of trade-policy negotiations. The final completed round, known as the Uruguay Round, resulted in the creation of the WTO on January 1, 1995. The WTO currently has more than 160 member countries and has struggled with its now-suspended Doha Round. But in combination, the GATT/WTO rounds surely represent one of the most important episodes of bargaining in economic history.

What accounts for the success of the GATT/WTO as a bargaining forum? We provide in this paper a stylized model of multilateral tariff bargaining that embodies key institutional features of GATT/WTO practice. We argue that several of these features dramatically simplify the bargaining environment, and in their presence we show that all countries have dominant strategy proposals. We characterize the bargaining outcomes that can be implemented under these proposals, show that the implementation sequence of initial proposals followed by "multilateral rebalancing" mimics stylized facts associated with GATT/WTO tariff bargaining, and describe conditions under which the bargaining outcomes are efficient.

The protocol for tariff negotiations in the GATT/WTO vary somewhat from round to round but have important common features. First, the negotiations are a form of barter: each government makes commitments (offers "concessions") on its own import tariffs in exchange for reciprocal commitments from its trading partners. Second, the negotiations are undertaken in the context of specific rules and norms. Under the principle of non-discrimination as enshrined in GATT Article I, the tariff commitment that a country makes with respect to any given import good must be extended to all GATT/WTO countries.[1] Tariffs thus must satisfy a "most-favored nation" or MFN rule. In addition, reciprocity rules and norms shape the pattern of negotiation.

A primary expression of GATT rules concerning reciprocity is found in GATT Article XXVIII, which addresses rules for renegotiation. Under this article, after negotiations are completed, a country retains the right to withdraw a tariff commitment and re-position an import tariff at a higher level, with the understanding that its principal trading partners are then allowed to behave in a reciprocal manner and withdraw "substantially equivalent concessions." Thus, GATT rules ensure that a form of reciprocity is followed when concessions are renegotiated, and this rule is of course known to participating countries

[1] GATT rules also include important exceptions to the principle of non-discrimination; for example, GATT Article XXIV provides conditions for the formation of preferential trading agreements.

at the time of negotiation.

In addition, when tariffs are originally negotiated within a round, a reciprocity norm shapes the expectations of negotiators and thus the negotiating outcome. Following Bagwell and Staiger (1999, 2002), we regard the principle of reciprocity as being satisfied when two countries exchange tariff reductions (or tariff increases, in the case of renegotiation) such that each country experiences changes in the volume of its imports which are equivalent in magnitude to the changes in the volume of its exports, with the changes in trade volumes valued at existing world prices. In GATT parlance, reciprocal tariff liberalization then facilitates a "balance of concessions."[2] As Bagwell and Staiger (1999, 2002) show for a two-good general equilibrium model of trade, when two countries make tariff changes that satisfy the principle of reciprocity, the changes leave the world price that governs trade between the two countries unaltered. In this way, reciprocity prevents countries from manipulating their terms of trade and thereby neutralizes the fundamental source of inefficiency in non-cooperative tariff setting. Bagwell and Staiger (2005) show further that, in a three-country, two-good general-equilibrium setting, if two countries negotiate in a manner that satisfies both the principles of non-discrimination and reciprocity, then the preservation of the terms-of-trade between the countries ensures as well the absence of any third-party externality.

The notion of reciprocity studied by Bagwell and Staiger (1999, 2002, 2005) may be understood as a form of bilateral reciprocity. We focus in this paper on a related but distinct notion of multilateral reciprocity. In the three-country setting and under the MFN rule, multilateral reciprocity can hold even if bilateral reciprocity fails. When a set of tariff changes satisfies multilateral reciprocity, a given country can experience an increase in imports from one trading partner that exceeds the magnitude of the increase in exports to that partner provided that the country experiences an increase in exports to the other trading partner that exceeds the magnitude of the increase in imports from that second partner, with the imbalance in the exchange in one bilateral relationship exactly offsetting the imbalance in the exchange in the other. As Bagwell, Staiger and Yurukoglu (2016) argue, under the MFN rule, multilateral reciprocity also serves to fix the world price in the three-country model and thus likewise neutralizes the key source of inefficiency under non-cooperative tariff setting.

The important role of multilateral as opposed to bilateral reciprocity was emphasized in early writings on GATT negotiations. The key point is that a bilateral exchange of tariff cuts is "multilateralized" under the MFN rule and may offer indirect benefits to other parties, where such indirect gains can be more effectively internalized in a multilateral

[2]For further discussion of the principle of reciprocity in GATT/WTO and recent research related to this topic, see Bagwell and Staiger (forthcoming).

bargaining forum.[3] The following excerpt from an early GATT report offers one example:

> *Multilateral tariff bargaining, as devised at the London Session of the Preparatory Committee in October 1946 and as worked out in practice at Geneva and Annecy, is one of the most remarkable developments in economic relations between nations that has occurred in our time. It has produced a technique whereby governments, in determining the concessions they are prepared to offer, are able to take into account the indirect benefits they may expect to gain as a result of simultaneous negotiations between other countries, and whereby world tariffs may be scaled down within a remarkably short time.* (ICITO, 1949, p. 10)

Related points are also made by Curzon (1966, pp. 75-77).

Utilizing recently declassified data from the GATT/WTO on tariff bargaining, Bagwell, Staiger and Yurukoglu (2016) study the pattern of tariff bargaining in the GATT Torquay (1950-51) Round. Negotiations in this round took a "request-offer" form, whereby the initial proposal of a country consisted of the tariff cuts it requested from its trading partner and the tariff cuts it offered in exchange. For our purposes here, we highlight three key findings from their study. First, the numbers of back-and-forth offers and counter offers in any bargain were relatively small. Second, once the initial proposals were on the table, the focus of bargaining narrowed to each country's own-tariff-cut offers. Countries responded to imbalances in the outstanding offers by adjusting their own offers rather than by adjusting their requests. Third, adjustments in offers typically took a simple and striking form. Offers for given import goods were rarely deepened as the round progressed, suggesting an absence of strategic screening behavior along this dimension.[4] Instead, when adjustments in offers did occur, the adjustment typically involved a country reducing the depth of its offer.[5] A potential interpretation of this pattern is that a country would propose for a given import good the tariff that generated its preferred trade volume for a fixed terms of trade, with the expectation that any subsequent "rebalancing" of offers necessary for multilateral reciprocity would arise later in the round after all offers had been recorded and might entail a reduction in the depth of its offer.

[3] Note that, according to the findings of Bagwell and Staiger (2005) just described, bilateral tariff cuts under the MFN rule offer potential indirect benefits to third parties only when those cuts fail to satisfy bilateral reciprocity (i.e., only when those cuts on their own would change world prices).

[4] Strategic screening occurs, for instance, in theoretical models with one-sided uncertainty in which the uniformed party makes all the offers (e.g., Gul, Sonnenschein and Wilson, 1986)

[5] A country could reduce the depth of its offer on the intensive margin (by reducing the magnitude of its tariff cut on a given import good) or on the extensive margin (by reducing the range of import goods in a bargain). In the Torquay Round, rebalancing typically occurred on the extensive margin. In the model that we develop here, each country has one import good, and so we focus on intensive-margin adjustments.

In this paper, motivated by GATT bargaining behavior and renegotiation rules, we construct a general-equilibrium model of trade and examine multilateral tariff bargaining under the constraints of non-discrimination and multilateral reciprocity. The model has two goods and three countries, corresponding to a home country and two foreign countries, where the foreign countries trade only with the home country. We allow for a general family of government preferences, construct a simple bargaining game and identify bargaining outcomes that can be implemented using dominant strategy proposals for all countries. The resulting bargaining outcome is efficient relative to government preferences if and only if the initial tariff vectors position the initial world price at its "politically optimal" level.[6] In symmetric settings, if the initial tariffs correspond to Nash tariffs, then the resulting bargaining outcome also ensures greater-than-Nash trade volumes and welfares for all countries.

To establish these results, we develop a bargaining game inspired by the request-offer structure that we described above in the context of the Torquay Round, a structure that has been commonly used across the GATT/WTO tariff bargaining rounds.[7] In this game, countries simultaneously make proposals concerning their own tariffs (their "offers") and the tariffs of their trading partners (their "requests"). For each country, we require that any proposed change in tariffs satisfies the principles of non-discrimination and multilateral reciprocity. We capture GATT Article XXVIII renegotiation provisions in a short-hand way, by assuming also that the bargaining outcome must respect "voluntary exchange," in the specific sense that no country is ever forced to accept a trade volume in excess of that implied by its proposal. A key issue is that the proposals may disagree and thus be imbalanced, with one side of the market seeking greater trade volume than the other. To address this issue, we construct a mechanism that maps tariff proposals into assigned tariffs. When the proposals "agree," as we define that term, the mechanism assigns the corresponding tariff vector upon which all parties agree. If the proposals disagree, the mechanism must introduce a rationing rule, since one side of the market is short relative to the other. The rationing rule that we employ uses randomization and ensures that foreign countries subjected to rationing are treated in an ex ante symmetric way. We construct a mechanism that maximizes the value of trade volume while satisfying the constraints of non-discrimination, multilateral reciprocity and voluntary exchange. We then show that the mechanism so constructed results in dominant

[6]The politically optimal tariffs are the tariffs that would be selected in the hypothetical situation in which governments are not motivated by the terms-of-trade implications of their unilateral trade-policy choices. The politically optimal world price is then the market-clearing world price that emerges when all governments select their politically optimal policies. See Bagwell and Staiger (1999, 2002) and Section 5 below for further discussion.

[7]With the exception of the Kennedy and Tokyo Rounds, which relied primarily on tariff-cutting formulas, all of the GATT rounds and the now-suspended WTO Doha Round have relied on request-offer bargaining structures of the kind we describe here.

strategies for each country, and we characterize the outcomes that can be implemented under dominant strategy proposals for each country.

In our model, dominant strategy proposals lead to assigned tariff vectors once adjustments are made that maintain multilateral reciprocity while not requiring any country to import more than is implied by its proposal. This simple sequence - initial tariff proposals followed by multilateral rebalancing - is broadly consistent with observed patterns identified by Bagwell, Staiger and Yurukoglu (2016) in the bargaining records for the GATT Torquay Round. As mentioned above, a notable feature of bargaining behavior in this round is the lack of back-and-forth haggling over the levels of proposed tariffs. In addition, subsequent to the initial proposals our constructed mechanism orchestrates multilateral rebalancing by placing primary emphasis on the own-tariff offers in those proposals, much as did the narrowed focus of bargaining in the Torquay Round once initial proposals were on the table. Also in line with the observed patterns from the Torquay Round, multilateral rebalancing is achieved through reductions in the depths of offers.[8]

Despite the importance of bargaining in GATT/WTO rounds, relatively little work has formally examined multilateral tariff bargaining behavior. As mentioned above, Bagwell and Staiger (1999, 2002, 2005) examine the purpose and design of trade agreements for a related setting. As we discuss in further detail in Section 2, some of the key implications of (bilateral) reciprocity and MFN that we utilize here are developed in their work. Our theoretical work is most closely related to that in Bagwell and Staiger (1999). In a related multi-country setting, Bagwell and Staiger (1999) study a tariff negotiation game in which countries make proposals consistent with reciprocity. Under disagreement, they assume that the assigned tariff vector maximizes the value of trade while not requiring any country to import a volume in excess of that implied by its proposal. Their analysis is at one level more general, since they also allow for discriminatory tariffs.[9] At other levels, however, the model considered in this paper offers several advantages.

In particular, Bagwell and Staiger (1999) assume that the home country proposes its own tariff policy as well as trade shares from foreign countries, and they then use this proposal and the reciprocity restriction to determine the home country's implied proposals for foreign tariffs. Similarly, Bagwell and Staiger (1999) assume that each foreign country proposes a tariff for itself, and they then use all foreign tariff proposals and the reciprocity restriction to determine the implied proposal by foreign countries together for home tariffs. By contrast, the model that we present here relates more directly to the GATT request-offer tariff bargaining data, since we assume that each country directly proposes a tariff for itself and for each of its trading partners. Rather than endow the home country with the

[8] As previously noted, however, in our two-good model we are not able to include rebalancing that takes the form of changes in the range of products that are included in the bargain.

[9] Bagwell and Staiger (1999) find that discriminatory policies are incompatible with efficiency for the game that they analyze.

power to choose trade shares directly, we propose an explicit rationing rule for settings in which one side of the market is short.[10] Another key difference is that the home country in the Bagwell-Staiger (1999) model adopts best-response rather than dominant proposals, whereas in the results featured here all countries adopt dominant strategy proposals. We also show that one of Bagwell and Staiger's (1999) main findings - that efficiency can be achieved if and only if the politically optimal MFN tariff vector is implemented - continues to hold when we generalize their analysis so that all countries make direct tariff proposals and use dominant strategy proposals.

Ludema's (1991) work is also related. He offers an interesting model of tariff bargaining under the MFN rule in a dynamic setting. His focus is on whether an MFN-efficient bargaining outcome is possible when countries can reject an outcome and continue bargaining in the event that a country attempts to free ride and withhold its own tariff cuts. By comparison, our bargaining set up is essentially static, imposes the additional constraint of multilateral reciprocity and addresses associated rationing issues, and features dominant strategy implementation.

Our work is also broadly related to previous research that examines strategy-proof rationing rules in other economic settings. In our model, a rationing issue arises at the given world price when the volume of trade proposed by the home country is lower than that proposed by the foreign countries in aggregate. We then require a rationing rule that is consistent with dominant strategy implementation. Our approach is to pick a foreign country at random, assign to that country its proposed volume so long as its proposed volume does not exceed the volume proposed by the home country, and then allocate any remaining volume to the other foreign country. Each country has a preferred volume of trade given the fixed world price, where preferences are single-peaked, and as noted no country is ever forced to accept a trade volume in excess of that implied by its proposal. A potentially attractive feature of this random priority rationing rule is that foreign countries are treated in an ex ante symmetric way. However, asymmetric rationing rules that use fixed (i.e., deterministic) priority schemes may also be attractive. For example, in settings where one trading partner is a primary supplier, the GATT principal supplier rule suggests that this partner receives priority. We consider such asymmetric rationing rules in Section 7 and argue that our results are robust to this extension.

Strategy-proof rationing rules are also examined by Benassy (1982) in the context of an analysis of fixed-price equilibria. Benassy assumes that each agent presents a preferred net demand volume in a given market, and he then considers rationing schemes that map from the set of net demand requests presented by all agents to actual transactions.

[10] While we focus on a probabilistic rationing rule in our main analysis, we consider other rationing rules in Section 7. As we discuss just below, one advantage of this approach is that we can relate our analysis to the literature on strategy-proof social choice functions, which considers alternative rationing rules that are compatible with dominant strategy implementation.

He emphasizes deterministic rationing rules that are strategy-proof, efficient (in that there are not both rationed demanders and suppliers in a given market), and respect voluntary exchange (in that no agent can be forced to purchase more units than that agent demands or sell more units than that agent supplies). One scheme considered by Benassy that satisfies these properties is a priority or queuing scheme, where demanders (or suppliers) are ordered in a pre-determined fashion. The setting that we consider is similar in some respects; however, we focus on a barter environment and use a random process to determine which foreign country is prioritized to be first in line. Given our tariff bargaining setting, we also assume that each country proposes tariffs for itself *and* its trading partner(s), subject to the institutional constraints of non-discrimination and multilateral reciprocity. The relevant transaction price in our model is the world price, which is fixed under these institutional constraints.

Strategy-proof rationing rules are also used in the social choice literature that considers outcomes that can be implemented under dominant strategies when the domain of possible preferences is restricted in various ways.[11] By contrast, we adopt particular tariff assignment rules that are motivated by GATT/WTO practice, show that those rules are consistent with dominant strategy proposals, and consider the positive and normative implications of the resulting bargaining outcomes. Despite these differences, our analysis of dominant strategy implementation and rationing rules has some interesting parallels in the social choice literature, wherein a related allotment problem is concerned with rationing volumes across agents with single-peaked preferences in a fixed-price setting with an exogenous total volume.[12] In this context, the rationing rule that we employ when the home country is on the short side of the market is closely related to that used in the random priority mechanism.[13] As we discuss further in Section 7, our findings also hold for other rationing rules featured in research on the allotment problem, including asymmetric rules that used fixed priority schemes and a rule based on the "uniform allocation rule."[14]

The rest of the paper is organized into seven remaining sections, which respectively (i) present the basic general-equilibrium trade model and its key properties, (ii) construct a

[11] See Barbera (2011) for an excellent survey.

[12] It is important to note that differences exist as well. In the model considered here, the total volume that is allocated when the foreign countries are rationed is endogenously determined by the home-country proposal, and the world price is fixed as a consequence of the institution-based constraints (non-discrimination, multilateral reciprocity) that we impose on the proposal strategy space.

[13] See Abdulkadiroglu and Sonmez (1998) and Bogomolnaia and Moulin (2001) for further discussion of the random priority mechanism (which the former paper refers to as a random serial dictator mechanism), as applied to settings in which indivisible objects are assigned to agents where each agent has use for only one unit.

[14] In the social choice literature, priority schemes and other asymmetric rationing approaches are considered by Barbera, Jackson and Neme (1997) and Moulin (2000), for example, while the uniform allocation rule is analyzed by Sprumont (1991).

mechanism that maps tariff proposals satisfying MFN and multilateral reciprocity into assigned tariffs, (iii) characterize dominant strategy proposals for each country, (iv) examine the efficiency properties of the resulting bargaining outcomes, (v) examine the resulting bargaining outcomes when the initial tariffs are Nash tariffs, (vi) discuss extensions concerning multiple countries, private information, alternative rationing rules, and additional constraints, and (vii) conclude.

2 Framework

We begin by presenting a general-equilibrium model of trade. The model has two goods and three countries. After presenting the model, we specify a general family of preferences, describe Nash tariffs and consider notions of reciprocity in trade negotiations.

The Trade Model Three countries trade two goods, where the goods are normal in consumption and produced in perfectly competitive markets under conditions of increasing opportunity costs. The three countries are respectively referred to as the home country (or home), foreign country $*1$ and foreign country $*2$. Throughout, we denote foreign country variables with an asterisk. The home country imports good x from each of the two foreign countries, and each foreign country imports good y from the home country.[15] We assume that the foreign countries do not trade with one another.

Each country selects an ad valorem import tariff. While the home country imports from two countries, we assume that it uses an MFN tariff and thus does not discriminate between imports from different foreign countries. With $t > -1$ denoting the home-country ad valorem import tariff and $t^{*i} > -1$ denoting the ad valorem import tariff of foreign country $*i$, we may define $\tau \equiv 1 + t > 0$ and $\tau^{*i} \equiv 1 + t^{*i} > 0$. We interpret $\tau > 1$ as an import tariff and similarly for τ^{*i}.

Our approach is to present the basic trade model under the assumption that the tariff vector $(\tau, \tau^{*1}, \tau^{*2})$ is such that the home country and each foreign country exchange a positive volume of trade. After describing the model under this assumption, we introduce notation to define the associated set of tariff vectors. Finally, we present an assumption under which we may extend the set of tariff vectors to include the possibility of a prohibitive tariff for one foreign country.

To present the basic trade model, we let $p \equiv p_x/p_y$ denote the local price faced by producers and consumers in the home country, and we similarly use $p^{*i} \equiv p_x^{*i}/p_y^{*i}$ to denote the local price in foreign country $*i$, $i = 1, 2$, respectively. The world (i.e., untaxed) price for trade between the home country and foreign country $*i$ is defined as $p^{wi} \equiv p_x^{*i}/p_y$.

[15] We assume throughout that trade policies never reverse the "natural" direction of trade; thus, the home country never imports good y and the foreign countries never import good x.

The local price in the home country is determined from the world price as $p = \tau p^{wi}$. Clearly, since the home country adopts an MFN tariff τ, a single world price must prevail: $p^w \equiv p_x^*/p_y$. The local price in foreign country $*i$ is now determined as $p^{*i} = p^w/\tau^{*i}$, where the local price varies across foreign countries if they select different import tariffs. Observe next that p^w represents foreign country $*i$'s terms of trade and that the home country's terms of trade is similarly given by $1/p^w$. Finally, it is convenient to introduce functional notation that summarizes the relationships between local and world prices: $p = \tau p^w \equiv p(\tau, p^w) > 0$ and $p^{*i} = p^w/\tau^{*i} \equiv p^{*i}(\tau^{*i}, p^w) > 0$.

In each country, the production levels of goods x and y are determined by the local price. Let $Q_g = Q_g(p)$ and $Q_g^{*i} = Q_g^{*i}(p^{*i})$ denote production levels for good g, where $g = x, y$, in the home country and in foreign country $*i$, respectively. Consumption in each country is determined by the local price in that country along with the world price: $C_g = C_g(p, p^w)$ and $C_g^{*i} = C_g^{*i}(p^{*i}, p^w)$ for $g = x, y$ and $i = 1, 2$, respectively. Within any country, the local price defines the trade-off that confronts consumers and also determines the level and distribution of factor income. Together, the local and world prices also determine tariff revenue for the country, which we assume is distributed lump sum to consumers.[16] Hence, for each good in each country, consumption is determined by the local price in that country along with the world price.

We now define import and export volumes. For the home country, imports of good x and exports of good y are respectively denoted as $M(p, p^w) \equiv C_x(p, p^w) - Q_x(p)$ and $E(p, p^w) \equiv Q_y(p) - C_y(p, p^w)$. Similarly, for foreign country $*i$, imports of good y and exports of good x are respectively denoted as $M^{*i}(p^{*i}, p^w) \equiv C_y^{*i}(p^{*i}, p^w) - Q_y^{*i}(p^{*i})$ and $E^{*i}(p^{*i}, p^w) \equiv Q_x^{*i}(p^{*i}) - C_x^{*i}(p^{*i}, p^w)$. We assume that these functions are all twice-continuously differentiable given positive trade volumes.

For a given world price, we also assume that each country imports less of its import good when the relative price of the import good rises in that country. Formally, for a given world price, we assume that $\partial M(p, p^w)/p < 0$ and that $\partial M^{*i}(p^{*i}, p^w)/\partial p^{*i} > 0$. We assume further that, for a given world price, the import volume for a given country can be made arbitrarily small as the tariff of that country is made sufficiently high. Formally, for any p^w and values $\underline{M} > 0$ and $\underline{M}^{*i} > 0$, we assume that there exists $\tau(\underline{M}) > 0$ and $\tau^{*i}(\underline{M}^{*i}) > 0$ such that $M(p(\tau, p^w), p^w) < \underline{M}$ for all $\tau > \tau(\underline{M})$ and $M^{*i}(p^{*i}(\tau^{*i}, p^w), p^w) < \underline{M}^{*i}$ for all $\tau^{*i} > \tau^{*i}(\underline{M}^{*i})$.[17] Notice that this assumption does not imply for any country the existence of a prohibitive tariff level that generates zero import volume.

Trade volumes are subjected to two market relationships. First, for any world price, trade balance must be satisfied in each country. For the home country, the trade-balance

[16] See Bagwell and Staiger (1999, 2002) for further details concerning the determination of tariff revenue.

[17] The role of this assumption is to ensure that we can always assign tariffs to generate the import values that arise in our constructed mechanism in Section 3.

condition is that, for any p^w,

$$p^w M(p(\tau, p^w), p^w) = E(p(\tau, p^w), p^w). \tag{1}$$

Similarly, for foreign country $*i$, the trade-balance condition is that, for any p^w,

$$M^{*i}(p^{*i}(\tau^{*i}, p^w), p^w) = p^w E^{*i}(p^{*i}(\tau^{*i}, p^w), p^w). \tag{2}$$

The trade-balance conditions are budget constraints that are captured as restrictions on the import and export functions in a given country.

The second relationship is market clearing. We thus define the equilibrium world price, $\widetilde{p}^w(\tau, \tau^{*1}, \tau^{*2})$, as the unique value for p^w that satisfies market clearing in good y :

$$E(p(\tau, p^w), p^w) = M^{*1}(p^{*1}(\tau^{*1}, p^w), p^w) + M^{*2}(p^{*2}(\tau^{*2}, p^w), p^w). \tag{3}$$

As is standard, market clearing for good x is implied by the two trade-balance conditions along with the requirement of market clearing for good y.

Our presentation of the basic trade model assumes that the tariff vector is such that a positive trade volume is exchanged between the home country and each foreign country. We now introduce the notation Υ to define the set of tariff vectors for which trade volumes are positive at the associated market-clearing world price:

$$\Upsilon \equiv \{(\tau, \tau^{*1}, \tau^{*2}) \in \Re^3_+ \mid M^{*i}(p^{*i}(\tau^{*i}, \widetilde{p}^w), \widetilde{p}^w) > 0, i = 1, 2\}.$$

Notice that, for $(\tau, \tau^{*1}, \tau^{*2}) \in \Upsilon$, we have from (1) and (3) that $M(p(\tau, \widetilde{p}^w), \widetilde{p}^w) > 0$ holds as well. Thus, for $(\tau, \tau^{*1}, \tau^{*2}) \in \Upsilon$, the assumptions presented above for the basic trade model all hold. We assume that Υ is a non-empty set.

Our presentation to this point assumes positive trade volumes between the home country and each foreign country, but our trade-balance and market-clearing conditions above can also be used to capture limiting cases where one foreign country has no trade volume.[18] While we do not assume that prohibitive tariffs exist as a general matter, we do assume the existence of prohibitive tariffs for individual foreign countries under one specific scenario.

To formalize this assumption, suppose we start with some initial tariff vector $(\tau_0, \tau_0^{*1}, \tau_0^{*2}) \in \Upsilon$ and associated initial world price $p_0^w \equiv \widetilde{p}^w(\tau_0, \tau_0^{*1}, \tau_0^{*2})$. Suppose further that for some foreign country $*i$ it is possible to satisfy the market-clearing condition (3) at the world price p_0^w when the trade volume for foreign country $*j$ is set to zero; that is, suppose

[18]Notice from (1) and (3) that if for foreign country $*1$, say, we have $M^{*1}(p^{*1}(\tau^{*1}, \widetilde{p}^w), \widetilde{p}^w) = 0$ for $\widetilde{p}^w = \widetilde{p}^w(\tau, \tau^{*1}, \tau^{*2})$, then we may still have that $M(p(\tau, \widetilde{p}^w), \widetilde{p}^w) > 0$ and $M^{*2}(p^{*2}(\tau^{*2}, \widetilde{p}^w), \widetilde{p}^w) > 0$.

that there exists τ_1^{*i} such that $E(p(\tau_0, p_0^w), p_0^w) = M^{*i}(p^{*i}(\tau_1^{*i}, p_0^w), p_0^w)$. For such initial tariff vectors, our assumption is that there exists a lowest prohibitive tariff $\tau_1^{*j} > \tau_0^{*j}$ for foreign country $*j$ such that $M^{*j}(p^{*j}(\tau_1^{*j}, p_0^w), p_0^w) = 0$ with $M^{*j}(p^{*j}(\tau^{*j}, p_0^w), p_0^w) > 0$ for all $\tau^{*j} \in [\tau_0^{*j}, \tau_1^{*j})$.[19] We then use Υ_+ to denote the extension of the set Υ to include limit-case tariff vectors, $(\tau_0, \tau_1^{*1}, \tau_1^{*2})$, that can be constructed in this way from some initial tariff vector $(\tau_0, \tau_0^{*1}, \tau_0^{*2}) \in \Upsilon$. We also extend the definition of the market-clearing world price to include such limit-case vectors and thus write $p_0^w = \widetilde{p}^w(\tau_0, \tau_1^{*1}, \tau_1^{*2})$ even though one foreign country has no trade volume.

We turn now to our assumptions on market-clearing prices. Our maintained assumptions are that Metzler and Lerner paradoxes are ruled out; thus, for $(\tau, \tau^{*1}, \tau^{*2}) \in \Upsilon$, we assume that

$$\begin{aligned} \frac{dp(\tau, \widetilde{p}^w)}{d\tau} \quad &> \quad 0 > \frac{dp^{*i}(\tau^{*i}, \widetilde{p}^w)}{d\tau^{*i}} \\ \frac{\partial \widetilde{p}^w(\tau, \tau^{*1}, \tau^{*2})}{\partial \tau} \quad &< \quad 0 < \frac{\partial \widetilde{p}^w(\tau, \tau^{*1}, \tau^{*2})}{\partial \tau^{*i}}. \end{aligned} \tag{4}$$

The world-price inequalities in (4) ensure that each country is large (i.e., that each country can improve its terms of trade by raising its import tariff).

Government Preferences Following Bagwell and Staiger (1999, 2002), we define a general family of government preferences. This family includes the traditional case in which governments maximize national income but allows as well that governments may have distributional concerns. Specifically, for a given vector of tariffs, the home government welfare function is represented as $W(p(\tau, \widetilde{p}^w), \widetilde{p}^w)$ while the welfare function for the government of foreign country $*i$ is represented as $W^{*i}(p^{*i}(\tau^{*i}, \widetilde{p}^w), \widetilde{p}^w)$. For simplicity, we refer to W as the welfare of the home country and to W^{*i} as the welfare of foreign country $*i$.

Our primary assumption on welfare functions is that, holding its local price fixed, each government values an improvement in its terms of trade:

$$W_{\widetilde{p}^w}(p(\tau, \widetilde{p}^w), \widetilde{p}^w) < 0 < W^{*i}_{\widetilde{p}^w}(p^{*i}(\tau^{*i}, \widetilde{p}^w), \widetilde{p}^w) \tag{5}$$

for $i = 1, 2$ and for $(\tau, \tau^{*1}, \tau^{*2}) \in \Upsilon$.[20] As Bagwell and Staiger (1999, 2002) discuss in detail, the experiment considered here may be understood as corresponding to underlying tariff changes whereby a government raises its own tariff while a trading partner reduces

[19] In our analysis below, this assumption ensures that we can assign tariff vectors under which one foreign country receives no trade volume.

[20] For a given world price, we also impose an assumption that each country has single-peaked preferences with respect to its own tariff (or local price). We postpone a formal statement of this assumption until Section 4.

its tariff, with the end result being that the government's local price is unchanged while its terms of trade improves. This assumption is satisfied when governments maximize national income and also in the leading political-economy models of trade policy, as Bagwell and Staiger (1999, 2002) discuss.

Nash Tariffs In the absence of a trade agreement, we assume that governments would each set their optimal unilateral policies, leading to a Nash equilibrium. To provide additional context for our analysis, we define and briefly characterize the Nash tariffs.

The optimal or best-response tariffs for the home country and foreign country $*i$ are respectively defined by

$$\begin{aligned} W_p \frac{dp}{d\tau} + W_{\widetilde{p}^w} \frac{\partial \widetilde{p}^w}{\partial \tau} &= 0 \\ W^{*i}_{p^{*i}} \frac{dp^{*i}}{d\tau^{*i}} + W^{*i}_{\widetilde{p}^w} \frac{\partial \widetilde{p}^w}{\partial \tau^{*i}} &= 0, \end{aligned} \tag{6}$$

where $i = 1, 2$ and for simplicity we suppress notation for functional dependencies. A *Nash equilibrium* is a tariff vector, $(\tau_N, \tau_N^{*1}, \tau_N^{*2}) \in \Upsilon$, satisfying these three first-order conditions. We assume that a unique Nash equilibrium exists, and we refer to the associated tariffs as *Nash tariffs*.[21]

Bagwell and Staiger (1999, 2002) show that the Nash tariffs are inefficient, where efficiency is measured relative to the preferences of governments (i.e., relative to the welfare functions, W, W^{*1} and W^{*2}). The key intuition is that each government is motivated in part by the terms-of-trade implications of its trade-policy selection, and a terms-of-trade gain for the home country is a terms-of-trade loss for the foreign countries. As Bagwell and Staiger (1999, 2002) discuss, this means that starting from the Nash tariffs each government would gain from a small increase in its trade volume (i.e., a small decrease in the relative price of its import good) if this could be achieved without altering its terms of trade.

The formal argument is useful for our subsequent discussion and is as follows. Using (4), (5) and (6), we may easily verify that $W_p < 0 < W^{*i}_{p^{*i}}$ at the Nash tariffs. Now suppose that the home country and foreign country $*i$ exchange small reciprocal tariff cuts that preserve the terms of trade. Since $p = \tau p^w$ and $p^{*i} = p^w/\tau^{*i}$, it then follows that p falls and p^{*i} rises. With $W_p < 0 < W^{*i}_{p^{*i}}$ at the Nash tariffs, we thus conclude that the home country and foreign country $*i$ both enjoy welfare gains from exchanging small reciprocal tariff cuts that preserve the terms of trade.

A government cannot alter its local price and preserve its terms of trade with a uni-

[21] As is well known (see Dixit, 1987), autarky Nash tariff equilibria typically exist as well. Our focus here is on characterizing interior Nash tariffs, which seems the natural focus for our purposes given that in Section 6 we consider the possibility that these tariffs are the initial tariffs from which countries bargain.

lateral trade-policy adjustment; however, under (4) and as we discuss in greater detail next, governments can achieve trade-volume increases without altering the terms of trade if they liberalize trade through reciprocal adjustments in trade policies.

Reciprocity We now explore notions of reciprocal adjustments in trade policies. Motivated by the preceding discussion, we are interested in the effects of reciprocal adjustments on negotiating partners and also third parties.

To begin our discussion, we follow Bagwell and Staiger (2005) and define a *welfare-preservation property* for the model. Specifically, for tariff vectors in Υ, if the home country and foreign country $*i$ negotiate changes in their respective tariffs that leave unaltered the world price, then the welfare of the government of foreign country $*j$, where $j \neq i$, is unaltered as well. This implication is easily verified. If the negotiation between the governments of home and foreign country i leaves the world price $\widetilde{p}^w$ fixed at some level p_0^w, and if the tariff τ^{*j} of foreign country $*j$ does not change, then $p^{*j} = \widetilde{p}^w/\tau^{*j}$ is also unaltered and so $W^{*j}(p^{*j}(\tau^{*j}, \widetilde{p}^w), \widetilde{p}^w)$ is unaltered as well.

When would a negotiated change in the tariffs of the home country and foreign country $*i$ leave the world price unaltered? Referring to (4), we see that a negotiated change in the tariffs of the home country and foreign country $*i$ can preserve the world price $\widetilde{p}^w$ only if the tariffs move in the same direction. Using foreign country $*i$'s trade-balance condition (2), Bagwell and Staiger (2005) go further and argue that the world price remains unaltered in this two-good setting if the home country and foreign country $*i$ negotiate tariff changes that satisfy the principle of bilateral reciprocity whereby the value of any change in foreign country $*i$'s exports is equal to the value of any change in its imports.[22] Given our maintained assumption that the home country's trade policy is nondiscriminatory, the principle of bilateral reciprocity thus completely insulates third parties from spillover effects associated with bilateral negotiations.

For our purposes here, it is convenient to formally define the principle of bilateral reciprocity directly in terms of its implication for the world price. To this end, we specify an initial tariff vector, $(\tau_0, \tau_0^{*1}, \tau_0^{*2}) \in \Upsilon$, and associated world price, $p_0^w = \widetilde{p}^w(\tau_0, \tau_0^{*1}, \tau_0^{*2})$, and consider a negotiation between home and foreign country $*1$, say. With τ^{*2} held fixed at the initial level τ_0^{*2}, the negotiated tariff vector may be represented as $(\tau_1, \tau_1^{*1}, \tau_0^{*2}) \in \Upsilon$,

[22]Formally, consider a negotiation between the home country and, say, foreign country $*1$ concerning changes in their respective tariffs. Let $(\tau_0, \tau_0^{*1}, \tau_0^{*2}) \in \Upsilon$ and $(\tau_1, \tau_1^{*1}, \tau_0^{*2}) \in \Upsilon$ represent the initial and negotiated tariff vectors, with associated world prices $p_0^w \equiv \widetilde{p}^w(\tau_0, \tau_0^{*1}, \tau_0^{*2})$ and $p_1^w \equiv \widetilde{p}^w(\tau_1, \tau_1^{*1}, \tau_0^{*2})$. Let the corresponding local prices in foreign country $*1$ be denoted as $p_0^{*1} = p_0^w/\tau_0^{*1}$ and $p_1^{*1} = p_1^w/\tau_1^{*1}$. Bagwell and Staiger (2005) define the principle of bilateral reciprocity as holding if and only if

$$M^{*1}(p_1^{*1}, p_1^w) - M^{*1}(p_0^{*1}, p_0^w) = p_0^w[E^{*1}(p_1^{*1}, p_1^w) - E^{*1}(p_0^{*1}, p_0^w)]$$

As Bagwell and Staiger (2005) argue, after applying (2) for $i = 1$ at both the initial and negotiated tariff vectors, it follows easily that the principle of bilateral reciprocity holds if and only if $p_0^w = p_1^w$.

with an associated world price that is given as $p_1^w = \widetilde{p}^w(\tau_1, \tau_1^{*1}, \tau_0^{*2})$. We now say that a negotiated tariff change between home and foreign country $*1$ satisfies the principle of *bilateral reciprocity* if the world price is unchanged: $p_0^w = p_1^w$. The definition extends in the obvious way if the bilateral negotiation is between the home country and foreign country $*2$.

Even though two countries are unable to alter the terms of trade when undertaking a negotiation that satisfies the principle of bilateral reciprocity, they are able to change their local prices and thereby experience welfare effects as a consequence of such a negotiation. Indeed, as noted above, starting at the Nash tariffs, both negotiating countries gain from exchanging small tariff cuts that satisfy the principle of bilateral reciprocity. Furthermore, as the welfare-preservation property indicates, the third country experiences no welfare effect as a consequence of a negotiated tariff change that is undertaken by the other countries and that satisfies bilateral reciprocity.

We turn now to multilateral negotiations in which the tariffs of *all* countries may change. One implication is that all three countries may experience welfare effects even when tariffs satisfy a notion of multilateral reciprocity. To make this argument precise, we first must define multilateral reciprocity.

To this end, we now consider a multilateral negotiation among all three countries. Let us specify an initial tariff vector, $(\tau_0, \tau_0^{*1}, \tau_0^{*2}) \in \Upsilon$, and associated world price, $p_0^w = \widetilde{p}^w(\tau_0, \tau_0^{*1}, \tau_0^{*2})$, and also a negotiated tariff vector, $(\tau_1, \tau_1^{*1}, \tau_1^{*2}) \in \Upsilon$, and associated world price, $p_1^w = \widetilde{p}^w(\tau_1, \tau_1^{*1}, \tau_1^{*2})$. We say that a negotiated tariff change satisfies the principle of *multilateral reciprocity* if the world price is unchanged: $p_0^w = p_1^w$. Of course, multilateral reciprocity is satisfied if the home country negotiates with only one foreign country and the negotiation conforms with bilateral reciprocity. Multilateral reciprocity is likewise satisfied if the home country negotiates separately with both foreign countries, with each individual negotiation satisfying bilateral reciprocity. Multilateral reciprocity is also consistent, however, with a scenario where individual negotiations, if viewed in isolation, would violate bilateral reciprocity. Finally, multilateral reciprocity is consistent as well with a scenario in which only the foreign tariffs are changed, where under (4) the world price is maintained only if the foreign tariffs are changed in opposite directions.

Building directly on arguments made above, we can now report as well a simple welfare result for negotiated tariff cuts that satisfy the principle of multilateral reciprocity. Specifically, starting at the Nash equilibrium, if all three countries offer slight tariff cuts and the three tariff cuts in combination satisfy the principle of multilateral reciprocity, then all three countries experience a welfare gain.

3 The Constructed Mechanism

With the basic model and some key properties now defined, we are prepared to analyze the manner in which multilateral tariffs may be determined through negotiation. Motivated by GATT tariff bargaining behavior, our approach is to require that any proposed change in tariffs satisfies the principles of non-discrimination and multilateral reciprocity. In line with renegotiation provisions found in GATT Article XXVIII, we require further that no country is ever forced to accept a trade volume in excess of that implied by its proposal.[23] The remaining challenge is then to introduce any priority or rationing rules that may be needed for situations in which one side of the market is short relative to the other. We address these issues in this section and construct a mechanism that translates simultaneous tariff proposals from each country into a vector of assigned tariffs. In the following section, we then argue that the constructed mechanism results in a dominant strategy for each country.

Setup We assume that the three countries begin their negotiation with an exogenous initial tariff vector, $(\tau_0, \tau_0^{*1}, \tau_0^{*2}) \in \Upsilon$. The associated initial world price is represented as $p_0^w \equiv \widetilde{p}^w(\tau_0, \tau_0^{*1}, \tau_0^{*2}) > 0$.

Strategies The game form involves simultaneous proposals by all three countries. We impose two restrictions on the strategy set. First, we assume that each country can only make proposals concerning its own tariff and that of its trading partner(s). Since the two foreign countries do not trade with one another, this means that no foreign country proposes a change in the tariff of the other foreign country. Second, we assume that each proposal if accepted must maintain the world price. The latter restriction means that we are restricting proposals to satisfy multilateral reciprocity, as that term is defined above.[24]

Formally, the respective strategy spaces are:

Home country's strategy: A proposal $T_h \equiv (T_h^h, T_h^{*1}, T_h^{*2}) \in \Upsilon$ such that $p_0^w \equiv \widetilde{p}^w(T_h^h, T_h^{*1}, T_h^{*2})$.

Foreign country $*1$'s strategy: A proposal $T_{*1} \equiv (T_{*1}^h, T_{*1}^{*1}, T_{*1}^{*2}) \in \Upsilon$ such that $p_0^w \equiv \widetilde{p}^w(T_{*1}^h, T_{*1}^{*1}, T_{*1}^{*2})$ and $T_{*1}^{*2} = \tau_0^{*2}$.

[23] As Bagwell and Staiger (1999, 2002) discuss in detail, GATT Article XXVIII contains renegotiation provisions under which a country can initiate reciprocal tariff increases that preserve the terms of trade. If a negotiated tariff agreement were such that a country achieved greater trade volume than it preferred at the given terms of trade, then the country could subsequently utilize GATT Article XXVIII and renegotiate to achieve a preferred trade volume at the given terms of trade. Following Bagwell and Staiger (1999, 2002), we capture the implications of this constraint here by assuming that no country can be forced to accept a trade volume in excess of that implied by its proposal.

[24] Recall that the MFN requirement is built into the model itself, with the assumption that the home country has only one import tariff, τ.

Foreign country $*2$'s strategy: A proposal $T_{*2} \equiv (T_{*2}^h, T_{*2}^{*1}, T_{*2}^{*2}) \in \Upsilon$ such that $p_0^w \equiv \widetilde{p}^w(T_{*2}^h, T_{*2}^{*1}, T_{*2}^{*2})$ and $T_{*2}^{*1} = \tau_0^{*1}$.

Using h to denote the home country and $*i$ to denote foreign country $*i$, we interpret the notation for proposals as follows: T_h is the tariff vector proposed by the home country, T_h^h is the tariff that the home country proposes for itself, T_h^{*i} is the tariff that the home country proposes for foreign country $*i$, T_{*i} is the tariff vector proposed by foreign country $*i$, T_{*i}^{*i} is the tariff proposed by foreign country $*i$ for itself, T_{*i}^h is the tariff that foreign country $*i$ proposes for the home country, and $T_{*i}^{*j} = \tau_0^{*j}$ is the (status quo) tariff that foreign country $*i$ proposes for foreign country $*j$, where $i \neq j$. Let S_h, S_{*1} and S_{*2} denote the respective strategy spaces so defined, and let $S \equiv S_h \times S_{*1} \times S_{*2}$.

The proposal of the home country may entail tariff changes by some or all countries, and the requirement of multilateral reciprocity ensures that any such changes would preserve the world price at its initial level. By contrast, the proposal of foreign country $*i$ can only entail changes in the tariffs of the home country and foreign country $*i$, and so the requirement of multilateral reciprocity for the proposal of foreign country $*i$ amounts to a requirement of bilateral reciprocity.

Summarizing, once the simultaneous proposals are made, we have the following objects:

$$\begin{aligned}
T_h &\equiv (T_h^h, T_h^{*1}, T_h^{*2}), T_{*1} \equiv (T_{*1}^h, T_{*1}^{*1}, T_{*1}^{*2}) \text{ and } T_{*2} \equiv (T_{*2}^h, T_{*2}^{*1}, T_{*2}^{*2}), \text{ where} \\
p_0^w &\equiv \widetilde{p}^w(T_h^h, T_h^{*1}, T_h^{*2}) = \widetilde{p}^w(T_{*1}^h, T_{*1}^{*1}, T_{*1}^{*2}) = \widetilde{p}^w(T_{*2}^h, T_{*2}^{*1}, T_{*2}^{*2}), \\
T_{*1}^{*2} &= \tau_0^{*2} \text{ and } T_{*2}^{*1} = \tau_0^{*1}.
\end{aligned}$$

Equivalence Class From the point of view of any single country, there exists a continuum of tariff adjustments by the other two countries that leave unaltered the world price. For any foreign country, tariff changes by the home country and the other foreign country that preserve the world price correspond to changes that satisfy bilateral reciprocity. By the welfare-preservation property, such adjustments leave the former foreign country indifferent. We recall also that, by (4), a world-price preserving tariff adjustment between the home country and any one foreign country requires that the tariffs are changed in the same direction. Foreign tariffs also may be adjusted in a way that maintains the world price and thus leaves the home country indifferent. In this case, as previously noted, we may use (4) to conclude that the adjusted foreign tariffs move in opposite directions.

In recognition of such policies, we are led to define for each country a class of tariffs for the other countries that are equivalent from the former country's perspective. We begin by defining an equivalence class of tariffs for each foreign country.

Definition 1 *Given $T_{*1} \equiv (T_{*1}^h, T_{*1}^{*1}, T_{*1}^{*2})$ and $p_0^w \equiv \widetilde{p}^w(T_{*1})$, we may define an equivalence* *class for foreign country* $*1$ *as a tariff set*

$$EC_{*1}(T_{*1}) \equiv \{\widehat{T}_{*1} \equiv (\widehat{T}^h_{*1}, \widehat{T}^{*1}_{*1}, \widehat{T}^{*2}_{*1})\}$$

that satisfies the requirements that (i) $\widehat{T}^{*1}_{*1} = T^{*1}_{*1}$ *and (ii)* $\widetilde{p}^w(\widehat{T}_{*1}) = p^w_0$*. Likewise, given* $T_{*2} \equiv (T^h_{*2}, T^{*1}_{*2}, T^{*2}_{*2})$ *and* $p^w_0 \equiv \widetilde{p}^w(T_{*2})$*, we may define an equivalence class for foreign country* $*2$ *as a tariff set*

$$EC_{*2}(T_{*2}) \equiv \{\widehat{T}_{*2} \equiv (\widehat{T}^h_{*2}, \widehat{T}^{*1}_{*2}, \widehat{T}^{*2}_{*2})\}$$

that satisfies the requirements that (i) $\widehat{T}^{*2}_{*2} = T^{*2}_{*2}$ *and (ii)* $\widetilde{p}^w(\widehat{T}_{*2}) = p^w_0$*.*

Thus, an equivalence class for foreign country $*i$ maintains $*i$'s proposed tariff for itself and allows for alternative tariffs for home and foreign country $*j$, where $j \neq i$, such that these alternative tariffs when joined with $*i$'s proposed tariff for itself serve to maintain the initial world price. Notice that an equivalence class is not empty, since $T_{*i} \in EC_{*i}(T_{*i})$. Next, we observe that we can *reach* any member of $EC_{*i}(T_{*i})$ by fixing $\widehat{T}^{*i}_{*i} = T^{*i}_{*i}$ and then allowing changes from (T^h_{*i}, T^{*j}_{*i}) to $(\widehat{T}^h_{*i}, \widehat{T}^{*j}_{*i})$ that satisfy bilateral reciprocity between home and foreign country $*j$ and that thus maintain the initial world price. Finally, let $e_{*i}(T_{*i})$ denote a representative member of $EC_{*i}(T_{*i})$. Since T_{*i} and any $e_{*i}(T_{*i}) \in EC_{*i}(T_{*i})$ generate the same world price p^w_0 and local price in foreign country $*i$ (as $*i$'s own tariff is unaltered by requirement (i)), it follows that T_{*i} and any $e_{*i}(T_{*i}) \in EC_{*i}(T_{*i})$ generate the same economic magnitudes (e.g., trade volumes) and government welfare for foreign country $*i$. The latter implication is a re-statement of the welfare-preservation property.

We now define an equivalence class of tariffs for the home country.

Definition 2 *Given* $T_h \equiv (T^h_h, T^{*1}_h, T^{*2}_h)$ *and* $p^w_0 \equiv \widetilde{p}^w(T_h)$*, we may define an equivalence class for the home country as a tariff set*

$$EC_h(T_h) \equiv \{\widehat{T}_h \equiv (\widehat{T}^h_h, \widehat{T}^{*1}_h, \widehat{T}^{*2}_h)\}$$

that satisfies the requirements that (i) $\widehat{T}^h_h = T^h_h$ *and (ii)* $\widetilde{p}^w(\widehat{T}_h) = p^w_0$*.*

Thus, an equivalence class for the home country maintains home's proposed tariff for itself and allows for alternative tariffs for the two foreign countries such that these alternative tariffs when joined with home's proposed tariff for itself serve to maintain the initial world price. Given that $T_h \in EC_h(T_h)$, we know that $EC_h(T_h)$ is not empty. We say that we can *reach* any member of $EC_h(T_h)$ by fixing $\widehat{T}^h_h = T^h_h$ and then allowing changes from (T^{*1}_h, T^{*2}_h) to $(\widehat{T}^{*1}_h, \widehat{T}^{*2}_h)$ that maintain the initial world price. Finally, since

T_h and any $e_h(T_h) \in EC_h(T_h)$ generate the same world price p_0^w and local price in the home country (as home's own tariff is unaltered by requirement (i)), it follows that T_h and any $e_h(T_h) \in EC_h(T_h)$ generate the same economic magnitudes (e.g., trade volumes) and government welfare for the home country.

Implied Import Volumes Each country's proposal can be associated with an implied import volume for itself. We now introduce some notation with which to represent for each country the import volume that is implied by its proposal.

Definition 3 *The home country's proposal T_h is associated with an implied import volume for home defined as*

$$M_h \equiv M(p(T_h^h, p_0^w), p_0^w).$$

Similarly, foreign country $*i$'s proposal T_{*i} is associated with an implied import volume for foreign country $*i$ defined as

$$M_{*i} \equiv M^{*i}(p^{*i}(T_{*i}^{*i}, p_0^w), p_0^w).$$

Notice that, given the initial world price, each country's implied import volume depends only on that country's proposed tariff for its own imports. Notice also that, for any given country and proposal by that country, any member of the resulting equivalence class entails the same tariff for that country and the same world price, and so generates as well the same implied import volume for that country. Finally, since proposals are members of Υ, we also observe that $M_h > 0$ and $M_{*i} > 0$ for $i = 1, 2$.

Agreement We now define agreement between the three tariff proposals.

Definition 4 *The proposals $\{T_h, T_{*1}, T_{*2}\}$ agree if and only if there exist $e_h(T_h) \in EC_h(T_h)$, $e_{*1}(T_{*1}) \in EC_{*1}(T_{*1})$ and $e_{*2}(T_{*2}) \in EC_{*2}(T_{*2})$ such that $e_h(T_h) = e_{*1}(T_{*1}) = e_{*2}(T_{*2})$.*

Thus, proposals agree when a common tariff vector is in the equivalence class for each country.

We observe that the common tariff vector under agreement must use the proposal that each country makes for its own tariff. We record this observation as follows:

Lemma 1 *The proposals $\{T_h, T_{*1}, T_{*2}\}$ agree if and only if*

$$(T_h^h, T_{*1}^{*1}, T_{*2}^{*2}) \in EC_h(T_h) \cap EC_{*1}(T_{*1}) \cap EC_{*2}(T_{*2}).$$

We now illustrate the notion of agreement with two examples. For simplicity, we assume in each example that the initial tariffs are $(\tau_0, \tau_0^{*1}, \tau_0^{*2}) = (15, 15, 15)$, the initial world price is $p_0^w = 1$, and the world price is preserved when one unit of home liberalization is balanced against a total of one unit of liberalization from the foreign countries. In the first example, the common tariff vector that lies in all three equivalence classes is simply the tariff proposal of the home country. The second example illustrates, however, that the common tariff vector that falls in all three equivalence classes may differ in part from all three proposals.

Example 1 *Suppose that home's proposal is* $T_h = (5, 10, 10)$*, which means that home proposes to cut its tariff by* 10 *in exchange for cuts of* 5 *by both of its trading partners. Suppose that foreign country* $*1$*'s proposal is* $T_{*1} = (10, 10, 15)$*, so that foreign country* $*1$ *proposes to exchange tariff cuts of* 5 *with the home country while leaving foreign country* $*2$*'s tariff at its initial level. Assume that foreign country* $*2$ *makes a symmetric proposal,* $T_{*2} = (10, 15, 10)$*. The proposals of home and each foreign country* $*i$ *maintain the world price under our assumptions, since* $p_0^w \equiv \widetilde{p}^w(15, 15, 15) = \widetilde{p}^w(5, 10, 10) = \widetilde{p}^w(10, 10, 15) = \widetilde{p}^w(10, 15, 10)$*. We establish now that the proposals agree since the home proposal* $T_h = (5, 10, 10)$ *is a member of all three equivalence classes. It is immediate that* $T_h \in EC_h(T_h)$*. Next, observe that given* $T_{*1} = (10, 10, 15)$*, we can reach* $T_h = (5, 10, 10)$ *by having home and foreign country* $*2$ *exchange tariff cuts of* 5 *units, which preserves the world price and leaves foreign country* $*1$ *indifferent. In other words,* $T_h \in EC_{*1}(T_{*1})$*. By a similar argument,* $T_h \in EC_{*2}(T_{*2})$*. We conclude that the proposals* $\{T_h = (5, 10, 10), T_{*1} = (10, 10, 15), T_{*2} = (10, 15, 10)\}$ *agree.*

Example 2 *Suppose that home's proposal is* $T_h = (5, 10, 10)$ *but that* $T_{*1} = (12, 12, 15)$ *and* $T_{*2} = (8, 15, 8)$*. The proposals of home and each foreign country* $*i$ *maintain the world price under our assumptions, since* $p_0^w \equiv \widetilde{p}^w(15, 15, 15) = \widetilde{p}^w(5, 10, 10) = \widetilde{p}^w(12, 12, 15) = \widetilde{p}^w(8, 15, 8)$*. We establish now that the proposals agree, since the proposal* $(5, 12, 8)$ *is a member of all three equivalence classes. To show that* $(5, 12, 8) \in EC_h(T_h)$*, we note that given* T_h *we can reach* $(5, 12, 8)$ *by having foreign country* $*1$ *raise its tariff by* 2 *units while foreign country* $*1$ *cuts its tariff by* 2 *units, which preserves the world price and leaves the home country indifferent. Next,* $(5, 12, 8) \in EC_{*1}(T_{*1})$ *follows, since we can reach* $(5, 12, 8)$ *from* T_{*1} *by having home and foreign country* $*2$ *exchange tariff cuts of* 7 *units, which preserves the world price and leaves foreign country* $*1$ *indifferent. Likewise, starting at* T_{*2} *we can reach* $(5, 12, 8)$ *by having home and foreign country* $*1$ *exchange tariff cuts of* 3 *units, which preserves the world price and leaves foreign country* $*2$ *indifferent, thus establishing that* $(5, 12, 8) \in EC_{*2}(T_{*2})$*. We conclude that the proposals* $\{T_h = (5, 10, 10), T_{*1} = (12, 12, 15), T_{*2} = (8, 15, 8)\}$ *agree.*

We may now report the following implication of agreement:

Lemma 2 *The proposals* $\{T_h, T_{*1}, T_{*2}\}$ *agree if and only if* $p_0^w M_h = M_{*1} + M_{*2}$*.*

Proof. The home proposal T_h implies the market-clearing world price of $\widetilde{p}^w(T_h) = p_0^w$ and an implied import volume for home of $M_h = M(p(T_h^h, p_0^w), p_0^w)$. For the home proposal T_h, the home trade-balance condition (1) may be stated as

$$p_0^w M_h = E(p(T_h^h, p_0^w), p_0^w) \tag{7}$$

Suppose first that the proposals $\{T_h, T_{*1}, T_{*2}\}$ agree. Then we know from Lemma 1 that $(T_h^h, T_{*1}^{*1}, T_{*2}^{*2}) \in EC_h(T_h) \cap EC_{*1}(T_{*1}) \cap EC_{*2}(T_{*2})$. Since $(T_h^h, T_{*1}^{*1}, T_{*2}^{*2}) \in EC_h(T_h)$, we have that $\widetilde{p}^w(T_h^h, T_{*1}^{*1}, T_{*2}^{*2}) = p_0^w$. It follows that

$$\begin{aligned} E(p(T_h^h, p_0^w), p_0^w) &= M^{*1}(p^{*1}(T_{*1}^{*1}, p_0^w), p_0^w) + M^{*2}(p^{*2}(T_{*2}^{*2}, p_0^w), p_0^w) \\ &= M_{*1} + M_{*2}. \end{aligned}$$

We may now refer to (7) to conclude that $p_0^w M_h = M_{*1} + M_{*2}$.

Suppose next that the proposals $\{T_h, T_{*1}, T_{*2}\}$ are such that $p_0^w M_h = M_{*1} + M_{*2}$. Using (7), we may rewrite this equality as

$$E(p(T_h^h, p_0^w), p_0^w) = M^{*1}(p^{*1}(T_{*1}^{*1}, p_0^w), p_0^w) + M^{*2}(p^{*2}(T_{*2}^{*2}, p_0^w), p_0^w).$$

It follows from the market-clearing condition (3) that $\widetilde{p}^w(T_h^h, T_{*1}^{*1}, T_{*2}^{*2}) = p_0^w$. Given that the proposal vector $(T_h^h, T_{*1}^{*1}, T_{*2}^{*2})$ employs the proposal that each country makes for its own tariff and satisfies $\widetilde{p}^w(T_h^h, T_{*1}^{*1}, T_{*2}^{*2}) = p_0^w$, we conclude that

$$(T_h^h, T_{*1}^{*1}, T_{*2}^{*2}) \in EC_h(T_h) \cap EC_{*1}(T_{*1}) \cap EC_{*2}(T_{*2}).$$

Thus, by Lemma 1, the proposals $\{T_h, T_{*1}, T_{*2}\}$ agree. ■

We further note that under agreement the common tariff vector $(T_h^h, T_{*1}^{*1}, T_{*2}^{*2})$ is a member of Υ. This follows from the strategy-space restriction that each country's own proposal vector belongs to Υ. Since the common tariff vector under agreement delivers the world price $\widetilde{p}^w(T_h^h, T_{*1}^{*1}, T_{*2}^{*2}) = p_0^w$, the common tariff vector also results in the same import volume for each country as does that country's own proposal vector.

Mechanism We define a *mechanism* as a pair $(S, g(\cdot))$, where S is the strategy space as defined above and g is an outcome function that maps from a vector of tariff proposals, (T_h, T_{*1}, T_{*2}), to a vector of tariffs, $(\tau, \tau^{*1}, \tau^{*2}) \in \Upsilon_+$. Given a vector of tariff proposals, a mechanism thus *assigns (*or *selects)* a tariff vector for application.

We impose two *baseline rules or requirements* for the mechanism that we construct. First, if the tariff proposals agree, then we require that the mechanism assigns the tariff vector constituted of each country's proposal for its own tariff: $(T_h^h, T_{*1}^{*1}, T_{*2}^{*2})$. We know from Lemma 1 that this is the only tariff vector that is in the equivalence class for each country. We also know from Lemma 2 that the proposals agree if and only if the home country and foreign countries (in aggregate) propose the same value of implied import volumes ($p_0^w M_h = M_{*1} + M_{*2}$). Second, if the tariff proposals do not agree, then we require that the mechanism assigns a tariff vector that maximizes trade volume valued at world prices while not forcing any country to import more than its implied import volume and while preserving the initial world price. As we will see, under disagreement, the baseline rules do not uniquely determine the outcome function, and so we will add further rules below to ensure a unique mapping for our constructed mechanism. For now, we note that there are two ways that disagreement may occur: the home country may be on the long side ($p_0^w M_h > M_{*1} + M_{*2}$), or the home country may be on the short side ($p_0^w M_h < M_{*1} + M_{*2}$). We address each of these two cases and define corresponding assignment rules. Then, in the next section, we characterize dominant strategies for countries when the resulting constructed mechanism is used.

Agreement: Our first requirement for the mechanism is associated with the case in which the tariff proposals agree. As just noted, in this case, we require that the mechanism assigns the tariff vector constituted of each country's proposal for its own tariff: $(T_h^h, T_{*1}^{*1}, T_{*2}^{*2})$. By Lemma 1, this is the unique tariff vector that is in the equivalence class for each country. We also know from Lemma 2 that the proposals agree if and only if $p_0^w M_h = M_{*1} + M_{*2}$.

Disagreement: Our second requirement for the mechanism is associated with the case in which the tariff proposals fail to agree. By Lemma 2, failure to agree, or disagreement, occurs if and only if $p_0^w M_h \neq M_{*1} + M_{*2}$. When disagreement occurs, we require that the mechanism assigns a tariff vector that maximizes trade volume valued at world prices while not forcing any country to import more than its implied import volume and while preserving the initial world price. After formally stating the associated program, we consider its implications when home is on the long side ($p_0^w M_h > M_{*1} + M_{*2}$) and when home is on the short side ($p_0^w M_h < M_{*1} + M_{*2}$).

To state the program, we must define trade volume valued at world prices. Consider any vector of applied tariffs, $(\tau, \tau^{*1}, \tau^{*2}) \in \Upsilon_+$, for which $\widetilde{p}^w(\tau, \tau^{*1}, \tau^{*2}) = p_0^w$. We define the associated value of trade volume as

$$TV(\tau, \tau^{*1}, \tau^{*2}) \equiv p_0^w M(p(\tau, p_0^w), p_0^w) + \sum_{i=1,2} M^{*i}(p^{*i}(\tau^{*i}, p_0^w), p_0^w). \tag{8}$$

Notice that the restriction $\widetilde{p}^w(\tau, \tau^{*1}, \tau^{*2}) = p_0^w$ is built into the definition of $TV(\tau, \tau^{*1}, \tau^{*2})$.

Consider now any vector of tariff proposals, (T_h, T_{*1}, T_{*2}), for which $p_0^w M_h \neq M_{*1} + M_{*2}$.

Our *disagreement program* is defined as follows:

$$\max_{(\tau,\tau^{*1},\tau^{*2})\in\Upsilon_+} TV(\tau,\tau^{*1},\tau^{*2}) \equiv p_0^w M(p(\tau,p_0^w),p_0^w) + \sum_{i=1,2} M^{*i}(p^{*i}(\tau^{*i},p_0^w),p_0^w)$$

subject to

$$\begin{aligned}
\widetilde{p}^w(\tau,\tau^{*1},\tau^{*2}) &= p_0^w \\
M(p(\tau,p_0^w),p_0^w) &\leq M_h \\
M^{*i}(p^{*i}(\tau^{*i},p_0^w),p_0^w) &\leq M_{*i}, \text{ for } i=1,2
\end{aligned}$$

Our second requirement now may be succinctly stated: whenever disagreement occurs, the mechanism must assign a tariff vector that is a solution to the disagreement program.

Home Long: We begin with the case in which the tariff proposals are such that the home country is on the long side:

$$p_0^w M_h > M_{*1} + M_{*2}. \tag{9}$$

We claim that in this case a mechanism that satisfies our baseline rules must assign the tariff vector

$$(\widetilde{\tau}, T_{*1}^{*1}, T_{*2}^{*2}) \tag{10}$$

where $\widetilde{\tau} = \widetilde{\tau}(T_{*1}^{*1}, T_{*2}^{*2})$ is defined to satisfy

$$\widetilde{p}^w(\widetilde{\tau}, T_{*1}^{*1}, T_{*2}^{*2}) = p_0^w. \tag{11}$$

Notice here that, conditional on (9) holding, the proposed assignment rule uses only the foreign proposals and assigns to each foreign country the tariff that it proposed for itself.

To establish this claim, we state and prove the following:

Lemma 3 *For a vector of tariff proposals (T_h, T_{*1}, T_{*2}) such that (9) holds, the unique solution to the disagreement program is given by the tariff vector $(\widetilde{\tau}, T_{*1}^{*1}, T_{*2}^{*2})$ where $\widetilde{\tau}$ is defined by (11).*

Proof. The assigned tariff vector $(\widetilde{\tau}, T_{*1}^{*1}, T_{*2}^{*2})$ where $\widetilde{\tau}$ is defined by (11) obviously maintains the initial world price. It also satisfies the constraint that implied import volumes are not exceeded. To see this, observe that at the assigned tariff vector foreign country $*i$ imports

$$M^{*i}(p^{*i}(T_{*i}^{*i}, p_0^w), p_0^w) = M_{*i}. \tag{12}$$

Next, at the assigned tariff vector, the home country imports

$$\begin{aligned} M(p(\widetilde{\tau}, p_0^w), p_0^w) &= [1/p_0^w] E(p(\widetilde{\tau}, p_0^w), p_0^w) \\ &= [1/p_0^w] \sum_{i=1,2} M^{*i}(p^{*i}(T_{*i}^{*i}, p_0^w), p_0^w) \\ &= [1/p_0^w][M_{*1} + M_{*2}] \\ &< M_h, \end{aligned} \tag{13}$$

where the first equality follows from the home trade-balance condition (1), the second equality follows from (11) and the market-clearing condition (3), the third equality uses (12), and the inequality employs (9).

Finally, we confirm that, given the implied import volume limits and world price, the assigned tariff vector also maximizes the value of trade volume. To see this, we consider an arbitrary vector of tariffs, $(\tau, \tau^{*1}, \tau^{*2}) \in \Upsilon_+$, for which $\widetilde{p}^w(\tau, \tau^{*1}, \tau^{*2}) = p_0^w$ and such that no country imports a volume in excess of its implied import volume. In other words, we consider any tariff vector that satisfies the constraints of the disagreement program.

Using the definition of $TV(\tau, \tau^{*1}, \tau^{*2})$ given in (8) and the home trade-balance condition (1), $\widetilde{p}^w(\tau, \tau^{*1}, \tau^{*2}) = p_0^w$ and the market-clearing condition (3), and (12), we obtain

$$\begin{aligned} TV(\tau, \tau^{*1}, \tau^{*2}) &= E(p(\tau, p_0^w), p_0^w) + \sum_{i=1,2} M^{*i}(p^{*i}(\tau^{*i}, p_0^w), p_0^w) \\ &= 2[M^{*1}(p^{*1}(\tau^{*1}, p_0^w), p_0^w) + M^{*2}(p^{*2}(\tau^{*2}, p_0^w), p_0^w)] \\ &\leq 2[M_{*1} + M_{*2}] \\ &= 2[M^{*1}(p^{*1}(T_{*1}^{*1}, p_0^w), p_0^w) + M^{*2}(p^{*2}(T_{*2}^{*2}, p_0^w), p_0^w)] \\ &= TV(\widetilde{\tau}, T_{*1}^{*1}, T_{*2}^{*2}), \end{aligned} \tag{14}$$

where the inequality follows from the restriction that imported volumes for foreign countries not exceed their respective implied import volume limits. Since by (12) the assigned tariff vector ensures that both foreign countries import volumes that equal their respective implied import volume limits, the assigned vector of tariffs thus achieves the maximum value for the value of trade volume.

In fact, given the proposals, any tariff vector $(\tau, \tau^{*1}, \tau^{*2}) \neq (\widetilde{\tau}, T_{*1}^{*1}, T_{*2}^{*2})$ such that $(\tau, \tau^{*1}, \tau^{*2}) \in \Upsilon_+$, $\widetilde{p}^w(\tau, \tau^{*1}, \tau^{*2}) = p_0^w$ and no country imports a volume in excess of its implied import volume must deliver strictly less trade volume: $TV(\tau, \tau^{*1}, \tau^{*2}) < TV(\widetilde{\tau}, T_{*1}^{*1}, T_{*2}^{*2})$. This is because the proposal can be distinct while maintaining the initial world price only if $(\tau^{*1}, \tau^{*2}) \neq (T_{*1}^{*1}, T_{*2}^{*2})$. It follows that $(\tau, \tau^{*1}, \tau^{*2})$ implies a distinct trade volume for at least one foreign country; thus, since $M^{*i}(p^{*i}(T_{*i}^{*i}, p_0^w), p_0^w) = M_{*i}$ and $M^{*i}(p^{*i}(\tau^{*i}, p_0^w), p_0^w) \leq M_{*i}$ for all $i = 1, 2$, we may conclude that $TV(\tau, \tau^{*1}, \tau^{*2}) <$

$TV(\widetilde{\tau}, T_{*1}^{*1}, T_{*2}^{*2}) = 2[M_{*1} + M_{*2}]$. Consequently, our baseline rules are sufficient to ensure the unique determination of the assigned tariff vector when the tariff proposals satisfy (9). In particular, for such tariff proposals, our constructed mechanism must assign the tariff vector $(\widetilde{\tau}, T_{*1}^{*1}, T_{*2}^{*2})$ where $\widetilde{\tau}$ is defined by (11). ■

Thus, in the case of disagreement in which the home country is on the long side, our baseline rules or requirements deliver a unique assigned tariff vector $(\widetilde{\tau}, T_{*1}^{*1}, T_{*2}^{*2})$, where conditional on (9) the assigned tariff vector uses only the foreign proposals and assigns to each foreign country the tariff that it proposed for itself.

Home Short: The other case of disagreement occurs when the tariff proposals are such that the home country is short:

$$p_0^w M_h < M_{*1} + M_{*2}. \tag{15}$$

An initial point is that under our baseline rules we cannot now assign tariffs that achieve the implied import volumes for the foreign countries, since to do so would violate the implied import volume limit for the home country. To see this point, let us assume to the contrary that we assign an applied tariff vector, $(\tau, \tau^{*1}, \tau^{*2})$, for which $\widetilde{p}^w(\tau, \tau^{*1}, \tau^{*2}) = p_0^w$ and such that $M^{*i}(p^{*i}(\tau^{*i}, p_0^w), p_0^w) = M_{*i}$ for each i. Using the home trade-balance condition (1), $\widetilde{p}^w(\tau, \tau^{*1}, \tau^{*2}) = p_0^w$ and the market-clearing condition (3), $M^{*i}(p^{*i}(\tau^{*i}, p_0^w), p_0^w) = M_{*i}$ for each i, and (15), we then obtain

$$\begin{aligned}
p_0^w M(p(\tau, p_0^w), p_0^w) &= E(p(\tau, p_0^w), p_0^w) \\
&= \sum_{i=1,2} M^{*i}(p^{*i}(\tau^{*i}, p_0^w), p_0^w) \\
&= M_{*1} + M_{*2} \\
&> p_0^w M_h,
\end{aligned}$$

which means that the import volume for home under this tariff vector must exceed the home country's implied import volume limit: $M(p(\tau, p_0^w), p_0^w) > M_h$. Hence, the tariff vector that we assign must be such that at least one foreign country imports a volume that is strictly lower than its implied import volume.

Based on our discussion so far, we may anticipate that our assignment for this case will be such that the home country imports a volume that equals that implied by its proposal: $M(p(\tau, p_0^w), p_0^w) = M_h$. At least one foreign country will then import a volume that falls strictly below its implied import volume. In fact, there are a continuum of possible ways to allocate a fixed value of trade volume, $p_0^w M_h$, across the two foreign countries, even while maintaining the initial world price and ensuring that no foreign country imports a volume that exceeds its implied import volume. We require additional rules, therefore, if we seek a basis for a unique assigned tariff vector when the tariff proposals are such that the home country is short. The problem is essentially one of choosing a rationing rule for allocating the fixed value of trade volume, $p_0^w M_h$, across the two foreign countries.

One approach might be to construct a mechanism that assigns tariffs so that foreign countries split the difference, with both foreign countries importing less than the volumes implied by their respective proposals. Looking ahead toward our dominant strategy arguments, however, a potential danger with this approach is that a foreign country might overstate its desired import volume in order to diminish the extent to which its assigned import volume falls short of the import volume that it actually prefers.[25] We thus pursue a different approach here. We pick a foreign country at random, and specify for that country a tariff that delivers its implied import volume provided that the value of that volume is no greater than the value of the home country's implied import volume. Otherwise, the selected foreign country imports a volume equal in value to the home country's implied import volume. The tariff of the other foreign country is then set so as to import the remaining value, if any, of the home country's implied import volume.[26] Finally, with these assignments in place, the home country's tariff is set so as to deliver the initial world price as the market-clearing world price. As we show below, the home country's proposed tariff for itself is then the home country tariff that delivers the initial world price.

To formalize this approach, suppose that the proposals are such that (15) holds and that foreign country $*i$ is randomly selected as the "first" country. In the assigned tariff vector, foreign country $*i$ then sets the tariff τ^{*i} such that

$$M^{*i}(p^{*i}(\tau^{*i}, p_0^w), p_0^w) = \min\{M_{*i}, p_0^w M_h\}. \tag{16}$$

There are thus two cases, which we consider in turn.

The first case arises if

$$M_{*i} \geq p_0^w M_h. \tag{17}$$

For this case, we claim that the mechanism satisfies our baseline rules by assigning the

[25] For example, if $p_0^w M_h < M_{*1} + M_{*2}$ with $M_{*1} = M_{*2}$, then one approach might assign tariffs such that foreign country $*i$ imports $p_0^w M_h/2 < M_{*i}$. If the mechanism further specifies that foreign country $*i$ achieves its implied import volume limit when it instead makes a proposal that implies the import volume limit of $M_{*i}^{'} = M_{*i} + \varepsilon$, then foreign country $*i$ would have incentive to propose for itself a lower tariff that implies the import volume $M_{*i}^{'}$, even if its preferred volume is M_{*i}, since $M_{*i}^{'} = M_{*i} + \varepsilon$ is closer to M_{*i} than is $p_0^w M_h/2$. Hence, when the home country is short, dominant strategy implementation may fail under some natural (Bertrand-like) assignment rules. Dominant strategy implementation likewise fails under proportional rationing schemes (see Benassy, 1982).

[26] We could allow the "second" foreign country to choose the minimum of its implied import volume and any remaining value of the home country's implied import volume. The scenario we consider here, however, is one in which the home country is short, which is to say that the implied import volume of the second foreign country exceeds any remaining value of the country's implied import volume.

tariff vector $(\widehat{\tau}, \widehat{\tau}^{*1}, \widehat{\tau}^{*2}) \in \Upsilon_{+}$, which is defined as follows. First, $\widehat{\tau}^{*i}$ is set so as to satisfy

$$M^{*i}(p^{*i}(\tau^{*i}, p_0^w), p_0^w) = p_0^w M_h. \tag{18}$$

Next, $\widehat{\tau}^{*j}$ is set at a prohibitive level, so that

$$M^{*j}(p^{*j}(\tau^{*j}, p_0^w), p_0^w) = 0. \tag{19}$$

Finally, we define $\widehat{\tau}$ so that the world price is maintained, given these foreign tariffs:

$$\widetilde{p}^w(\widehat{\tau}, \widehat{\tau}^{*1}, \widehat{\tau}^{*2}) = p_0^w.^{27} \tag{20}$$

To establish this claim, we state and prove the following:

Lemma 4 *For a vector of tariff proposals (T_h, T_{*1}, T_{*2}) such that (15) holds in the form of the first case (17), a solution to the disagreement program is given by the tariff vector $(\widehat{\tau}, \widehat{\tau}^{*1}, \widehat{\tau}^{*2})$ where $\widehat{\tau}^{*i}$ is defined by (18), $\widehat{\tau}^{*j}$ is defined by (19) and $\widehat{\tau} = T_h^h$ is defined by (20).*

Proof. The assigned tariff vector, $(\widehat{\tau}, \widehat{\tau}^{*1}, \widehat{\tau}^{*2}) \in \Upsilon_{+}$, delivers the initial world price by (20) and is also such that no country imports a volume that exceeds its implied import volume. It is immediately clear from (17)-(19) that neither foreign country imports a volume that exceeds its implied import volume. The home country imports a volume that equals its implied import volume. To see this, we respectively use the home trade-balance condition (1), $\widetilde{p}^w(\widehat{\tau}, \widehat{\tau}^{*1}, \widehat{\tau}^{*2}) = p_0^w$ and the market-clearing condition (3), (19) and (18) to obtain

$$\begin{aligned} p_0^w M(p(\widehat{\tau}, p_0^w), p_0^w) &= E(p(\widehat{\tau}, p_0^w), p_0^w) \\ &= M^{*i}(p^{*i}(\widehat{\tau}^{*i}, p_0^w), p_0^w) + M^{*j}(p^{*j}(\widehat{\tau}^{*j}, p_0^w), p_0^w) \\ &= M^{*i}(p^{*i}(\widehat{\tau}^{*i}, p_0^w), p_0^w) \\ &= p_0^w M_h, \end{aligned} \tag{21}$$

and thus $M(p(\widehat{\tau}, p_0^w), p_0^w) = M_h$. Given this equality, it now follows that $\widehat{\tau} = T_h^h$; thus, in the first case, the tariff that is assigned to the home country is the home country's proposed tariff for itself.

Finally, we confirm that it is not possible to find another tariff vector that generates a greater value for trade volume while also delivering the initial world price and ensuring

[27] Notice that we assume here that, given the initial world price, there exists a finite tariff for foreign country $*j$ at and above which import volume into foreign country $*j$ is zero. We show in the proof of Lemma 4 that $\widehat{\tau} = T_h^h$, where $T_h \in \Upsilon$. Thus, our assumptions in Section 2 ensure the existence of $(\widehat{\tau}, \widehat{\tau}^{*1}, \widehat{\tau}^{*2}) \in \Upsilon_{+}$ such that foreign country $*j$ receives no trade volume.

that no country imports a volume in excess of its implied import volume. To see this, we consider an arbitrary vector of tariffs, $(\tau, \tau^{*1}, \tau^{*2}) \in \Upsilon_+$, for which $\widetilde{p}^w(\tau, \tau^{*1}, \tau^{*2}) = p_0^w$ and such that no country imports a volume in excess of its implied import volume. In other words, we consider any tariff vector that satisfies the constraints of the disagreement program.

Using the definition of $TV(\tau, \tau^{*1}, \tau^{*2})$ as in (8), the foreign-country trade-balance condition (2), $\widetilde{p}^w(\tau, \tau^{*1}, \tau^{*2}) = p_0^w$ and the implied market-clearing condition for good x, the requirement that the import volume of the home country not exceed its implied import volume, and (21), we obtain

$$\begin{aligned} TV(\tau, \tau^{*1}, \tau^{*2}) &= p_0^w M(p(\tau, p_0^w), p_0^w) + p_0^w \sum_{i=1,2} E^{*i}(p^{*i}(\tau^{*i}, p_0^w), p_0^w) \\ &= 2p_0^w M(p(\tau, p_0^w), p_0^w) \\ &\leq 2p_0^w M_h \\ &= 2p_0^w M(p(\widehat{\tau}, p_0^w), p_0^w) \\ &= TV(\widehat{\tau}, \widehat{\tau}^{*1}, \widehat{\tau}^{*2}). \end{aligned}$$

For the first case, the assigned tariff vector thus achieves the maximum value for the value of trade volume, given the initial world price and the restriction that no country imports a volume in excess of its implied import volume. ■

We note in this first case that our baseline rules do not uniquely identify an assigned tariff vector; for example, we could achieve the same trade volume while satisfying the other constraints by slightly increasing (lowering) the implemented tariff for foreign country $*i$ (foreign country $*j$) in a fashion that maintains the aggregate implied import volume for the two foreign countries. Thus, when the proposals induce this first case, we impose some additional rules in constructing our mechanism so as to arrive at the assigned tariff vector, $(\widehat{\tau}, \widehat{\tau}^{*1}, \widehat{\tau}^{*2})$.

The second case arises if

$$M_{*i} < p_0^w M_h. \tag{22}$$

For this case, we claim that the mechanism satisfies our baseline rules by assigning the tariff vector $(\overline{\tau}, \overline{\tau}^{*1}, \overline{\tau}^{*2}) \in \Upsilon$, which is defined as follows. First, $\overline{\tau}^{*i}$ is set so as to satisfy

$$M^{*i}(p^{*i}(\tau^{*i}, p_0^w), p_0^w) = M_{*i}, \tag{23}$$

from which it follows that $\overline{\tau}^{*i} = T_{*i}^{*i}$. Next, $\overline{\tau}^{*j}$ is set so that

$$M^{*j}(p^{*j}(\tau^{*j}, p_0^w), p_0^w) = \min\{M_{*j}, p_0^w M_h - M_{*i}\} = p_0^w M_h - M_{*i}, \tag{24}$$

where the second equality follows from (15). Finally, we define $\overline{\tau}$ so that the initial world price is maintained, given these foreign tariffs:

$$\widetilde{p}^w(\overline{\tau}, \overline{\tau}^{*1}, \overline{\tau}^{*2}) = p_0^w. \tag{25}$$

To establish this claim, we state and prove the following:

Lemma 5 *For a vector of tariff proposals (T_h, T_{*1}, T_{*2}) such that (15) holds in the form of the second case (22), a solution to the disagreement program is given by the tariff vector $(\overline{\tau}, \overline{\tau}^{*1}, \overline{\tau}^{*2})$ where $\overline{\tau}^{*i} = T_{*i}^{*i}$ is defined by (23), $\overline{\tau}^{*j}$ is defined by (24) and $\overline{\tau} = T_h^h$ is defined by (25).*

Proof. This assigned tariff vector, $(\overline{\tau}, \overline{\tau}^{*1}, \overline{\tau}^{*2}) \in \Upsilon$, delivers the initial world price and is also such that no country imports a volume that exceeds its implied import volume. It is immediately clear from (23) and (24) that neither foreign country imports a volume that exceeds its implied import volume. The home country imports a volume that equals its implied import volume. To see this, we respectively use the home trade-balance condition (7), $\widetilde{p}^w(\overline{\tau}, \overline{\tau}^{*1}, \overline{\tau}^{*2}) = p_0^w$ and the market-clearing condition (3), (23) and (24) to obtain

$$\begin{aligned} p_0^w M(p(\overline{\tau}, p_0^w), p_0^w) &= E(p(\overline{\tau}, p_0^w), p_0^w) \\ &= M^{*i}(p^{*i}(\overline{\tau}^{*i}, p_0^w), p_0^w) + M^{*j}(p^{*j}(\overline{\tau}^{*j}, p_0^w), p_0^w) \\ &= M_{*i} + M^{*j}(p^{*j}(\overline{\tau}^{*j}, p_0^w), p_0^w) \\ &= M_{*i} + p_0^w M_h - M_{*i} \\ &= p_0^w M_h, \end{aligned} \tag{26}$$

and thus $M(p(\overline{\tau}, p_0^w), p_0^w) = M_h$. Given this equality, it now follows that $\overline{\tau} = T_h^h$; thus, in the second case as well, the home country's assigned tariff is the tariff that it proposed for itself.

Finally, we confirm that it is not possible to find another tariff vector that generates a greater value for trade volume while also delivering the initial world price and ensuring that no country imports a volume in excess of its implied import volume. To see this, we employ a similar argument to that above for the first case. Specifically, we consider an arbitrary vector of tariffs, $(\tau, \tau^{*1}, \tau^{*2}) \in \Upsilon_+$, for which $\widetilde{p}^w(\tau, \tau^{*1}, \tau^{*2}) = p_0^w$ and such that no country imports a volume in excess of its implied import volume. In other words, we consider any tariff vector that satisfies the constraints of the disagreement program.

Using the definition of $TV(\tau, \tau^{*1}, \tau^{*2})$ given in (8), the foreign-country trade-balance condition (2), $\widetilde{p}^w(\tau, \tau^{*1}, \tau^{*2}) = p_0^w$ and the implied market-clearing condition for good x, the requirement that the import volume of the home country not exceed its implied import volume, and (26), we obtain

$$\begin{aligned} TV(\tau,\tau^{*1},\tau^{*2}) &= p_0^w M(p(\tau,p_0^w),p_0^w) + p_0^w \sum_{i=1,2} E^{*i}(p^{*i}(\tau^{*i},p_0^w),p_0^w) \\ &= 2p_0^w M(p(\tau,p_0^w),p_0^w) \\ &\leq 2p_0^w M_h \\ &= 2p_0^w M(p(\overline{\tau},p_0^w),p_0^w) \\ &= TV(\overline{\tau},\overline{\tau}^{*1},\overline{\tau}^{*2}) \end{aligned}$$

Thus, for the second case, the assigned tariff vector achieves the maximum value for the value of trade volume, given the initial world price and the restriction that no country imports a volume in excess of its implied import volume. ∎

We note in this second case that our baseline rules do not uniquely identify an assigned tariff vector; for example, we could achieve the same trade volume while satisfying the other constraints by slightly increasing (lowering) the implemented tariff for foreign country $*i$ (foreign country $*j$) in a fashion that maintains the aggregate implied import volume for the two foreign countries. Thus, when the proposals induce this second case, we impose some additional rules in constructing our mechanism so as to arrive at the assigned tariff vector, $(\overline{\tau},\overline{\tau}^{*1},\overline{\tau}^{*2})$.

The Constructed Mechanism: Recall that a mechanism is defined by the strategy space S and an outcome function g that takes tariff proposals and assigns tariffs. We may now summarize the tariffs that our *constructed mechanism* assigns as a function of the tariff proposals:

A. If the tariff proposals agree, then the assigned tariff vector is $(T_h^h, T_{*1}^{*1}, T_{*2}^{*2})$. The tariff proposals can agree if and only if $p_0^w M_h = M_{*1} + M_{*2}$.

B. If the tariff proposals do not agree and the home country is long, so that $p_0^w M_h > M_{*1} + M_{*2}$, then the assigned tariff vector is $(\widetilde{\tau}, T_{*1}^{*1}, T_{*2}^{*2})$ where $\widetilde{\tau}$ satisfies $\widetilde{p}^w(\tau, T_{*1}^{*1}, T_{*2}^{*2}) = p_0^w$.

C. If the tariff proposals do not agree and the home country is short, so that $p_0^w M_h < M_{*1} + M_{*2}$, then there are two cases:

1. In the first case, the randomly selected first country, foreign country $*i$, makes a proposal such that $M_{*i} \geq p_0^w M_h$. The assigned tariff vector is then $(\widehat{\tau},\widehat{\tau}^{*1},\widehat{\tau}^{*2})$ where $\widehat{\tau}^{*i}$ satisfies $M^{*i}(p^{*i}(\tau^{*i},p_0^w),p_0^w) = p_0^w M_h$, $\widehat{\tau}^{*j}$ satisfies $M^{*j}(p^{*j}(\tau^{*j},p_0^w),p_0^w) = 0$ and $\widehat{\tau} = T_h^h$ satisfies $\widetilde{p}^w(\tau,\widehat{\tau}^{*1},\widehat{\tau}^{*2}) = p_0^w$.

2. In the second case, the randomly selected first country, foreign country $*i$, makes a proposal such that $M_{*i} < p_0^w M_h$. The assigned tariff vector is then $(\overline{\tau}, \overline{\tau}^{*1}, \overline{\tau}^{*2})$ where $\overline{\tau}^{*i} = T_{*i}^{*i}$ satisfies $M^{*i}(p^{*i}(\tau^{*i}, p_0^w), p_0^w) = M_{*i}$, $\overline{\tau}^{*j}$ satisfies $M^{*j}(p^{*j}(\tau^{*j}, p_0^w), p_0^w) = p_0^w M_h - M_{*i}$, and $\overline{\tau} = T_h^h$ satisfies $\widetilde{p}^w(\tau, \overline{\tau}^{*1}, \overline{\tau}^{*2}) = p_0^w$.

We may now summarize our findings for this section:

Proposition 1 *The constructed mechanism satisfies the two baseline rules or requirements.*

Proof. The constructed mechanism is defined above, and we may use Lemmas 1, 2, 3, 4 and 5, to confirm that the mechanism so defined satisfies the two baseline rules or requirements. ■

To conclude this section, we relate our model and constructed mechanism to the "request-offer" language and practice of GATT tariff bargaining. In the context of this language, we may think of T_h^{*1} and T_h^{*2} as the home country's *requests* of foreign countries $*1$ and $*2$, respectively, and T_h^h as the home country's *offer*. In similar fashion, for $i = 1, 2$, we may think of T_{*i}^h as foreign country $*i$'s *request* and T_{*i}^{*i} as foreign country $*i$'s *offer*. In the context of this language, an interesting implication of our constructed mechanism is that the offer in each proposal plays a central role, both when tariff proposals agree and when they do not. Indeed, when tariff proposals agree, the mechanism assigns the tariff vector that is constituted of each country's offer. Under disagreement, the assigned tariff vector for foreign countries corresponds to their offers when the home country is long, and the assigned tariff vector for the home country corresponds to its offer when the home country is short.[28] When the proposals disagree, a country that is on the long side may need to reduce the depth of its offer in order to ensure that the assigned tariff vector satisfies multilateral reciprocity. The central role for offers resonates with patterns reported by Bagwell, Staiger and Yurukoglu (2016), wherein once initial proposals were on the table, tariff bargaining in the GATT Torquay Round focused on possible modifications to the offers in each proposal rather than requests, and such modifications typically entailed reductions in the depths of offers.

4 Dominant Strategies

We now consider the endogenous determination of tariffs in the constructed mechanism when governments use only dominant strategies. In this section, we take the first step in

[28] When the home country is short, if the second case prevails, then the constructed mechanism also assigns the tariff offer for one foreign country.

this process and characterize the respective sets of dominant strategies for foreign country $*i$ and the home country when the constructed mechanism is used.

An initial observation is that, for any foreign country $*i$, the proposal strategy is completely described by T^{*i}_{*i}. To see the point, consider foreign country $*1$. Since foreign country $*1$ is restricted to set $T^{*2}_{*1} = \tau^{*2}_0$ and to set $T^h_{*1} = T^h_{*1}(T^{*1}_{*1})$ at the unique value given T^{*1}_{*1} that delivers $p^w_0 \equiv \widetilde{p}^w(T^h_{*1}, T^{*1}_{*1}, \tau^{*2}_0)$, its proposal $(T^h_{*1}, T^{*1}_{*1}, T^{*2}_{*1}) = (T^h_{*1}(T^{*1}_{*1}), T^{*1}_{*1}, \tau^{*2}_0)$ is completely determined by its selection of T^{*1}_{*1}. By contrast, as noted previously, the home country's proposal is not fully determined by its proposal for its own tariff, T^h_h, since the home country's proposal includes levels for both foreign tariffs and these tariffs can be combined in different ways to generate the initial world price.

To characterize dominant strategies, we must utilize the payoff functions. For a given initial world price p^w_0, the home-country payoff is defined by the welfare function $W(p(\tau, p^w_0), p^w_0)$ while the payoff for foreign country $*i$ is defined by the welfare function $W^{*i}(p^{*i}(\tau^{*i}, p^w_0), p^w_0)$. In (5), we describe how each welfare function varies with the world price, for a given local price. For our present purposes, however, the world price is fixed at its initial level, p^w_0, and the more relevant issue is how each welfare function then varies with the corresponding local price. We now impose some modest structure on the dependence of each welfare function on the corresponding local price.

To begin, we follow Bagwell and Staiger (1999, 2002) and define the *politically optimal reaction tariff for the home country* as the tariff that satisfies

$$W_p(p(\tau, p^w_0), p^w_0) = 0 \tag{27}$$

and the *politically optimal reaction tariff for foreign country* $*i$ as the tariff that satisfies

$$W^{*i}_{p^{*i}}(p^{*i}(\tau^{*i}, p^w_0), p^w_0) = 0. \tag{28}$$

Let τ_{PO} and τ^{*i}_{PO} denote the respective politically optimal reaction tariffs for the home country and foreign country $*i$.

Having defined politically optimal reaction tariffs for each country, we may now state three further assumptions. Our first assumption, which requires a couple of additional definitions, is that the corresponding politically optimal proposals for each country generate positive trade volumes for all countries and thus reside in Υ. To state this assumption formally, let us define for foreign country $*i$ the proposal strategy $T_{*i,PO}$ where $T^{*i}_{*i,PO} = \tau^{*i}_{PO}$, $T^{*j}_{*i,PO} = \tau^{*j}_0$ and $T^h_{*i,PO} = T^h_{*i}(\tau^{*i}_{PO})$ is then uniquely specified to deliver p^w_0 as the market-clearing world price. Similarly, for the home country, we define a set of home-country proposal strategies for which $T^h_h = \tau_{PO}$ with T^{*1}_h and T^{*2}_h then specified in any fashion so that $\widetilde{p}^w(\tau_{PO}, T^{*1}_h, T^{*2}_h) = p^w_0$. With these definitions in place, our first assumption is that the initial tariff vector and associated world price are such that (i) $T_{*i,PO} \in \Upsilon$ and (ii) there exists (T_h^{*1}, T_h^{*2}) such that $\widetilde{p}^w(\tau_{PO}, T_h^{*1}, T_h^{*2}) = p_0^w$ and $(\tau_{PO}, T_h^{*1}, T_h^{*2}) \in \Upsilon$.[29]

Our second assumption is that, given the fixed initial world price p_0^w, each country has *single-peaked preferences* with respect to its own tariff (or equivalently, with respect to its local price).[30] Formally, for the given p_0^w, we assume that $W_p(p(\tau, p_0^w), p_0^w) > 0$ for $p(\tau, p_0^w) < p(\tau_{PO}, p_0^w)$ and $W_p(p(\tau, p_0^w), p_0^w) < 0$ for $p(\tau, p_0^w) > p(\tau_{PO}, p_0^w)$, where we recall that $p(\tau, p_0^w) = \tau p_0^w$. Similarly, for the given p_0^w, we assume that $W_{p^{*i}}^{*i}(p^{*i}(\tau^{*i}, p_0^w), p_0^w) > 0$ for $p^{*i}(\tau^{*i}, p_0^w) < p^{*i}(\tau_{PO}^{*i}, p_0^w)$ and $W_{p^{*i}}^{*i}(p^{*i}(\tau^{*i}, p_0^w), p_0^w) < 0$ for $p^{*i}(\tau_{PO}^{*i}, p_0^w) > p(\tau_{PO}, p_0^w)$, where we recall that $p^{*i}(\tau^{*i}, p_0^w) = (1/\tau^{*i})p_0^w$. These assumptions are all understood to hold for tariffs such that the corresponding country has positive trade volume. Any scenario in which a foreign country has zero trade volume corresponds to a limiting case.

A final assumption that we add at this point serves to simplify the characterization of dominant strategies for the home country. Specifically, we assume that, for any foreign country $*i$ and tariff vector $(\tau, \tau^{*1}, \tau^{*2}) \in \Upsilon$ such that $\widetilde{p}^w(\tau, \tau^{*1}, \tau^{*2}) = p_0^w$, there exists an alternative tariff vector $(\tau', \tau^{*1\prime}, \tau^{*2\prime}) \in \Upsilon$ such that $\widetilde{p}^w(\tau', \tau^{*1\prime}, \tau^{*2\prime}) = p_0^w$ and $\tau^{*i\prime} = \tau^{*i}$, $\tau^{*j\prime} = \tau_0^{*j}$. Thus, if it feasible for foreign country $*i$ to achieve an import volume $M^{*i}(p^{*i}(\tau^{*i}, p_0^w), p_0^w)$ with some tariff vector $(\tau, \tau^{*1}, \tau^{*2}) \in \Upsilon$, then we assume that it is also feasible for foreign country $*i$ to achieve that same tariff volume with world-price-preserving modifications in τ and τ^{*j} that re-position the latter tariff to the initial level, τ_0^{*j}.[31]

Dominant Strategies for Foreign Country $*$i: We characterize first the dominant strategies for foreign country $*i$. As the following proposition establishes, the characterization of foreign country $*i$'s dominant strategy set is quite simple. In the single member of this set, foreign country $*i$ proposes τ_{PO}^{*i} for itself and proposes a tariff for the home country that in combination with the initial tariff for foreign country $*j$ maintains the market-clearing world price at its initial level, p_0^w.

Proposition 2 *Given the constructed mechanism, the set of dominant strategy proposals for foreign country $*i$ is non-empty and in fact contains a singleton defined by $T_{*i,PO}$,*

[29] For the home country, our goal here is simply to ensure the existence of a tariff vector such that the home-country tariff is τ_{PO}, the market-clearing world price is p_0^w, and all countries receive positive import volumes. Tariff vectors for which the home-country tariff is τ_{PO}, the market-clearing world price is p_0^w, and some foreign country receives zero import volume may exist but are not in Υ and thus are not part of the set of dominant strategy proposals for the home country.

[30] Bagwell and Staiger (1999, 2002) capture this assumption with the assumption that global second-order conditions hold for all maximization problems. The global second-order condition assocated with the maximization problem leading to home's politically optimal reaction tariff, for example, is that $W_{pp}(p, p_0^w) < 0$.

[31] Achieving the import volume $M^{*i}(p^{*i}(\tau^{*i}, p_0^w), p_0^w)$ with τ^{*j} set equal to τ_0^{*j} would not be feasible if this could not be achieved with a home tariff level above -1 and below the level that would prohibit trade between the home country and foreign country $*j$. Hence, with this assumption we rule out extreme size asymmetries between the home country and each of its foreign trading partners.

where $T^{*i}_{*i,PO} = \tau^{*i}_{PO}$, $T^{*j}_{*i,PO} = \tau^{*j}_0$ and $T^h_{*i,PO} = T^h_{*i}(\tau^{*i}_{PO})$ is then uniquely set to deliver p^w_0 as the market-clearing world price.

Proof. Consider foreign country $*i$. We wish to argue that foreign country $*i$'s dominant strategy is to propose $T_{*i,PO}$ defined by $T^{*i}_{*i,PO} = \tau^{*i}_{PO}$ with $T^{*j}_{*i,PO} = \tau^{*j}_0$ and $T^h_{*i,PO} = T^h_{*i}(\tau^{*i}_{PO})$ then set to deliver the initial world price, p^w_0, as the market-clearing world price under the proposal. By assumption, $T_{*i,PO} \in \Upsilon$ exists. We compare this proposal strategy to an alternative strategy T_{*i} associated with a different own tariff for foreign country $*i$, $T^{*i}_{*i} \equiv \tau^{*i} \neq T^{*i}_{*i,PO} = \tau^{*i}_{PO}$, where as described $T^{*j}_{*i} = \tau^{*j}_0$ and $T^h_{*i} = T^h_{*i}(\tau^{*i})$ then follow. Let $M_{*i,PO} \equiv M^{*i}(p^{*i}(\tau^{*i}_{PO}, p^w_0), p^w_0)$ and $M_{*i} = M^{*i}(p^{*i}(\tau^{*i}, p^w_0), p^w_0)$ denote the corresponding implied import volumes.

If the proposals of the home country and foreign country $*j$ are such that the tariff proposals agree when foreign country $*i$ proposes $T_{*i,PO}$, then the alternative proposal T_{*i} cannot possibly represent an improvement for foreign country $*i$. This follows since under proposal $T_{*i,PO}$ foreign country $*i$ enjoys its favorite local price for the given initial world price. By similar reasoning, if the proposals of the home country and foreign country $*j$ are such that the home country is long when foreign country $*i$ proposes $T_{*i,PO}$, then the proposal $T_{*i,PO}$ again results in foreign country $*i$'s favorite local price for the given initial world price, and so the alternative proposal T_{*i} cannot possibly represent an improvement for foreign country $*i$.[32] The remaining possibility is that the proposal $T_{*i,PO}$ and the proposals of other countries are such that the home country is short. To address this remaining possibility, we distinguish between two cases for the alternative proposal, T_{*i}.

The first case is that the alternative proposal entails a lower tariff for foreign country $*i$: $\tau^{*i} < \tau^{*i}_{PO}$ and thus $M_{*i} > M_{*i,PO}$. Given that the proposals of other countries are such that the home country is short when foreign country $*i$ proposes $T_{*i,PO}$, the home country will again be short in this first case under the alternative proposal, T_{*i}. If foreign country $*i$ is not randomly selected to go first, then its assigned tariff does not depend on its proposal (conditional on the home country being short) and so it is then indifferent between the two proposals. If foreign country $*i$ is randomly selected to go first, then it enjoys its favorite local price under the proposal $T_{*i,PO}$ if $M_{*i,PO} \leq p^w_0 M_h$. The alternative proposal then cannot represent an improvement for foreign country $*i$. If foreign country $*i$ is randomly selected to go first and $M_{*i,PO} > p^w_0 M_h$, then the assigned tariff for foreign country $*i$ is $\widehat{\tau}^{*i}$ where $\widehat{\tau}^{*i}$ satisfies $M^{*i}(p^{*i}(\tau^{*i}, p^w_0), p^w_0) = p^w_0 M_h$. The alternative proposal entails an even higher implied import volume, $M_{*i} > M_{*i,PO}$, and thus leads to the same assigned tariff for foreign country $*i$. Hence, when the home country is short, and in the first case where $\tau^{*i} < \tau^{*i}_{PO}$, we conclude that the politically optimal proposal $T_{*i,PO}$ is always at least weakly preferred to the alternative proposal, T_{*i}.

[32] Recall that, under the constructed mechanism defined above, foreign country $*i$'s proposed tariff for itself is assigned under agreement and also under disagreement when the home country is long.

The second case is that the alternative proposal entails a higher tariff for foreign country $*i$: $\tau^{*i} > \tau^{*i}_{PO}$ and thus $M_{*i} < M_{*i,PO}$. Suppose first that the other proposals are such that the home country remains short under the alternative proposal (despite the fact that the alternative proposal implies a lower trade volume for foreign country $*i$). If foreign country $*i$ is not randomly selected to go first, then its assigned tariff does not depend on its proposal (conditional on the home country being short) and so it is then indifferent between the two proposals. If foreign country $*i$ is randomly selected to go first, then it enjoys its favorite local price under the proposal $T_{*i,PO}$ if $M_{*i,PO} \leq p^w_0 M_h$. The alternative proposal then cannot represent an improvement for foreign country $*i$. If foreign country $*i$ is randomly selected to go first and $M_{*i,PO} > p^w_0 M_h$, then the assigned tariff for foreign country $*i$ under the proposal $T_{*i,PO}$ is $\widehat{\tau}^{*i}$ where $\widehat{\tau}^{*i}$ satisfies $M^{*i}(p^{*i}(\tau^{*i}, p^w_0), p^w_0) = p^w_0 M_h$. If the alternative proposal satisfies $M_{*i} \geq p^w_0 M_h$, then the same tariff is assigned for foreign country $*i$. If the alternative proposal satisfies $M_{*i} < p^w_0 M_h$, then the assigned tariff for foreign country $*i$ under the alternative proposal T_{*i} is $\overline{\tau}^{*i}$ which satisfies $M^{*i}(p^{*i}(\tau^{*i}, p^w_0), p^w_0) = M_{*i}$. Given $M_{*i} < p^w_0 M_h < M_{*i,PO}$, we then see that $\overline{\tau}^{*i} > \widehat{\tau}^{*i} > \tau^{*i}_{PO}$. We conclude that the politically optimal proposal $T_{*i,PO}$ is then preferred to the alternative proposal T_{*i}, since the assigned tariff for foreign country $*i$ is closer to its politically optimal reaction tariff under the proposal $T_{*i,PO}$.

Continuing with the second case where $M_{*i} < M_{*i,PO}$, we suppose second that the other proposals are such that the home country is short under the proposal $T_{*i,PO}$ but is not short under the alternative proposal T_{*i}. Thus, we now focus on the scenario where $M_{*i} + M_{*j} \leq p^w_0 M_h < M_{*i,PO} + M_{*j}$. Since $M_{*i} > 0$, the other proposals then must be such that $M_{*j} < p^w_0 M_h$. Under the proposal $T_{*i,PO}$, if foreign country $*i$ is randomly selected, then it enjoys a trade volume of either $M_{*i,PO}$ (if $M_{*i,PO} \leq p^w_0 M_h$) or $p^w_0 M_h$ (if $M_{*i,PO} > p^w_0 M_h$). Under the proposal $T_{*i,PO}$, if foreign country $*i$ is not randomly selected, then it enjoys a trade volume of $p^w_0 M_h - M_{*j} > 0$. Under the alternative proposal, the home country is not short and so foreign country $*i$ enjoys a trade volume of $M_{*i} \leq p^w_0 M_h - M_{*j}$. Thus, foreign country $*i$ enjoys a trade volume closer to $M_{*i,PO}$ under the proposal $T_{*i,PO}$ than under the proposal T_{*i}.

Having now considered all possible trade-volume scenarios when foreign country $*i$ proposes $T_{*i,PO}$, and the corresponding possibilities were foreign country $*i$ instead to propose an alternative proposal T_{*i}, we now conclude that alternative proposals T_{*i} which entail $\tau^{*i} \neq \tau^{*i}_{PO}$ are dominated by the proposal $T_{*i,PO}$ which entails $\tau^{*i} = \tau^{*i}_{PO}$.

Finally, we argue that any tariff proposal for foreign country $*i$ such that $T_{*i} \neq T_{*i,PO}$ is not a dominant strategy. Let T_{*i} be any tariff proposal for foreign country $*i$ for which $T^{*i}_{*i} \neq \tau^{*i}_{PO}$. Proposals $T_{*i,PO}$ and T_{*i} are in Υ. Of these two proposals, the one with the lower proposed tariff for foreign country $*i$ must also have the lower proposed tariff for the home country. Denote this tariff proposal vector as $T_{*i,L}$. Suppose now that the home country proposes the vector $T_{*i,L}$ as well, and that foreign country $*j$ proposes the initial or status quo tariff vector, $(\tau_0, \tau_0^{*1}, \tau_0^{*2}) \in \Upsilon$. Given these tariff proposals for foreign country $*j$ and the home country, the home country is long or agrees whether foreign country $*i$ proposes T_{*i} or $T_{*i,PO}$; thus, in both cases, foreign country $*i$ imports a volume that equals its implied import volume, which is M_{*i} under the proposal T_{*i} and $M_{*i,PO}$ under the proposal $T_{*i,PO}$, respectively, with $M_{*i} \neq M_{*i,PO}$. The tariff proposal $T_{*i,PO}$ is then strictly better for foreign country $*i$ than is the tariff proposal T_{*i}. ■

Dominant Strategies for the Home Country: We characterize next the dominant strategies for the home country. As the following proposition establishes, the characterization of the home country's dominant strategy set is quite simple, too. In any member of this set, the home country proposes the tariff τ_{PO} for itself and proposes a pair of tariffs for foreign countries such that the three tariffs together maintain the market-clearing world price at its initial level, p_0^w.

Proposition 3 *Given the constructed mechanism, the set of dominant strategy proposals for the home country is a non-empty set whose members are the home-country proposal strategies for which* $T_h^h = \tau_{PO}$*, with* T_h^{*1} *and* T_h^{*2} *then specified in any fashion so that* $\widetilde{p}^w(\tau_{PO}, T_h^{*1}, T_h^{*2}) = p_0^w$.

Proof. We wish to argue that the set of dominant strategies for the home country is defined by a set of proposals under which the home country proposes the tariff τ_{PO} for itself and tariffs for the foreign countries that in combination with τ_{PO} deliver the initial world price as the market-clearing world price. By assumption, we know that some such proposals exist in Υ. To fix ideas, let us select any proposal $T_{h,PO}$ from this set, where the proposal strategy $T_{h,PO}$ is thus defined by $T_{h,PO}^h = \tau_{PO}$ with $(T_{h,PO}^{*1}, T_{h,PO}^{*2})$ then satisfying $p_0^w \equiv \widetilde{p}^w(\tau_{PO}, T_{h,PO}^{*1}, T_{h,PO}^{*2})$. We compare this proposal strategy to an alternative strategy T_h for which $T_h^h \equiv \tau \neq T_{h,PO}^h = \tau_{PO}$ with (T_h^{*1}, T_h^{*2}) then satisfying $p_0^w \equiv \widetilde{p}^w(\tau, T_h^{*1}, T_h^{*2})$. Recall that, given the initial world price, the home-country's implied import volume is determined by its proposed tariff for itself. Let $M_{h,PO} \equiv M(p(\tau_{PO}, p_0^w), p_0^w)$ and $M_h = M(p(\tau, p_0^w), p_0^w)$ denote the corresponding implied import volumes.

If the proposals of the foreign countries are such that the tariff proposals agree when the home country proposes $T_{h,PO}$, then the alternative proposal T_h cannot possibly represent an improvement for the home country. This follows since under proposal $T_{h,PO}$ the home country enjoys its favorite local price for the given initial world price. By similar reasoning, if the proposals of the foreign countries are such that the home country is short when the home country proposes $T_{h,PO}$, then the home country is again assigned the tariff τ_{PO} and thus enjoys its favorite local price for the given initial world price; hence, once again, the alternative proposal T_h cannot possibly represent an improvement for the home country.

The remaining possibility is that the proposal $T_{h,PO}$ and the proposals of the foreign countries are such that the home country is long so that $p_0^w M_{h,PO} > M_{*1} + M_{*2}$. Under the proposal $T_{h,PO}$, the home country is then assigned the tariff $\widetilde{\tau}$ defined given the foreign proposals $(T_{*1}^{*1}, T_{*2}^{*2})$ to deliver $p_0^w \equiv \widetilde{p}^w(\widetilde{\tau}, T_{*1}^{*1}, T_{*2}^{*2})$. Given the foreign proposals, if the home country remains long under the alternative proposal T_h, then the same tariff vector is assigned and so the alternative proposal fails to offer an improvement for the home country. Suppose then the home country achieves agreement or is short under the alternative proposal T_h. For the given foreign proposals, under any of these cases for the alternative proposal T_h, the tariff that the home country proposes for itself, τ, is assigned, and so we have that $p_0^w M(p(\tau, p_0^w), p_0^w) = p_0^w M_h \leq M_{*1} + M_{*2} = p_0^w M(p(\widetilde{\tau}, p_0^w), p_0^w) < p_0^w M_{h,PO}$ where the final equality follows from (13). It follows that $\tau_{PO} < \widetilde{\tau} \leq \tau$, and so the alternative proposal T_h results in an assigned home-country tariff τ that is (weakly) further from τ_{PO} than is the assigned home-country tariff $\widetilde{\tau}$ that results from the proposal $T_{h,PO}$.

Having now considered all possible trade-volume scenarios when the home country proposes $T_{h,PO}$, and the corresponding possibilities were the home country instead to propose an alternative proposal T_h, we conclude that alternative proposals T_h which entail $\tau \neq \tau_{PO}$ are dominated by the proposal $T_{h,PO}$ which specify a home-country tariff of τ_{PO}. Since $T_{h,PO}$ is an arbitrary selection in from the set of home proposals for which $T_{h,PO}^h = \tau_{PO}$, we conclude that the alternative proposal T_h is dominated by all such home-country proposal strategies that specify a home-country tariff of τ_{PO}.

Finally, we compare distinct home-country proposal strategies that both specify a home-country tariff of τ_{PO}, and we argue that for any given foreign proposals such home-country proposal strategies must result in the same assigned tariff vector. A corollary is that one home-country strategy in this class cannot dominate another. To develop this argument, we use $T_{h,PO} = (\tau_{PO}, T_{h,PO}^{*1}, T_{h,PO}^{*2})$ to denote one such proposal, and we denote an alternative such proposal as $T_{h,PO}^{'} = (\tau_{PO}, T_{h,PO}^{*1'}, T_{h,PO}^{*2'})$, where $(T_{h,PO}^{*1}, T_{h,PO}^{*2}) \neq (T_{h,PO}^{*1'}, T_{h,PO}^{*2'})$. For given foreign proposals, if $T_{h,PO}$ achieves agreement, then $T_{h,PO}^{'}$ achieves agreement as well. Thus, the same tariff vector would be assigned under either home-country proposal. Given the foreign proposals, if the home country is short under $T_{h,PO}$, then the home country similarly is short under $T_{h,PO}^{'}$. For this case, whether the home country proposes $T_{h,PO}$ or $T_{h,PO}^{'}$, it is assigned the tariff τ_{PO} and imports a volume that equals its implied import volume, $M_{h,PO}$. Further, the assigned foreign tariff vectors are independent of whether the home country proposes $(T_{h,PO}^{*1}, T_{h,PO}^{*2})$ or $(T_{h,PO}^{*1'}, T_{h,PO}^{*2'})$ for the foreign countries. The same tariff vector thus would be assigned under either home-country proposal.[33] Finally, given the foreign proposals, if the home

[33]This statement is understood to refer to expected values when the home country is short and a "first" foreign firm is selected at random. The key point is that the selection probability is random and thus independent of the specific home-country proposal.

country is long under $T_{h,PO}$, then the home country is long as well under $T'_{h,PO}$. The assigned tariff vector is then $(\widetilde{\tau}, T^{*1}_{*1}, T^{*2}_{*2})$ whether the home country proposes $T_{h,PO}$ or $T'_{h,PO}$.

We now summarize our arguments and complete the proof. Having considered all possible trade-volume scenarios when the home country proposes $T_{h,PO}$, and the corresponding possibilities were the home country instead to propose alternative proposal T_h, we conclude that alternative proposals T_h which entail $\tau \neq \tau_{PO}$ are dominated by the proposal $T_{h,PO}$ which entails $\tau = \tau_{PO}$. We have also argued that the home-country proposal $T_{h,PO}$ offers the same assigned tariff vector for any given foreign proposals as does the home-country proposal $T'_{h,PO}$, where $T_{h,PO}$ and $T'_{h,PO}$ both entail $\tau = \tau_{PO}$ but propose different foreign tariffs.

Finally, we argue that any tariff proposal for the home country such that $T^h_h \neq \tau_{PO}$ is not a dominant strategy. Let T_h be any tariff proposal for the home country for which $T^h_h \neq \tau_{PO}$. Proposals $T_{h,PO}$ and T_h are in Υ. Of these two proposals, and given that both must deliver market clearing at the world price p^w_{PO}, the one with the lower proposed tariff for the home country must be associated with a higher aggregate foreign import volume. Denote this tariff proposal vector as $T_{h,L}$. This proposal implies positive import volumes for each foreign country $*i$ when the tariff proposed for that country by the home country, $T^{*i}_{h,L}$, is imposed. Since $\widetilde{p}^w(T^h_{h,L}, T^{*1}_{h,L}, T^{*2}_{h,L}) = p^w_0$, we know from our assumptions that the same positive import volume for foreign country $*i$ can be achieved with an alternative proposal in Υ by foreign country $*i$ such that $T^{*i}_{*i} = T^{*i}_{h,L}$ and $T^{*j}_{*i} = \tau^{*j}_0$ with T^h_{*i} then selected so that $\widetilde{p}^w(T^h_{*i}, T^{*1}_{*i}, T^{*2}_{*i}) = p^w_0$. Suppose now that the foreign countries propose the alternative proposals in Υ just constructed. The implied import volumes, M_{*1} and M_{*2}, are then such that $M_{*1} + M_{*2} = p^w_0 M_{h.L}$, where $M_{h.L} \equiv M(p(T^h_{h.L}, p^w_0), p^w_0)$. Given these constructed foreign proposals, the home country is short or agrees whether it proposes $T_{h,PO}$ or T_h; thus, for both proposals, the home country imports a volume that is equal to its implied import volume, which is $M_{h,PO}$ under the proposal $T_{h,PO}$ and $M_h \neq M_{h,PO}$ under the proposal T_h, respectively. The tariff proposal $T_{h,PO}$ is then strictly better for the home country than is the proposal T_h. ■

5 Dominant Strategy Implementation

Having characterized the sets of dominant strategies for foreign country $*i$ and the home country, we now characterize the tariff vectors that can be assigned or *implemented* in the constructed mechanism when governments use only dominant strategies. Our discussion shows how the final negotiation outcome actually emerges from dominant strategy proposals, and we also assess the efficiency of the negotiated outcome.

To begin, we require some further definitions. Recall from (27) and (28) that the politically optimal reaction tariffs, τ_{PO}, τ^{*1}_{PO} and τ^{*2}_{PO}, are defined relative to an initial world price, p^w_0, which we have taken to be exogenous. Let us now define p^w_{PO} as the particular initial world price p^w_0 such that if each country were to apply its politically optimal reaction tariff relative to $p^w_0 = p^w_{PO}$, then the resulting market-clearing world price would preserve the initial world price: $\widetilde{p}^w(\tau_{PO}, \tau^{*1}_{PO}, \tau^{*2}_{PO}) = p^w_{PO}$ when $p^w_0 = p^w_{PO}$.

Next, following Bagwell and Staiger (1999, 2002), we define the *politically optimal tariffs* as the three tariffs that simultaneously solve the following three equations:

$$W_p(p(\tau, \widetilde{p}^w), \widetilde{p}^w) = 0 = W^{*i}_{p^{*i}}(p^{*i}(\tau^{*i}, \widetilde{p}^w), \widetilde{p}^w), \; i = 1, 2. \tag{29}$$

At the politically optimal tariffs, the associated market-clearing world price $\widetilde{p}^w$ takes the value p^w_{PO}. We may thus understand p^w_{PO} to be the politically optimal world price. For $p^w_0 = p^w_{PO}$, we assume that the politically optimal tariffs reside in Υ.[34]

Bagwell and Staiger (1999, 2002) show that politically optimal tariffs are efficient, where efficiency is measured relative to the preferences of governments and is assessed relative to the full set of tariff vectors $(\tau, \tau^{*1}, \tau^{*2}) \in \Upsilon$.[35] Efficiency fails, however, at tariffs for which some but not all of the equations in (29) are satisfied. In terms of the analysis conducted here, the politically optimal tariffs that Bagwell and Staiger (1999, 2002) define are the politically optimal reaction tariffs when those tariffs are defined relative to the initial world price p^w_{PO}. An immediate implication is that the politically optimal reaction tariffs are efficient when they are defined relative to p^w_{PO}.

Motivated by this discussion, in our analysis of dominant strategy implementation, we distinguish between two cases: $p^w_0 \neq p^w_{PO}$ and $p^w_0 = p^w_{PO}$.

Case 1: $\mathbf{p}^w_0 \neq \mathbf{p}^w_{PO}$. In this case, a first point is that, when dominant strategy proposals are used, agreement does not occur. To see this, assume to the contrary that agreement occurs. Our constructed mechanism then requires that the assigned tariff vector is $(T^h_h, T^{*1}_{*1}, T^{*2}_{*2})$. For dominant strategy proposals, we further have from Propositions 2 and 3 that $(T^h_h, T^{*1}_{*1}, T^{*2}_{*2}) = (\tau_{PO}, \tau^{*1}_{PO}, \tau^{*2}_{PO})$, where as always the politically optimal reaction tariffs are defined relative to the initial world price, p^w_0. By Lemma 2, agreement

[34] In terms of our assumptions above, for $p^w_0 = p^w_{PO}$, we thus assume that the pair $(\tau^{*1}_{PO}, \tau^{*2}_{PO})$ is one of the pairs (T^{*1}_h, T^{*2}_h) such that $\widetilde{p}^w(\tau_{PO}, T^{*1}_h, T^{*2}_h) = p^w_0$ and $(\tau_{PO}, T^{*1}_h, T^{*2}_h) \in \Upsilon$.

[35] We distinguish this notion of efficiency from that used in the social choice literature on strategy-proof rationing rules. In the social choice literature, the volume of supply and price are given exogenously, and the notion of efficiency refers to whether the rationing rule leads to an efficient allocation of this fixed volume across agents. (See Barbera, 2011, Section 9.1, for additional discussion of that literature.) The counterpart of this situation in our analysis arises when proposals are such that the home country is short, and the rationing rule then concerns how the home-country implied trade volume is allocated across foreign countries. In this context, the rationing rule that we employ allocates volume across foreign countries in an efficient manner. Our notion of efficiency in this paper, however, is defined in relation to the full set of tariff vectors, Υ, and thus recognizes that different tariff vectors give rise to different world prices and implied home-country trade volumes.

is possible if any only if

$$p_0^w M_{h,PO} = M_{*1,PO} + M_{*2,PO}, \tag{30}$$

where $M_{h,PO} \equiv M(p(\tau_{PO}, p_0^w), p_0^w)$ and $M_{*i,PO} \equiv M^{*i}(p^{*i}(\tau_{PO}^{*i}, p_0^w), p_0^w)$. Using (30), the home trade-balance condition (1), and the market-clearing condition (3), we then see that $\widetilde{p}^w(\tau_{PO}, \tau_{PO}^{*1}, \tau_{PO}^{*2}) = p_0^w$, which contradicts the assumption that $p_0^w \neq p_{PO}^w$.

Thus, when $p_0^w \neq p_{PO}^w$, there are two possible outcomes under dominant strategy implementation. One possibility is that under dominant strategy proposals the home country is long. Using Propositions 2 and 3, we know that under dominant proposals $(T_h^h, T_{*1}^{*1}, T_{*2}^{*2}) = (\tau_{PO}, \tau_{PO}^{*1}, \tau_{PO}^{*2})$, and so this possibility occurs if and only if

$$p_0^w M_{h,PO} > M_{*1,PO} + M_{*2,PO}. \tag{31}$$

When home is long so that (31) obtains, the implemented tariff vector is $(\widetilde{\tau}, T_{*1}^{*1}, T_{*2}^{*2})$ where $\widetilde{p}^w(\widetilde{\tau}, T_{*1}^{*1}, T_{*2}^{*2}) = p_0^w$ defines $\widetilde{\tau}$. Thus, with $T_{*i}^{*i} = \tau_{PO}^{*i}$ under dominant proposals, $\widetilde{\tau}$ is defined to satisfy $\widetilde{p}^w(\widetilde{\tau}, \tau_{PO}^{*1}, \tau_{PO}^{*2}) = p_0^w$. Given $p_{PO}^w \neq p_0^w$, it follows that $\widetilde{\tau} \neq \tau_{PO}$.[36] Since for the given initial world price the foreign countries achieve their favorite local price while the home country does not, an implication from Bagwell and Staiger (1999, 2002) is that the implemented tariff vector is inefficient when countries use only dominant strategies, the home country is long and $p_0^w \neq p_{PO}^w$.[37]

When $p_0^w \neq p_{PO}^w$, it is interesting to compare the implemented tariff vector with the proposed tariffs when countries use dominant strategy proposals and the home country is long. The home-country proposal entails $T_h^h = \tau_{PO}$ along with proposals for foreign tariff that preserve the initial world price, and this proposal is clearly not employed since $\widetilde{\tau} \neq \tau_{PO}$ when $p_{PO}^w \neq p_0^w$. Provided that $\tau_0^{*j} \neq \tau_{PO}^{*j}$, foreign country $*i$'s proposal is also not exactly implemented. But the implemented tariff vector is in foreign country $*i$'s equivalence class given its proposal. Thus, for each foreign country $*i$, we can think in this case of its proposal being accepted, once world-price-preserving modifications are made to its proposed tariffs for the home country and for foreign country $*j$.

The other possibility when $p_0^w \neq p_{PO}^w$ is that under dominant strategies the home country is short. Since Propositions 2 and 3 ensure that under dominant proposals

[36] In particular, $\widetilde{\tau} > \tau_{PO}$ if $p_0^w < p_{PO}^w$, and $\widetilde{\tau} < \tau_{PO}$ if $p_0^w > p_{PO}^w$.

[37] To see why such a tariff vector is inefficient, suppose that $W_p > 0 = W_{p^{*i}}^{*i}$ at the tariffs $(\widetilde{\tau}, \tau_{PO}^{*1}, \tau_{PO}^{*2})$. From here, suppose all three tariffs are slightly increased in a way that preserves the market-clearing world price at its initial level, p_0^w. The foreign countries experience only a second-order loss, since they initially enjoyed their favorite local prices, while the home country enjoys a first-order gain from the induced higher value for p. We can now make a further small adjustment (e.g., a small cut in τ) that slightly raises the world price, so as to give the foreign countries a first-order gain. Provided that the second change is small relative to the first, the home country continues to enjoy a first-order gain, and in this way a Pareto improvement has been engineered. A related argument applies if $W_p < 0 = W_{p^{*i}}^{*i}$ at the tariffs $(\widetilde{\tau}, \tau_{PO}^{*1}, \tau_{PO}^{*2})$.

$(T_h^h, T_{*1}^{*1}, T_{*2}^{*2}) = (\tau_{PO}, \tau_{PO}^{*1}, \tau_{PO}^{*2})$, this possibility occurs if and only if

$$p_0^w M_{h,PO} < M_{*1,PO} + M_{*2,PO}. \tag{32}$$

When home is short so that (32) obtains, the implemented home tariff is $T_h^h = \tau_{PO}$. The implemented foreign tariffs depend on whether for the randomly selected foreign country $*i$ we have $M_{*i,PO} \geq p_0^w M_{h,PO}$ or $M_{*i,PO} < p_0^w M_{h,PO}$. Under the first inequality, the implemented tariff, $\widehat{\tau}^{*i}$, for the randomly selected foreign country $*i$ satisfies $\widehat{\tau}^{*i} \geq \tau_{PO}^{*i}$ while foreign country $*j$ sets a prohibitive tariff $\widehat{\tau}^{*j}$ which thus satisfies $\widehat{\tau}^{*j} > \tau_{PO}^{*j}$. Under the second inequality, the implemented tariff, $\overline{\tau}^{*i}$, for the randomly selected foreign country $*i$ satisfies $\overline{\tau}^{*i} = \tau_{PO}^{*i}$ while foreign country $*j$ sets a tariff $\overline{\tau}^{*j}$ under which by (24) we have $M^{*j}(p^{*j}(\overline{\tau}^{*j}, p_0^w), p_0^w) < M_{*j,PO}$ and so $\overline{\tau}^{*j} > \tau_{PO}^{*j}$. Given that the home country applies the tariff τ_{PO} while at least one foreign country applies a tariff that differs from its politically optimal reaction tariff, an implication from Bagwell and Staiger (1999, 2002) is that the implemented tariff vector is inefficient when countries use only dominant strategies, the home country is short and $p_0^w \neq p_{PO}^w$.[38]

When $p_0^w \neq p_{PO}^w$, it is also interesting to compare the implemented tariff vector with the proposed tariffs when countries use dominant strategy proposals and the home country is short. The home-country proposal entails $T_h^h = \tau_{PO}$ along with proposals for foreign tariffs that preserve the initial world price. Since the implemented tariff vector specifies that the home country apply the tariff τ_{PO}, any difference between the home-country proposal and the implemented tariff vector must involve the associated foreign-country tariffs. Provided that $\widehat{\tau}^{*j}$ and $\overline{\tau}^{*j}$ differ from τ_0^{*j}, the randomly selected foreign country $*i$'s proposal is also not exactly implemented, even when (as under the second inequality above) its implemented tariff is τ_{PO}^{*i}. The dominant strategy proposal for foreign country $*j$ (i.e., the foreign country which is not randomly selected) sets $T_{*j}^{*j} = \tau_{PO}^{*j}$; thus, its proposal is clearly not implemented, since the implemented tariff vector specifies either $\widehat{\tau}^{*j} > \tau_{PO}^{*j}$ or $\overline{\tau}^{*j} > \tau_{PO}^{*j}$ for foreign country $*j$. It thus follows as well that the implemented tariff vector is not in foreign country $*j$'s equivalence class given its proposal. We can think in this case of the home-country proposal being accepted as is (if foreign country tariffs are specified appropriately), or after world-price-preserving modifications are made to the home-country proposal for foreign-country tariffs.[39]

Case 2: $\mathbf{p}_0^w = \mathbf{p}_{PO}^w$. Since $p_0^w = p_{PO}^w$ in this case, we have that $\widetilde{p}^w(\tau_{PO}, \tau_{PO}^{*1}, \tau_{PO}^{*2}) = p_{PO}^w$.

[38] At the implemented tariffs, we have $W_p = 0$ and $W_{p^{*i}}^{*i} \neq 0$ for at least one i. We may thus engineer small local price changes that offer a first-order gain to at least one foreign country while imposing only a second-order cost on the home country. In line with the discussion in footnote 37, from here we can engineer a Pareto improvement with a small change that generates a terms-of-trade gain for home.

[39] When making its proposal, the home country does not know which foreign country will be randomly selected to go first; thus, the home-country proposal cannot be accepted as is with probability one.

As above, for dominant strategy proposals, Propositions 2 and 3 yield $(T_h^h, T_{*1}^{*1}, T_{*2}^{*2}) = (\tau_{PO}, \tau_{PO}^{*1}, \tau_{PO}^{*2})$. For this case, under dominant strategy proposals, we thus have that

$$p_0^w M_{h,PO} = M_{*1,PO} + M_{*2,PO}, \tag{33}$$

where again $M_{h,PO} \equiv M(p(\tau_{PO}, p_0^w), p_0^w)$ and $M_{*i,PO} \equiv M^{*i}(p^{*i}(\tau_{PO}^{*i}, p_0^w), p_0^w)$. By Lemma 2, the proposals thus agree. The implemented tariff vector is thus $(T_h^h, T_{*1}^{*1}, T_{*2}^{*2}) = (\tau_{PO}, \tau_{PO}^{*1}, \tau_{PO}^{*2})$. Since for the given initial world price all countries achieve their favorite local price, the implemented tariff vector corresponds to the vector of politically optimal tariffs. Hence, an implication from Bagwell and Staiger (1999, 2002) is that the implemented tariff vector is efficient when countries use only dominant strategies and $p_0^w = p_{PO}^w$.

When $p_0^w = p_{PO}^w$, it is also interesting to compare the implemented tariff vector $(T_h^h, T_{*1}^{*1}, T_{*2}^{*2}) = (\tau_{PO}, \tau_{PO}^{*1}, \tau_{PO}^{*2})$ with the proposed tariffs when countries use dominant strategy proposals. The set of dominant strategy proposals for the home country includes $(T_h^h, T_h^{*1}, T_h^{*2}) = (\tau_{PO}, \tau_{PO}^{*1}, \tau_{PO}^{*2})$. This proposal is now feasible, since $\widetilde{p}^w(\tau_{PO}, \tau_{PO}^{*1}, \tau_{PO}^{*2}) = p_{PO}^w = p_0^w$. The home country may also propose $(T_h^h, T_h^{*1}, T_h^{*2})$ where $T_h^h = \tau_{PO}$, $(T_h^{*1}, T_h^{*2}) \neq (\tau_{PO}^{*1}, \tau_{PO}^{*2})$ and the market-clearing world price under the home-country's proposed tariffs equals $p_0^w = p_{PO}^w$. Relative to home's proposal, the implemented tariff vector then entails a world-price preserving adjustment in foreign tariffs and is thus equivalent from home's perspective. Next, recall that the dominant strategy set for foreign country $*i$ is a singleton defined by $T_{*i,PO}$, where $T_{*i,PO}^{*i} = \tau_{PO}^{*i}$, $T_{*i,PO}^{*j} = \tau_0^{*j}$ and $T_{*i,PO}^h = T_{*i}^h(\tau_{PO}^{*i})$ is then uniquely set to deliver p_0^w as the market-clearing world price. Since $p_{PO}^w = p_0^w$, the implemented tariff vector is in the equivalence class for foreign country $*i$ that is defined by its dominant strategy proposal.

If the home country proposes $(T_h^h, T_h^{*1}, T_h^{*2}) = (\tau_{PO}, \tau_{PO}^{*1}, \tau_{PO}^{*2})$, then we may understand that the home-country proposal is accepted as is. If instead the home country proposes $(T_h^h, T_h^{*1}, T_h^{*2})$ where $T_h^h = \tau_{PO}$ and $(T_h^{*1}, T_h^{*2}) \neq (\tau_{PO}^{*1}, \tau_{PO}^{*2})$, then we can think of the home-country proposal being accepted, once world-price preserving adjustments are made to its proposed tariffs for the foreign countries. Whether or not the home-country proposal is accepted as is, we can think of each foreign country $*i$'s proposal as being accepted, once world-price-preserving modifications are made to its proposed tariffs for the home country and for foreign country $*j$.

Summary: We have established the following proposition:

Proposition 4 *Given the constructed mechanism, under dominant strategy proposals, (i) the implemented tariff vector is efficient if and only if $p_0^w = p_{PO}^w$, and (ii) when $p_0^w = p_{PO}^w$, the efficient tariff vector that is implemented is the politically optimal tariff vector.*

As illustrated above, we can also interpret the process through which outcomes are achieved. In some cases, the outcome entails accepting the home-country proposal as is, or after world-price-preserving modifications are made to the home-country proposal for foreign-country tariffs. In other cases, we can think of each foreign country $*i$'s proposal as being accepted, once world-price-preserving modifications are made to its proposed tariffs for the home country and for foreign country $*j$. When $p_0^w = p_{PO}^w$, it is also possible that the proposals agree. Then, the home-country proposal may even be accepted as is, and the proposal of each foreign country $*i$ is accepted once world-price-preserving modifications are made to its proposed tariffs for the home country and for foreign country $*j$.

To conclude this section, we return to the "request-offer" language and practice of GATT tariff bargaining and again highlight the central role played by offers (i.e., T_h^h, T_{*1}^{*1} and T_{*2}^{*2}). In the case where $p_0^w = p_{PO}^w$, for example, the implemented tariff vector consists of each country's offer from its initial proposal. The world-price-preserving modification of foreign country $*i$'s proposal achieves this tariff vector by replacing foreign country $*i$'s requests of the home country and foreign country $*j$ with their offers contained in their proposals. From a practical perspective, the countries could achieve this tariff vector by simply agreeing to the offers on the table. Similarly, when $p_0^w \neq p_{PO}^w$, the offers of foreign countries are implemented when the home country is long, and the offer of the home country (and perhaps one foreign country) is implemented when the home country is short. In this situation, a country that is on the long side may need to modify its offer in order to ensure that the implemented tariff vector satisfies multilateral reciprocity.

6 Nash Beginnings

Throughout, we have assumed a setup under which the initial tariff vector, $(\tau_0, \tau_0^{*1}, \tau_0^{*2})$, and associated world price, $p_0^w \equiv \widetilde{p}^w(\tau_0, \tau_0^{*1}, \tau_0^{*2})$, are exogenous. An interesting possibility is that the initial tariff vector corresponds to Nash tariffs, so that $(\tau_0, \tau_0^{*1}, \tau_0^{*2}) = (\tau_N, \tau_N^{*1}, \tau_N^{*2})$ with $p_0^w = \widetilde{p}^w(\tau_N, \tau_N^{*1}, \tau_N^{*2}) \equiv p_N^w$.[40] We now briefly discuss some implications associated with this possibility.

As we note in Section 2, Nash tariffs are inefficient; furthermore, starting at the Nash equilibrium, if all three countries offer slight tariff cuts that in combination satisfy the principle of multilateral reciprocity, then all three countries experience a welfare gain. The key ideas behind the latter finding are that multilateral reciprocity fixes the world price and $W_p < 0 < W_{p^{*i}}^{*i}$ at the Nash tariffs.

Let us now suppose that countries start at the Nash equilibrium, with $(\tau_0, \tau_0^{*1}, \tau_0^{*2}) =$

[40] Given our maintained assumption that $(\tau_0, \tau_0^{*1}, \tau_0^{*2}) \in \Upsilon$, if $(\tau_0, \tau_0^{*1}, \tau_0^{*2}) = (\tau_N, \tau_N^{*1}, \tau_N^{*2})$, then it follows that $(\tau_N, \tau_N^{*1}, \tau_N^{*2}) \in \Upsilon$.

$(\tau_N, \tau_N^{*1}, \tau_N^{*2})$ and $p_0^w = \widetilde{p}^w(\tau_N, \tau_N^{*1}, \tau_N^{*2}) \equiv p_N^w$. If countries use dominant strategy proposals, then $(T_h^h, T_{*1}^{*1}, T_{*2}^{*2}) = (\tau_{PO}, \tau_{PO}^{*1}, \tau_{PO}^{*2})$, where $(\tau_{PO}, \tau_{PO}^{*1}, \tau_{PO}^{*2})$ is defined relative to the initial world price $p_0^w = p_N^w$. Since no country can be forced to import a volume greater than its implied import volume, the implemented tariff vector $(\tau, \tau^{*1}, \tau^{*2})$ satisfies $M(p(\tau, p_0^w), p_0^w) \leq M_{h,PO} \equiv M(p(\tau_{PO}, p_0^w), p_0^w)$ and also satisfies $M^{*i}(p^{*i}(\tau^{*i}, p_0^w), p_0^w) \leq M_{*i,PO} \equiv M^{*i}(p^{*i}(\tau_{PO}^{*i}, p_0^w), p_0^w)$, $i = 1, 2$.

Suppose that the proposals are such that agreement occurs or the home country is long. We then may conclude that $M(p(\tau, p_0^w), p_0^w) > M_{h,N} \equiv M(p(\tau_N, p_0^w), p_0^w)$ and $M^{*i}(p(\tau^{*i}, p_0^w), p_0^w) > M_{*i,N} \equiv M^{*i}(p^{*i}(\tau_N^{*i}, p_0^w), p_0^w)$, $i = 1, 2$, so that the implemented tariff vector gives each country greater-than-Nash trade volumes and welfares. Given the initial world price $p_0^w = p_N^w$, this conclusion follows under (4) from the assumption of single-peaked preferences, $W_p < 0 < W_{p^{*i}}^{*i}$ at the Nash tariffs, $W_p = 0$ at τ_{PO}, and $W_{p^{*i}}^{*i} = 0$ at τ_{PO}^{*i}. The result holds as well when the home country is short, provided that the residual volume left for foreign country $*j$ (i.e., the "second" foreign country) is positive and exceeds its Nash volume, $M_{*j,N}$. This case is expected if the home country is large relative to the individual foreign countries but is not guaranteed by our assumptions.

One case of particular interest occurs when the home country is symmetric in size relative to the two foreign countries in aggregate. This "symmetric" case corresponds to the setting in which $p_N^w = p_{PO}^w$. Hence, under symmetry, if $p_0^w = p_N^w$ and countries use dominant strategies, then agreement would occur and the politically optimal tariffs would be implemented. The outcome is then efficient, with all three countries enjoying trade-volume and welfare gains relative to the Nash starting point.

We summarize these findings as follows:

Proposition 5 *Suppose the initial tariff vector is the Nash tariff vector. Given the constructed mechanism, under dominant strategy proposals, the following obtains: (i) if agreement occurs or the home country is long, then the implemented tariff vector gives each country greater-than-Nash trade volumes and welfares; and (ii) if the setting is symmetric with $p_0^w = p_N^w$, then agreement occurs and the implemented tariff vector is the politically optimal tariff vector, which is efficient and gives each country greater-than-Nash trade volumes and welfares.*

7 Extensions

The analysis can be extended in multiple ways. We discuss here four possible extensions.

Multiple countries As a first example, we may extend the analysis to consider multiple foreign countries. Suppose for example that there are three foreign countries. When the home country is short, one of the foreign countries, say foreign country $*i$, is selected as the "first" foreign country. As above, in the constructed mechanism, foreign country $*i$ imports a volume that is the minimum of M_{*i} and $p_0^w M_h$. If $p_0^w M_h > M_{*i}$, then the value of the home country's implied import volume is not exhausted by foreign country $*i$'s implied import volume. We can then treat this residual value, $p_0^w M_h - M_{*i}$, as the value of home trade volume that is allocated across the remaining two foreign countries (i.e., $p_0^w M_h - M_{*i}$ in the model with three foreign countries then plays the role of M_h in the constructed mechanism defined above for the model with two foreign countries). In this general way, we can proceed inductively to define the constructed mechanism for any number of foreign countries.

Private information A second extension allows for private information. Suppose payoff functions are given as $W(p(\tau, p_0^w), p_0^w; \theta)$ and $W^{*i}(p^{*i}(\tau^{*i}, p_0^w), p_0^w; \theta^{*i})$, where $\theta \in \Theta$ is privately observed by the home country and $\theta^{*i} \in \Theta^{*i}$ is privately observed by foreign country $*i$, $i \neq j$. We may think of Θ and Θ^{*i} as intervals on the real line, for example. The variables θ and θ^{*i} correspond to preference shocks and do not directly impact the determination of economic variables (i.e., $\tau_0, \tau_0^{*1}, \tau_0^{*2}, p_0^w$ and the function $\widetilde{p}^w$ are all independent of θ and θ^{*i}).

For this extended model, the constructed mechanism remains the same as above. The politically optimal tariff reactions are also defined as above, except that now they are defined in an ex post sense. Thus, $\tau_{PO}(\theta)$ satisfies $W_p(p(\tau, p_0^w), p_0^w; \theta) = 0$ and $\tau_{PO}^{*i}(\theta^{*i})$ satisfies $W_{p^{*i}}^{*i}(p^{*i}(\tau^{*i}, p_0^w), p_0^w; \theta^{*i}) = 0$. When our assumptions are extended to apply to ex post states, Proposition 2 and 3 hold as stated above, once τ_{PO}^{*i} is replaced by $\tau_{PO}^{*i}(\theta^{*i})$ in Proposition 2 and once τ_{PO} is replaced by $\tau_{PO}(\theta)$ in Proposition 3. In the extended model, Proposition 2 and 3 thus characterize ex post dominant strategies. Finally, Proposition 4 carries over as well, once p_{PO}^w is replaced by $p_{PO}^w(\theta, \theta^{*1}, \theta^{*2})$ where $p_{PO}^w(\theta, \theta^{*1}, \theta^{*2}) \equiv \widetilde{p}^w(\tau_{PO}(\theta), \tau_{PO}^{*1}(\theta^{*1}), \tau_{PO}^{*2}(\theta^{*2}))$. With this adjustment, Proposition 4 characterizes when an ex post efficient outcome can be implemented using dominant strategies in the private information model, when the constructed mechanism is used.

Additional Constraints We place little restriction above on the initial tariff vector, $(\tau_0, \tau_0^{*1}, \tau_0^{*2})$. The implemented tariff vector may involve tariff cuts if the initial tariffs are high, as Proposition 5 illustrates. At the same time, if the initial tariff vector entails tariffs that are low, then an efficient outcome such as described in Proposition 4 could entail tariff increases. When the initial tariff vector is such that the home country is short under dominant strategy proposals, it is also possible that one foreign country (the "second" foreign country) is assigned a prohibitive tariff and receives zero trade volume under the constructed mechanism. This assignment is not fundamental to our arguments, however. For example, with some additional notation, we could impose an exogenous upper bound on the tariff that each foreign country can apply, in which case the prohibitive tariff would be replaced with a maximum tariff. Another possible extension would be to include a minimum-welfare, or ex post participation, constraint for each country, where the threshold welfare level is exogenous.

Alternative Rationing Rules In the constructed mechanism, when the home country is short, we specify that a randomly selected foreign country be given first priority in the allocation of trade volume. As we noted, alternative rationing rules could be used. A key task is to ensure that the any new rule is also consistent with implementation using dominant strategies. We mention here two kinds of alternative rationing rules.

A first alternative rule allows that different foreign countries may be treated differently, even in an ex ante sense. Suppose, for example, that foreign country $*i$ is, for exogenous reasons, a more significant trading partner for the home country. The home country might then regard foreign country $*i$ as a "principal supplier" in the GATT/WTO context. An alternative rationing rule could then be specified in which, when the home country is short, foreign country $*i$ always assumes the first-priority position (i.e., conditional on home being short, foreign country $*i$ is always treated as if it were randomly selected to go "first" in the scheme above). The results above would continue to hold under this asymmetric rationing rule that utilizes a fixed priority scheme. Indeed, our assumption above that each foreign country is selected to go first with equal probability generates an attractive symmetry property but plays no formal role in our analysis, and so the fixed (i.e., determinstic) priority scheme can be understood as a limiting case of the analysis already conducted.

The second rule is based on the "uniform allocation rule." Sprumont (1991) defines this rule for an allotment problem in which shares of a fixed volume of a divisible good are to be allocated at a fixed price among N agents, each of whom has a continuous, single-peaked and privately observed preference as to its preferred share. The rule gives each agent his preferred share, provided that the shares do not fall outside of upper and lower bounds that are determined so that shares add up to one.[41] For the private-information setting, Sprumont shows that an allotment rule is efficient, strategy-proof and anonymous if and only if it is the uniform allocation rule.[42]

We could impose a similar rule in our complete-information setting, although we would

[41] Sonmez (1994) provides a helpful algorithm for reaching the outcome prescribed by the uniform rule. See also Barbera (2011).

[42] Efficiency is defined in this context relative to the problem of allocating the fixed volume among privately informed agents in an efficient way. (See also footnote 35.) An anonymous rule treats agents symmetrically.

need to modify the rule in the case of excess supply (i.e., when the home country is long).[43] Similar results would then obtain. An appealing feature of the uniform allocation rule is that both foreign countries receive positive trade volumes when the home country is short, even if the import volume implied by one foreign country's proposal exceeds that implied by the home country's proposal. At the same time, in a decentralized bargaining setting, the uniform allocation rule may require significant coordination among parties to ensure that the bounds are properly determined.

8 Conclusion

Motivated by GATT bargaining behavior and renegotiation rules, we construct a three-country, two-good general-equilibrium model of trade and examine multilateral tariff bargaining under the constraints of non-discrimination and multilateral reciprocity. We allow for a general family of government preferences and identify bargaining outcomes that can be implemented using dominant strategy proposals for all countries. The resulting bargaining outcome is efficient relative to government preferences if and only if the initial tariff vector positions the initial world price at its "politically optimal" level. In symmetric settings, if the initial tariffs correspond to Nash tariffs, then the initial world price is indeed positioned at its politically optimal level, and the resulting bargaining outcome is efficient and ensures greater-than-Nash trade volumes and welfares for all countries.

In our model, dominant strategy proposals lead to assigned tariff vectors once a round of adjustments are made to ensure that multilateral reciprocity is maintained while not requiring any country to import more than is implied by its proposal. This simple sequence - tariff proposals followed by multilateral rebalancing - is broadly consistent with observed patterns identified by Bagwell, Staiger and Yurokoglu (2016) in the bargaining records for the GATT Torquay Round. A notable feature of bargaining behavior in this round is the lack of back-and-forth haggling over the levels of proposed tariffs. Moreover, the own-tariff offers contained in the proposals – rather than the requested tariff changes by others that complete each proposal – take center stage in our constructed mechanism, consistent with the additional finding of Bagwell, Staiger and Yurukoglu that, once initial proposals were on the table, tariff bargaining at Torquay focused on modifications to the offers in each proposal rather than requests. Finally, and also in broad alignment with observed patterns from the Torquay Round, when offers are modified to achieve multilateral reciprocity in the constructed mechanism, the modifications take the form of

[43] Given our requirement that a country cannot be forced to accept a trade volume in excess of that implied by its proposal, we are not able to require a foreign country to import a reference volume that exceeds its proposed (i.e., preferred) volume. We could thus handle the case in which the home country is long as we do above and use the uniform allocation rule when the home country is short.

shallower, rather than deeper, offers.

Our work also contributes to the theoretical literature on tariff bargaining under nondiscrimination and reciprocity. For the case of nondiscriminatory tariffs, we generalize prior work by Bagwell and Staiger (1999) by allowing each country to make direct proposals regarding the tariffs of its trading partner(s) and by characterizing bargaining outcomes that obtain when all countries use dominant strategy proposals. This generalization that we consider here offers a more direct path to the GATT tariff bargaining records. With this generalization, we also show that a key finding - that efficiency can be achieved if and only if the politically optimal MFN tariff vector is implemented - extends to a setting where all countries make direct tariff proposals and use dominant strategy proposals. We leave a many-good generalization of our results as an important direction for future work.

Finally, our work contributes by drawing novel links between multilateral tariff bargaining and the literatures that feature strategy-proof rationing schemes. As we argue, when tariff negotiations are constrained to satisfy the MFN rule and multilateral reciprocity, trade is conducted at a fixed world price. The rationing problems that emerge are then broadly similar to those that have been studied in other research on strategy-proof rationing. We mention above several extensions and directions for future work that could help to develop this relationship more fully. Interesting future work might also explore the relationship between multilateral tariff bargaining and strategy-proof exchange, as studied by Barbera and Jackson (1995), so as to determine whether circumstances exist under which some form of multilateral reciprocity is necessary for dominant strategy implementation of multilateral tariff bargaining outcomes.

References

Abdulkadiroglu, Atila and Tayfun Sonmez (1998), "Random Serial Dictatorship and the Core from Random Endowments in House Allocation Problems," *Econometrica*, 66, 689-701.

Bagwell, Kyle and Robert W. Staiger (1999), "An Economic Theory of GATT," *American Economic Review* 89(1), 215-48.

Bagwell, Kyle and Robert W. Staiger (2002), *The Economics of the World Trading System*, The MIT Press, Cambridge, MA.

Bagwell, Kyle and Robert W. Staiger (2005), "Multilateral Trade Negotiations, Bilateral Opportunism and the Rules of GATT," *The Journal of International Economics* 67(2), 268-294.

Bagwell, Kyle and Robert W. Staiger (forthcoming), "The Design of Trade Agreements," in Kyle Bagwell and Robert W. Staiger (eds.), *The Handbook of Commercial Policy*, Vol. 1, Elsevier.

Bagwell, Kyle, Robert W. Staiger and Ali Yurukoglu (2016), "Multilateral Trade Bargaining: A First Look at the GATT Bargaining Records," September.

Barbera, Salvador (2011), "Strategyproof Social Choice," in Kenneth. J. Arrow, Amartya Sen and Kotaro Suzumura (eds.), *Handbook of Social Choice and Welfare*, Vol. 2, Chapter 25, 731-831, Elsevier.

Barbera, Salvador and Matthew O. Jackson (1995), "Strategy-Proof Exchange," *Econometrica*, 63(1), 51-87.

Barbera, Salvador, Matthew O. Jackson and Alejandro Neme (1997), "Strategy-Proof Allotment Rules," *Games and Economic Behavior*, 18(1), 1-21.

Benassy, Jean-Pascal (1982), *The Economics of Market Disequilibrium*, New York: Academic Press.

Bogomolnaia, Anna and Herve Moulin (2001), "A New Solution to the Random Assignment Problem," *Journal of Economic Theory*, 100, 295-328.

Curzon, Gerard (1966), *Multilateral Commercial Diplomacy: The General Agreement on Tariffs and Trade and its Impacts on National Commercial Policies and Techniques*, Praeger: New York.

Dixit, Avinash (1987), "Strategic Aspects of Trade Policy," in *Advances in Economic Theory: Fifth World Congress*, edited by Truman F. Bewley, 329-62. New York, NY: Cambridge University Press.

Gul, Faruk, Hugo Sonnenschein and Robert Wilson (1986), "Foundations of Dynamic Monopoly and the Coase Conjecture," *Journal of Economic Theory*, 39, 155-90.

Interim Commission for the ITO (1949), *The Attack on Trade Barriers: A Progress Report on the Operation of the General Agreement on Tariffs and Trade.* Geneva, August.

Ludema, Rodney (1991), "International Trade Bargaining and the Most-Favored Nation Clause," *Economics and Politics*, 3(1), 1-20.

Moulin, Herve (2000), "Priority Rules and Other Asymmetric Rationing Methods," *Econometrica*, 68(3), 643-684.

Sonmez, Tayfun (1994), "Consistency, Monotonicity, and the Uniform Rule," *Economic Letters*, 46, 229-235.

Sprumont, Yves (1991), "The Division Problem with Single-Peaked Preferences: A Characterization of the Uniform Allocation Rule," *Econometrica*, 59(2), 509-519.