Non-Tariff Barriers and Trade Liberalization[*]

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Abstract

This paper shows that governments have no incentive to introduce non-tariff barriers when they are free to set tariffs but they do when tariffs are determined cooperatively. Quotas are preferred to antidumping restrictions so that the model is consistent with a progression from using tariffs only to quotas, and then to antidumping constraints (when quotas are eliminated). There is a corresponding narrowing of the range of industries affected by trade restrictions. Simulating the model, the degree of tariff liberalization and of replacement of tariffs by NTBs are shown to depend on industry characteristics in line with stylized facts.

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1. Introduction

It is commonplace to recognize that tariffs have gradually been replaced by non-tariff barriers (hereafter, NTBs). Some authors go even further and argue there is a "Law of Constant Protection" (an expression used by Bhagwati (1988) mainly to dismiss the idea). Baldwin (1984) for instance writes: "Not only have these measures become more visible as tariffs have declined significantly through successive multilateral trade negotiations but they have been used more extensively by governments to attain the protectionist goals formerly achieved with tariffs"(p. 600).

The purpose of this paper is to set up a model in which the effect of trade liberalization on the use of quotas and antidumping laws can be investigated directly. We analyze two types of bilateral trade liberalization: tariff reductions and quota elimination. We show that our model is consistent with a *progression* from the use of tariffs only to the use of quotas (following tariff liberalization), to the use of antidumping laws (when quotas have been jointly tarrified). Second, it is also consistent with a *narrowing* of the range of industries in which each of these instruments is used. Third, the extent of bilateral tariff liberalization and the ensuing *degree of replacement* of tariffs by NTBs depend on the combination of two industry-specific characteristics: the government's preferences for domestic firm profits and the importance of international transport cost in the industry. Overall, our results suggest that treaties that remove or reduce one type of distortion may lead to the use of other policies that are even worse, but, despite the use of NTBs, overall trade is more liberal.

To show these results, we use a standard two-country model with two-way trade where the policymaker's objective function is quasi-concave. This last characteristic is important to explain some of the results of this paper as it leads to strategic complementarity in the tariff game and to the possibility of interior solutions in the quota game.

Our results appear to track well three separate sets of empirical facts. First, evidence shows that there is a clear emergence of quantitative restrictions in the 1960s in manufacturing sectors and in developed economies followed by an explosion in the use of antidumping constraints since the 1980s.[1] The emergence of these two NTBs can be linked to preceding multilateral trade rounds and, in particular to the completion of the Kennedy Round.

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[1] See Renner (1971) for evidence on quotas, and Dale (1980) and Finger and Olechowski (1987) for evidence on antidumping measures.

Today, GATT (1990) notes that "[d]espite a recent decline in the number of anti-dumping investigations initiated in the United States and the European Communities, anti-dumping remains (after tariffs) the most frequently invoked trade policies in these countries" (p.10). Antidumping measures are also spreading to developing countries (Nogués, 1993). Quantitative restrictions are meanwhile on the decline as signatories of the Uruguay Round agreement are now required to 'tariffy' existing quotas and constrain their future use. GATT (1993a) documents specific import quotas, import licensing restrictions, and items subject to import prohibition that have been eliminated in recent years.

Second, the gradual replacement of trade tools has also been accompanied by a reduction of the number of sectors affected by NTBs. Whereas very few products were traded without levy before the various GATT rounds, Renner (1971) finds that 7% of the (4 digit) product classes were affected by quantitative restrictions in the US and in the EC in 1970. The number of antidumping cases in the EC (initiated and/or ending up with a positive decision) represents a fraction of this number (see GATT, 1993b) mainly concentrated on a very small number of sectors (see Messerlin and Reed, 1995). Of course, it is not because a smaller number of sectors are affected by NTBs that overall protection necessarily decreases. However, given the high rates of growth in world trade, it seems likely that, despite this substitution, the overall level of protection has decreased over time.

Third, the links between tariff liberalization and the emergence of NTBs have been investigated empirically with interesting results with respect to industry characteristics. Marvel and Ray (1983), in particular, show that tariff liberalization is stronger (on average) in industries that are more competitive and that enjoy higher growth rates. Moreover, Ray (1981) and Marvel and Ray (1983) argue that NTBs are found predominantly in more competitive industries because NTBs are better than tariffs at shielding rents among existing firms when barriers to entry are low. There is much less use of NTBs in less competitive industries as tariff liberalization has been more modest. Marvel and Ray also argue that there are some sectors (in both types of industry) in which overall protection has increased as a result of the emergence of NTBs.

There is an abundant theoretical literature on barriers to trade. Tariff games go back to Johnson (1954) and quota games have been investigated by Rodriguez (1974) and Tower (1975). Papers investigating why, for instance, a government might prefer quantitative restrictions to tariffs include Cassing and Hillman (1985), Deardorff (1987), Falvey and Lloyd

(1991), Kaempfer et al. (1988). As pointed out by McCulloch (1987), these papers do not explain the *changes* from tariffs to quotas, let alone the changes to other forms of NTBs such as antidumping restrictions. Recently, Anderson (1993) and Rosendorf (1996) have argued that antidumping constraints and quantitative restrictions might go hand in hand. Copeland (1990) proposes a model in which two countries bargain over the level of a 'negotiable' trade instrument, anticipating the subsequent use of a non-negotiable instrument. He shows that there is some substitution into the less efficient non-negotiable instrument as a result of this negotiation. However, net protection decreases. It is this link we wish to investigate and in particular the combination of industry-specific characteristics which is associated with it.

In the next Sections, we investigate the case of quotas and antidumping as devices to maintain protection when tariffs are negotiated away or when international transport costs get lower. We are interested in developing a model (i) which is consistent with the sequential introduction of quantitative restrictions and antidumping measures; (ii) where the range of sectors affected by these tools gets smaller, and (iii) where the degree of tariff liberalization and the use of NTBs depend on industry characteristics.

The paper is organized as follows. In Section 2, we present the theoretical model that indicates both a progression of trade instruments and a narrowing of the affected sectors. In Section 3, we derive the non-cooperative tariff equilibrium and we show that a symmetric quota equilibrium exists possibly with an interior solution. In Section 4, we simulate the model. We show first the extent of tariff liberalization and then analyze the quota equilibrium. Depending on industry characteristics, the use of quotas may result in a net increase or decrease in protection. Finally, we suppose that quotas are negotiated away and investigate the subsequent scope for antidumping restrictions. Section 5 summarizes the main points of the analysis.

2. The Model

Our starting point is the simple reciprocal dumping model of Brander and Krugman (1983) with two firms, one in each country, selling the same good. Competition between firms within each country is described by the Cournot model. The reasons for this modeling strategy are as follows. In a perfectly competitive world, firms would never dump so there would be no role for antidumping measures (see Ethier, 1982 for an exception under

uncertainty). Furthermore, there would be no incentive to use quotas if the foreigners get the rents from them. Hence some market imperfection is needed to explain the use of quotas and antidumping restrictions in a simple static framework. The most natural one is market power, which is also the relevant market structure for many manufacturing industries. The basic choices to model oligopolistic interaction are the Cournot and Bertrand descriptions. The Bertrand model requires differentiated products otherwise there would be neither imports nor exports. Under quotas, the price equilibria are typically in mixed strategies (see for example Krishna, 1989), which are both cumbersome analytically and unappealing to some critics. Therefore we use the Cournot model, which is generally manageable, as well as tracking to a fair degree the stylized facts of the Introduction. For simplicity we do not allow for entry, and consider only two countries with one firm each.

Firm 1 is domiciled in country A, in which it sells x_1 units of output, while it sells y_1 in country B. Firm 2, domiciled in B, sells x_2 in A and y_2 in B. There are no marginal production costs, but the cost of shipping one unit of output abroad is t per unit.

The inverse demands in market A and B are, respectively

$$p_A = 1 - (x_1 + x_2); \qquad \text{and} \qquad p_B = 1 - (y_1 + y_2).$$

If a tariff τ_A is imposed by government A, the foreign firm's marginal cost for its exports is $T_A = t + \tau_A$; T_B and τ_B are analogously defined. The standard linear-demand Cournot model then yields equilibrium outputs as

$$\hat{x}_1 = \frac{1 + T_A}{3}; \qquad \hat{x}_2 = \frac{1 - 2T_A}{3}; \qquad \hat{y}_1 = \frac{1 - 2T_B}{3}; \qquad \hat{y}_2 = \frac{1 + T_B}{3}. \qquad (1)$$

These solutions are valid for $T_i \in [-1, \frac{1}{2}]$, $(i = A, B)$. If $T_i \geq \frac{1}{2}$, there is a domestic monopoly in country i with the rival firm excluded by too high export cost (and thus the solution is that of $T_i = \frac{1}{2}$). If $T_i \leq -1$, the foreign firm is a monopolist in the domestic firm's market.

The equilibrium profits are simply $\pi_j = \hat{x}_j^2 + \hat{y}_j^2$, $(j = 1, 2)$, or for Firm 1,

$$\pi_1 = \left(\frac{1 + T_A}{3}\right)^2 + \left(\frac{1 - 2T_B}{3}\right)^2. \qquad (2)$$

This model produces reciprocal dumping since $p_A - T_A \leq p_B$ and $p_B - T_B \leq p_A$. Each firm dumps its product in the foreign market, not by using predatory pricing, but by using (third

4

degree) price discrimination between the two countries. In effect, each firm sells the same product at a lower (net) price abroad than at home.

Consumer surplus in A is simply $\frac{1}{2}(\hat{x}_1 + \hat{x}_2)^2$. We assume that tariff revenues are redistributed to consumers. Consumer benefits, β_A, are then the sum of consumer surplus and tariff revenue:

$$\beta_A = \frac{1}{2}\left(\frac{2 - T_A}{3}\right)^2 + \tau_A\left(\frac{1 - 2T_A}{3}\right). \tag{3}$$

A similar expression applies to market B. Notice we make the standard assumption of constant marginal cost of production. hence, as long as a firm does not face a constraint linking the two markets, its profit-maximizing decisions are separate for each market.

The two NTBs we consider are quotas and antidumping restrictions. Suppose that Government A imposes a quota, $\bar{x}_2 \geq 0$, on the foreign firm. We assume there is no government revenue from quotas (see below for further discussion). A quota is binding if it is less than the Cournot output (see (1)) of the foreign firm in the domestic market, i.e. if $\bar{x}_2 < \frac{1 - 2T_A}{3}$, where T_A is the sum of transport cost and whatever tariff is currently in effect. The domestic firm then chooses its Cournot best reply to $\bar{x}_2$,

$$\hat{x}_1 = \frac{1 - \bar{x}_2}{2}.$$

A quota at home has no effect in the foreign market. It is well known that tariffs and quotas are equivalent in a Cournot game (see Hwang and Mai, 1988). This implies that quotas would be as efficient as tariffs if quota rights were auctioned off by the government.

The third tool available to each government is an antidumping constraint. Following Anderson, Schmitt, and Thisse (1995), we model antidumping measures as a binding constraint on the affected firm's outputs to eliminate the dumping margin, which is the difference between the price received on each domestic unit sold and the net price received on each unit exported. Hence, we assume that evidence of dumping is determined by a price-based method.[2] If Government A imposes an antidumping restriction on the foreign firm, then Firm 2's outputs must ensure that

$$p_A \geq p_B + T_A, \tag{4}$$

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[2] This is the method of choice in the US; it is generally based on a foreign firm's own home market sale price or on sale prices in a third country. The cost-based method is used as a method of last recourse. See Gallaway, Blonigen and Flynn (1999).

if Firm 2 is to sell in market A (it may prefer giving up market A and selling only in market B). The concavity of the profit functions ensures that (4) will hold with equality whenever Firm 2 opts to still serve market A.[3]

An equilibrium under antidumping constraints is a non-negative quadruple of outputs (x_1, x_2, y_1, y_2) such that each firm's profit is maximal under any constraint faced, given the rival's outputs. For example, an equilibrium at which Firm 2 is restricted while Firm 1 is not entails Firm 2 facing the constraint $(1 - y_1 - y_2) \leq (1 - x_1 - x_2 - T_B)$ and the standard non-negativity constraints, while Firm 1's problem is the standard Cournot one. Under an antidumping constraint, the restricted firm may either withdraw from its export market or else serve it without dumping. As shown in the Appendix, the equilibrium involves the restricted firm selling in both markets when T is low enough. When T is large, the equilibrium involves the restricted firm selling only in its domestic market competing there with the other firm (the other firm being a monopolist at home).[4] We show in the Appendix that an antidumping restriction on Firm 2 reduces its equilibrium output in market A and increases it in B (Firm 1's outputs go the other way). As expected, the equilibrium price rises in A and falls in B.

We have deliberately sketched a simplistic portrayal of antidumping restraints (for example, we ignore antidumping duties) in order to provide a tractable broad picture of the overall progression. Nevertheless, our treatment is still consistent with most antidumping cases. First antidumping is viewed here as an anti-discrimination device decreasing inter-firm rivalry to the benefit of domestic firms. This is consistent with most antidumping cases as 90% of them are implemented according to very loose injury criteria (including price differences) rather than strict predatory pricing (see Messerlin and Reed, 1995). Second, it is well known that a significant share of antidumping investigations end up with price or quantity undertakings and no duties.[5] As far as the foreign firm is concerned, (4) can be interpreted as the quantity undertaking (since it plays Cournot) satisfying this antidumping constraint. Third, antidumping duties are mainly aimed at checking firm's behavior. As a

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[3] In our equilibrium, the constraint is binding with equality so that the domestic firm could, if it wished, increase its home output slightly, reducing the domestic price and leading to a violation. And the domestic firm would wish to do this if it could thereby gain (as in Fischer, 1992). On the other hand, if there is no *direct* benefit to the domestic firm (for example, the foreign violator is fined) then there is no incentive to deviate from the equilibrium strategies described in the text.

[4] There is a small range of T over there is no pure strategy equilibrium for firms; see Anderson and Schmitt (2000) for details. We ignore this range in the sequel.

[5] 38% of all the cases in the US during the 1980-85 period according to Prusa (1992).

result, many firms respect antidumping constraints due to the threat of an investigation and being hit by a duty. In addition, those cases ending up with duties are reviewed periodically and duties are often reduced once foreign firms have been found to adjust their prices. DeVault (1996) finds that 77% of the US antidumping duties first levied during 1980s had been reviewed by 1994 and that a first review decreases average duties from 29.5% to 15.9%. Our model is consistent with the above since an alternative interpretation of the antidumping constraint is that a firm that violates (4) is hit with an antidumping duty equal to the dumping margin. It is then easy to show that this is equivalent to facing the antidumping constraint, as firms drive the duty to zero.[6]

The final ingredient of the model is the description of how trade policies are determined. We posit a policy-maker's objective function, $U(\beta, \pi)$, over consumer benefits and profit which is strictly increasing in each argument and quasiconcave so the indifference curves have the standard shape (downward sloping with diminishing marginal rate of substitution). We also assume that this objective function is applied to each industry separately. This assumption is a simple way to allow for different trade-offs between consumer benefits and profits in different industries. As we show below, our approach can explain the observed fact of binding but non-prohibitive quotas, whereas this observation rejects the simple surplus maximization approach. For the most part, we shall think of a strictly quasiconcave objective function (and strictly diminishing marginal rate of substitution), and later we shall use a Cobb-Douglas form for the policymaker's objective function, $U = \beta^{1-\alpha}\pi^{\alpha}$. Here α denotes the relative weight on profit, or the importance of the domestic firm to the policymaker.

There are several justifications for such a form. For example, following Stigler (1971) and Peltzman (1976), governments care about consumer welfare (with tariff revenues spent, say, on public goods) because consumers vote, and they care about profit because legislators get perks from lobbyists (and there are diminishing returns to each argument). In a similar vein, government policy is determined by costly lobbying from interested parties as in Becker (1983). Insofar as greater concessions are only achieved at the cost of larger lobbying expenditures, a balance will be struck between the lobbying parties, just as the Cobb-Douglas function tends to select outcomes that are 'in the middle' (whereas a linear utility function

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[6] Hence, our model is consistent with Boltuck, Francois and Kaplan (1991) when they write 'In essence, an exporter who continued to dump would be deciding to share revenue with the US Treasury that it could have captured by itself by raising the export price to the US price'. This suggests that explaining observed antidumping duties would either require noise or imperfect information, or alternatively that the duty covers less than 100% of the dumping margin.

tends to select more extreme outcomes, especially under convex constraints). We can think of the outcome of the lobbying game as the solution to the simpler maximization problem. In adopting $U(\beta, \pi)$ to investigate the choice and the level of the three trade tools available to policymakers, we assume they have as much freedom in choosing antidumping constraints on an industry-by-industry basis as they have over tariffs and quotas.[7]

We first establish that quotas are preferred to antidumping restrictions, and that tariffs are universally preferred to the other instruments.

Proposition 1: *Given an arbitrary tariff rate τ^0, if governments can use both quotas and antidumping restrictions, they will only use quotas or else no NTBs at all.*

Proof: Consider a combination of tariff τ^0 and an antidumping constraint on Firm 2. Imposing the antidumping constraint changes the profit of Firm 1 in both markets. As we just noted (and is shown in the Appendix), the output of Firm 2 rises in Market B. Since a firm's profit is decreasing in its rival's output in any market, the profit of Firm 1 must fall in market B. In Market A, an antidumping constraint can be replaced by a quota equal to Firm 2's output. This leads to the same outcome in Market A and hence to the same profit and consumer surplus there. Since an antidumping constraint lowers Firm 1's profit abroad, Firm 1's overall profit must rise when an antidumping constraint is replaced by a quota at the same level of imports. Hence no tariff-cum-antidumping constraint can be preferred to a tariff-cum-quota. ∎

Basically, an antidumping restriction has the same effect as a specific quota on the domestic market, but also reduces the home firm's profit in the foreign market. This result is consistent with the fact that quotas were the trade restriction of choice prior to the completion of the Kennedy Round. However, quotas have been used less frequently over the recent years. In large part this is due to constraints placed by GATT.

Proposition 2: *There is no incentive for a government to use quotas or antidumping constraints if there is no restriction on tariff use.*

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[7] For instance, the application of antidumping laws are subject to political influence. Moore (1992) finds empirical evidence that decisions on antidumping cases in the US are partly determined by political variables. Baldwin and Steagall (1994) reach less strong conclusions but note that commissioners do not have a very strict interpretation of the law.

Proof: An antidumping constraint or a prohibitive quota may cause the foreign firm to stop selling in the home market. A government imposing a prohibitive quota or an antidumping constraint which eliminates trade cannot prefer this outcome to the optimal tariff because the tariff could have originally been chosen to be prohibitive. So consider the case where NTBs do not eliminate trade. In particular, consider a combination of tariff τ^0 and a non-prohibitive binding quota, $\bar{x}_2$. Then any quota can be 'tariffied' to yield a revenue gain: any quota output can be attained via a tariff $\tau^1(\bar{x}_2)$ with $\tau^1 > \tau^0$ (see (1)). Imposing τ^1 leaves both profit and consumer surplus unchanged from their values at the pair $(\tau^0, \bar{x}_2)$, but tariff revenue must rise since $\tau^1 > \tau^0$. Since τ^* maximizes $U(.)$, then no other tariff can be better, and therefore no tariff-cum-quota or, with Proposition 1, no tariff-cum-antidumping can be preferred. ∎

This last proposition showcases an important property of the model: tariffs are more efficient trade policy tools than quotas, and quotas are more efficient than antidumping restrictions. These results are important because they are consistent with a progression in the use of barriers to trade from tariffs to quotas and from quotas to antidumping restrictions. To see this, suppose both countries have negotiated lower tariff rates than the unrestricted Nash equilibrium tariff rates. In addition, suppose it is understood they can no longer deviate from this negotiated tariff rate. They are likely to look for alternative ways to influence the pattern of trade to their own advantage. Restricting the set of possible instruments to quotas and antidumping restrictions, we have shown that they will prefer quotas and they will use antidumping measures only if the use of quotas is itself restricted. Accompanying this progression is the result (that we now establish) that the range of industries affected by trade restrictions narrows. We assume (for reasons elaborated upon below) that tariffs are constrained to be non-negative.

Proposition 3: *If the equilibrium to the tariff game involves zero tariffs, then the equilibrium to the quota game involves no quotas.*

Proof: We prove the result for a quota game with a zero tariff in place. Since any tariff has an equivalent quota in terms of the equilibrium outputs (see Hwang and Mai, 1988), then the only difference between a positive tariff and a corresponding quota is that the quota involves lower consumer benefits because the tariff revenues are lost. The government utility is therefore lower under quotas than tariffs at any positive tariff rate. Suppose then that the best reply to a zero tariff is a zero tariff so the equilibrium to the tariff game involves zero

tariffs. Then the best reply to no quota is no quota because payoffs are the same as if a zero tariff were imposed and any binding quota would yield a lower payoff than the corresponding tariff payoff, which is in turn lower than the payoff to a zero tariff. ∎

As we argue in Section 3 below, a zero-tariff equilibrium also entails a zero-cooperative tariff. This means that even if tariffs are negotiated down from the non-cooperative equilibrium levels before the quota game is played (as we assume below in the simulations), then we still associate zero-tariff equilibria with no quota equilibria. Conversely, if quotas are observed then they must have been preceded by positive tariffs. The next Proposition establishes a similar narrowing from the range of industries where quotas are imposed to those impacted by antidumping restraints.

Proposition 4: *If the equilibrium to the quota game involves no quotas, then no antidumping restraints will be used.*

Proof: Observe first that if the quota equilibrium involves no quotas, then the best reply to no quota is no quota. This means that no quota is preferred to any binding quota, and we showed in Proposition 1 that an antidumping constraint is equivalent to a quota plus a loss to domestic firms in the foreign market. Thus, antidumping will never be used in response to no antidumping and antidumping will not be used if quotas were not optimal when they could be used. Hence, if the quota equilibrium involves no quotas, then no antidumping constraint will be used. ∎

The last two propositions show that the set of industries (each characterized by a pair (α, t) below) over which a particular trade policy is used shrinks with the progression to less efficient trade tools. In Section 4 we return to this point when we simulate the progression using the Cobb-Douglas objective function. The simulations show that the narrowing of the range of industries affected by trade restrictions can be quite drastic. In the next Section we analyze further two key aspects of the model: the non-cooperative tariff equilibrium and the non-cooperative quota equilibrium.

3. Tariff and Quota

In this section we analyze the tariff game and the quota game for the model. This analysis is useful to explain the later simulation results. It is also of independent interest since

our formulation of the policymaker's objective function yields more appealing results than does standard social surplus maximization. For example, we find that tariffs are strategic complements while the standard approach yields an equilibrium tariff that is independent of the other nation's tariff level (i.e., a dominant strategy). Our quota game can generate interior solutions while the standard approach gives either completely prohibitive quotas or no quota at all.

We start with the tariff game. The government in A has to choose a tariff, τ_A, to maximize $U(\beta_A, \pi_1)$. Here, β_A is the sum of domestic consumer surplus and tariff revenue given by (3), and π_1 is the total profit earned by the domestic firm in both countries given by (2). The solution is described by a tangency condition between an indifference curve in (π_1, β_A) space and the constraint defined by the set of (π_1, β_A) pairs attainable via different levels of the tariff. There is also a possible corner solution corresponding to $T_A = \frac{1}{2}$, where profit attains its maximum value since the foreign presence is eliminated. The constraint slope is described by

$$\frac{d\pi_1}{d\beta_A} = \frac{\pi_1'}{\beta_A'} = \frac{2(1 + T_A)}{1 - 5T_A - 6\tau_A} = \frac{2(1 + t + \tau_A)}{1 - 5t - 11\tau_A}, \tag{5}$$

where a prime denotes a partial derivative with respect to τ_A. From (5), the constraint locus slopes up for $\tau_A < \frac{1-5t}{11}$, so there can never be a maximum of U on this portion. This is because higher tariffs here increase β_A, while they increase π_1 throughout. Hence the relevant part of the locus involves $\tau_A > \frac{1-5t}{11}$ or, equivalently (recalling $T_A = \tau_A + t$),

$$T_A > \frac{1 + 6t}{11}, \tag{6}$$

in which case there is a trade-off between higher profit and higher consumer benefits: a higher τ_A increases profit by squeezing out the rival firm while decreasing consumer benefits since consumers pay through higher prices. Note that (6) implies that the effective trade barrier $T_A > \frac{1}{11}$, while T_A can be effectively bounded above by $\frac{1}{2}$ (then the foreign firm is excluded from the domestic market). The solution to the government's problem is illustrated in Figure 1, where τ_A is monotonically increasing as we move counter-clockwise around the constraint locus. It is readily shown that the constraint locus is necessarily concave in the relevant range, so a tangency solution is a maximum.

[Insert Figure 1 here]

11

The tangency condition is described by the first-order condition, $U_\beta \beta_A' + U_\pi \pi_1' = 0$, or

$$f(\tau_A, \tau_B, t) \equiv (1 - 11\tau_A - 5t)U_\beta + 2(1 + t + \tau_A)U_\pi = 0. \tag{7}$$

Let τ_A^* denote the tariff rate solving (7); the slope of government A's reaction function is

$$\frac{d\tau_A^*}{d\tau_B} = -\frac{\partial f/\partial \tau_B}{\partial f/\partial \tau_A},$$

where $\partial f/\partial \tau_A = \beta_A'' U_\beta + \pi_1'' U_\pi + (\beta_A')^2 U_{\beta\beta} + 2\beta_A' \pi_1' U_{\beta\pi} + (\pi_1')^2 U_{\pi\pi}$ is negative by the second-order condition, and $\partial f/\partial \tau_B = -\frac{4}{9}(1 - 2T_B)(\beta_A' U_{\beta\pi} + \pi_1' U_{\pi\pi})$ is positive. Hence the reaction functions slope up: tariffs are strategic complements in the non-cooperative game between governments. The reaction functions are also continuous since the constraint locus is strictly concave in the relevant region and varies continuously with the other government's tariff rate, while the indifference curves are convex. A non-cooperative tariff equilibrium then exists by Brouwer's fixed point theorem since tariffs must be effectively chosen from the compact set $[\frac{1}{11} - t, \frac{1}{2} - t]$ (which stems from the fact that $T \,\epsilon\, [\frac{1}{11}, \frac{1}{2}]$).

We have shown that tariff reaction functions are continuous, upward sloping, and that they must cross. The symmetry of the governments' problems then implies that any equilibrium must be symmetric. Stability and uniqueness of the equilibrium are discussed in Anderson and Schmitt (2000). The reaction functions are sketched in Figure 2, in which we also represent some government indifference curves.

[Insert Figure 2 here]

The quasiconcave government objective function U is instrumental to the strategic complementarity result. If instead governments maximized the sum of consumer surplus, tariff revenues and firm profits, there is a dominant strategy with $\tau_A^* = \frac{1-t}{3}$. Although the *level* of social welfare depends on the rival's tariff (through the domestic firm's profit abroad), the equilibrium tariff does not. When the government trades off consumer benefits with profit in a non-linear fashion, as we assume, the higher the rival government's tariff, the lower will be the domestic firm's profit, ceteris paribus. At the margin, the government now wishes to redress the balance in favor of the firm and at the expense of consumers, resulting in a higher tariff best reply. To our knowledge, this feature of quasiconcave government objective function has not been noted previously.

From Figure 1, a relatively higher weight on firms in the government objective function (an increase in α in the Cobb-Douglas formulation) corresponds to an indifference curve that tilts more towards the π-axis, and a greater best reply value of π (and lower β). This is achieved by a higher tariff so tariff reaction functions shift up, resulting in a higher equilibrium tariff. Similarly, the effect of lower transport costs is to shift the reaction functions up and so to raise equilibrium tariffs.[8] A lower transport cost implies a greater foreign presence, ceteris paribus, and thus higher consumer benefits. Given the trade off between consumer benefits and profits, each government wants to increase protection and to exploit the monopoly power of the home market. It is apparent that the features of the model and in particular of the quasiconcave policymaker's objective function create an interdependence between α, t and the non-cooperative tariff rate. This interdependence is a central feature of the simulations of Section 4.

In the sequel, we shall also analyze (symmetric) cooperative tariffs. This means a tangency between iso-utility curves for the governments. Figure 2 indicates that cooperative tariffs (denoted τ^{**}) are no higher than equilibrium ones. The result follows since utility levels fall with rival tariffs along the reaction functions. Note that non-negativity constraints on tariffs merely convert an unrestricted negative tariff equilibrium to a zero tariff. Then zero equilibrium levels imply zero cooperative levels.

Consider now the quota game between the two governments. By Proposition 2, quotas are used only under restrictions on tariff use, so assume both governments have negotiated some arbitrary (and identical) tariff rate. Countries can no longer deviate from this tariff.

The locus of (π, β) combinations attainable through quotas is convex. To see this, consider the Cournot equilibrium in the presence of a quota. If the quota on Firm 2 is binding, $\bar{x}_2 \, \epsilon \, [0, \frac{1-2T}{3}]$ (where $T = t + \tau$ depends on the common tariff) and Firm 1's best reply is $\hat{x}_1 = \frac{1-\bar{x}_2}{2}$ (which is also the domestic market price, from Firm 1's first-order condition). Hence total output in market A is $\hat{X} = \frac{1+\bar{x}_2}{2}$ and Firm 1's equilibrium profit, if it faces a binding quota $\bar{y}_1$ in market B, is

$$\tilde{\pi}_1 = \frac{(1 - \bar{x}_2)^2}{4} + \bar{y}_1 \left(\frac{1 - \bar{y}_1}{2} - T \right),$$

while consumer benefit in A is $\hat{X}^2/2$ plus tariff revenue, i.e.,

$$\tilde{\beta}_A = \frac{1}{2}\left(\frac{1+\bar{x}_2}{2}\right)^2 + \tau\bar{x}_2.$$

These equations describe a parameterized curve (the parameter being $\bar{x}_2$) in $(\pi,\ \beta)$ space. To describe the curve, first note that $\frac{\partial\tilde{\pi}_1}{\partial\bar{x}_2} = -(\frac{1-\bar{x}_2}{2}) < 0$ and $\frac{\partial\tilde{\beta}_A}{\partial\bar{x}_2} = (\frac{1+\bar{x}_2}{4}) + \tau$, which is positive for $\tau > -\frac{1}{4}$. Since we concentrate on non-negative tariffs, the feasible locus slopes down in $(\pi,\ \beta)$ space. It is also strictly convex since $\frac{\partial^2\pi_1}{\partial\tilde{\beta}_A^2} = (\frac{\partial\tilde{\beta}_A}{\partial\bar{x}_2})^{-1}\partial\left(\frac{\partial\tilde{\pi}_1}{\partial\bar{x}_2}/\frac{\partial\tilde{\beta}_A}{\partial\bar{x}_2}\right)/\partial\bar{x}_2 > 0$. Under the standard social surplus maximization, the convex locus implies either completely prohibitive quotas or none at all. This is true irrespective of the weight chosen by the government between consumer benefits and firm profits.

By producing convex indifference curves, a quasiconcave policymakers' objective function can also generate non-prohibitive quotas if the indifference curves are more convex than the feasible locus. Section 4 provides examples. We now show that there exists an equilibrium to the quota game and that any equilibrium is symmetric.

The strategy space for each government is $[0,\hat{x}(\tau)]$. It suffices to show that the quota reaction functions slope up (strategic complementarity) and that any jump is a jump up (the game is supermodular). This means that the reaction function for a government must cross the 45^0 degree line. By symmetry of the reaction functions around the 45^0 line, the only possible equilibria are symmetric. Strategic complementarity follows if $\frac{\partial^2 U}{\partial\bar{x}_2\partial\bar{y}_1} \geq 0$. Given the Cobb-Douglas government's payoff function,

$$\frac{\partial U}{\partial\bar{y}_1} = \alpha\left(\frac{\tilde{\beta}_A}{\tilde{\pi}_2}\right)^{1-\alpha}\left(\frac{1-2\bar{y}_1}{2} - T\right),$$

and so,

$$\frac{\partial^2 U}{\partial\bar{x}_2\partial\bar{y}_1} \propto \left[\tilde{\pi}_1\frac{\partial\tilde{\beta}_A}{\partial\bar{x}_2} - \tilde{\beta}_A\frac{\partial\tilde{\pi}_1}{\partial\bar{x}_2}\right]\left(\frac{1-2\bar{y}_1}{2} - T\right).$$

The first expression on the RHS is positive since $\frac{\partial\tilde{\beta}_A}{\partial\bar{x}_2} > 0$ and $\frac{\partial\tilde{\pi}_1}{\partial\bar{x}_2} < 0$ (for $\tau > -\frac{1}{4}$). The second is positive since it is smallest at $\bar{y}_1 = \hat{x}_2 = \frac{1-2T}{3}$, where it equals $\frac{1}{6}(1-2T)$ which is positive since $T < \frac{1}{2}$ (or else there is no trade in the first place).

14

A candidate symmetric interior binding quota equilibrium is found by solving $\frac{\partial U}{\partial \tilde{\beta}_A} \frac{\partial \tilde{\beta}_A}{\partial \bar{x}_2} + \frac{\partial U}{\partial \tilde{\pi}_1} \frac{\partial \tilde{\pi}_1}{\partial \bar{x}_2} = 0$, when this derivative is evaluated at $\bar{x}_2 = \bar{y}_1 = \bar{q}$. For the Cobb-Douglas government payoff function, the resulting equation is

$$(1 - \alpha)(1 + \bar{q} + 4\tau)[1 - \bar{q}^2 - 4(t + \tau)\bar{q}] - \alpha[(1 + \bar{q})^2 + 8\tau\bar{q}](1 - \bar{q}) = 0, \qquad (8)$$

which is a cubic with at most three real roots. Any root outside $[0, \hat{x}_2(\tau)]$ is irrelevant. The candidate symmetric equilibrium is any relevant root or else one of the endpoints. It is not easy to tell from (8) when a solution is interior and when it is not. To do so we use simulations. We also use the above results to simulate the progression from tariffs to quotas and from quotas to antidumping measures.

4. Simulations

Propositions 1 and 2 are consistent with a natural progression in the type of barriers to trade that countries wish to use over the process of trade liberalization as well as the issues that countries negotiate over, starting with tariffs, then quotas and finally with antidumping measures. We now simulate this progression, with non-cooperative phases interspersed with trade negotiations that lead to cooperative policies. In doing so, we assume a certain degree of myopia in the cooperative phases. In particular, trade negotiators do not consider how governments may later resort to other policies that are within the letter of the trade agreement (but contrary to its spirit). For example, when setting cooperative tariffs, negotiators do not anticipate that countries may afterwards resort to antidumping measures to unilaterally improve their positions. While this approach is not subgame perfect, it does capture the realistic aspect that laws and agreements typically do not foresee all contingencies. Loopholes in practice are typically only closed in later negotiations and once there have been significant violations.[9]

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[9] There is some evidence that negotiators may be myopic in the above sense. First, Marvel and Ray (1983, p.196) note that their empirical findings "support the view that the NTBs actually augmented protection in favored industries". If a higher level of protection were unilaterally desirable, it could have been attained through tariffs in the initial non-cooperative equilibrium. Therefore, tariff negotiations would not ultimately lead to higher protection unless negotiators did not foresee the subsequent use of NTBs. Second, if negotiators are aware that countries would want to change quotas following tariff negotiations, then these quotas should themselves be part of the negotiations. Historically, tariffs were negotiated first, without explicit consideration of NTBs as if countries prefer agreements which limit their options as little as possible while producing apparent gains. Only in later rounds of negotiation, once quotas had actually proliferated,

Using the Cobb-Douglas policy-maker's objective function, we show that the above progression of trade policy not only leads to a more narrow range of industries over which less efficient trade policies are used but also that the use of these NTBs depends very much on industry characteristics.

We start by deriving the common tariff rate that maximizes joint welfare (and can equivalently be attained through a Nash bargaining solution). It is obvious from Figure 2 that the Nash equilibrium tariffs leave room for negotiation. Both countries can be better off with lower tariffs that increase the volume of trade and reduce local market power. The key difference from the non-cooperative problem is that the cooperative tariff explicitly accounts for profits earned abroad. The common tariff τ^{**} is given by maximizing the policymaker's utility function where the tariff determines β and π (we can drop the subscripts since the problem is the same for both governments). The first-order condition is

$$U_\beta \beta' + U_\pi \pi' = 0. \tag{9}$$

The trade-off between β and π is determined from the relations (3) and (2) where $T = T_A = T_B$ and $\tau = \tau_A = \tau_B$. The corresponding derivative expressions are

$$\beta' = \frac{1 - 5T - 6\tau}{9} \qquad \text{and} \qquad \pi' = \frac{2(5T - 1)}{9}, \tag{10}$$

while $\beta'' < 0$ and $\pi'' > 0$. The locus of (β, π) combinations attained by varying τ is described more fully in Anderson and Schmitt (2000). The cooperative tariff rate for the Cobb-Douglas example is found by solving (9), or

$$\left(\frac{1 - \alpha}{\alpha}\right) \frac{\pi}{\beta} = \frac{\pi'}{\beta'}, \tag{11}$$

(marginal rate of substitution equals marginal rate of transformation along the feasible locus).

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did attention turn to them. The Economist (1999) underlines this point well: 'Countries agreed to lower their blatant barriers to trade [..] while intervening at will [..] in their domestic economies. [B]y the 1970s, problems began to emerge. As border barriers fell, it became clear that domestic regulations were also a big impediment to trade [..]. Moreover, governments began to abuse these loopholes for protectionist ends: antidumping cases and import restricting regulations proliferated. So the focus of trade policy turned to limiting such abuses.'

Figure 3 illustrates the cooperative, τ^{**} and the non-cooperative tariff rate, τ^*.[10] It shows that $\tau^{**} = 0$ for $t = \frac{1}{5}$ (up to $\alpha = .55$) and along the locus between the origin of the graph and the point $(.5, .5)$. This locus is given by

$$\alpha = \frac{2 - 2t + 5t^2}{6(1 - t + t^2)}. \tag{12}$$

The sign of τ^{**} for any parameter combination is then determined by considering on which side of the loci $t = \frac{1}{5}$ and (12) we are. Below the locus (12), $\tau^{**} > 0$ when $t < \frac{1}{5}$, and above the locus (12), $\tau^{**} > 0$ when $t > \frac{1}{5}$. The theoretical result of $\tau^{**} < 0$ for some parameter values seems unrealistic. In practice, such negative tariffs might be undone by arbitrage: individuals could cross and recross the frontier and keep collecting subsidies.[11] In the sequel, we therefore restrict tariffs to be non-negative.[12]

[Insert Figure 3 here]

The right most curve in the Figure corresponds to a cooperative tariff that eliminates trade, and hence to monopoly in each country. From (11), and using $\tau^{**} = \frac{1}{2} - t \geq 0$, this locus for $t > \frac{1}{5}$ is given by $\tilde{t} = \text{Min}\left\{\frac{3 - 4\alpha}{4(1 - \alpha)}; \frac{1}{2}\right\}$.

Comparing the cooperative and the non-cooperative tariff rates enables us to define three types of region consistent with two-way trade. In the first type, τ^* is positive but τ^{**} is zero so that tariff liberalization is 100%; in the second type, both τ^* and τ^{**} are positive so that tariff liberalization is less than 100%, and in the third type of region, both τ^* and τ^{**} are zero so that there is no tariff liberalization. Figure 3 also includes a few points where τ^* and τ^{**} are computed.

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[10] The non-cooperative tariff for the Cobb-Douglas example is given by solving (7) to give $(\frac{1-\alpha}{\alpha})\frac{\pi_1}{\beta_A} = \frac{d\pi_1}{d\beta_A}$, where the RHS is given by (5) and β_A and π_1 are given by (3) and (2). Using symmetry yields an implicit formula

$$\tau^* = \frac{(1 - \alpha)(1 - 5T)(2 - 2T + 5T^2) + \alpha(1 + T)(2 - T)^2}{6\{(1 - \alpha)(2 - 2T + 5T^2) - \alpha(1 + T)(1 - 2T)\}}.$$

In Figure 3, we have constrained $\tau^* \geq 0$.

[11] Similar stories are told about trucks crossing borders between EC countries, driving round the roundabout, collecting agricultural subsidies under the Common Agricultural Policy, and recrossing the border. Between Northern Ireland and Eire, this is known as the 'turnaround pig'.

[12] This is actually more complex than simply replacing $\tau^{**} < 0$ by a zero tariff since, given the shape of the locus of feasible (π, β) combinations, the local maximum positive value of τ^{**} might be preferred to free trade. However this happens only when the two sides of the constraint locus are very close. As a result, the constraint τ^{**} is zero when the unconstrained τ^{**} is negative except for a small range of parameters ($\alpha > .55$ and $.12 < t < .2$; see Figure 3) where τ^{**} is strictly positive.

17

The intuition for the tariff patterns shown in Figure 3 is as follows. The model has two distortions: imperfect competition and relative inefficiency of trade due to the presence of international transport costs. The first distortion induces countries to jointly subsidize trade, while the second one induces them to tax trade. At $t = \frac{1}{5}$, the two forces just balance resulting in $\tau^{**} = 0$. Consider now a marginal increase in t from $\frac{1}{5}$. Consumer benefits decrease since the equilibrium price increases with less trade. Governments that care about consumers (low α) then want to decrease τ^{**}, and thus to subsidize trade (or retain a zero tariff under a non-negativity constraint). If governments like firms (high α) they are induced to tax trade because less trade implies higher firm profits. When $t < \frac{1}{5}$, governments jointly want to subsidize trade and this helps firms (since π is convex in τ). It is only when governments care about consumers (low α) that they tax trade.

Inspection of Figure 3 and the underlying rates reveal a number of features, summarized in Result 1.

Result 1:
(i) Tariff negotiation does not change the range of trading industries.
(ii) A high degree of tariff liberalization occurs when transport cost is low even when governments weigh profits highly (high α and low t).
(iii) A low degree of tariff liberalization despite high non-cooperative tariffs occurs when governments weigh profits highly and transport cost is high (high α and t).
(iv) A low degree of tariff liberalization from low non-cooperative tariffs occurs when governments weigh consumers highly and transport cost is high (low α and high t).

The first feature comes from the fact that the boundary condition at which trade is eliminated under the cooperative tariff is the same as that for the non-cooperative tariff and that each point inside the boundary involves trade with both the cooperative and the non-cooperative tariff rates. Naturally, this implies that the degree of trade liberalization decreases to zero as one approaches the boundary. The parameter α is a policymaker's taste parameter that can be related to several broader indices. For example, one might expect higher α in sectors where economic activity is geographically concentrated, so the industry is important to politicians. Ceteris paribus, trade liberalization tends to be low when α is high. The parameter t is the international transport cost (as a fraction of the demand intercept), and so high t corresponds to industries for which the domestic market is much more important than foreign markets. Hence, t is inversely related to the degree

18

of import penetration in an industry and thus, in this model, with effective competition. Under this interpretation, the results on tariffs are in line with the empirical results noted in the Introduction. In particular, the more competition between firms (low t), the higher the degree of tariff liberalization.

Given τ^{**}, suppose now each government feels free to use a non-tariff barrier. Proposition 1 tells us that quota is the preferred policy. Using (8), we only found one interior solution, if any, and we then checked to see whether it is an equilibrium (see Anderson and Schmitt, 2000 for details). Figure 4 illustrates the findings. There are three types of symmetric equilibria: no quantitative restrictions ($\bar{q} = \hat{x}$); binding quotas ($0 < \bar{q} < \hat{x}$), and prohibitive quotas ($\bar{q} = 0$).

[Insert Figure 4 here]

Comparing Figures 3 and 4, interesting patterns emerge.

Result 2:
(i) Quotas are associated with both high and low degrees of tariff liberalization;
(ii) Quotas applied on top of the cooperative tariff, τ^{**}, can lead to a net trade expansion or to a net decline in trade as compared to the non-cooperative tariff equilibrium.
(iii) The set of industries in which a quota is used is a strict subset of the industries in which the non-cooperative tariff was positive.

The first result comes from the fact that binding quotas are mainly associated with industries for which governments care about firm profit (high α) and the degree of tariff liberalization depends more on t than on α. The only difference that t brings is whether the quota is prohibitive or not. In particular, high values of t are associated with lower degrees of tariff liberalization which decreases the need for quotas even if α is high.

Result 2(ii) establishes that there exist industries (i.e., (α, t) combinations) where no quotas are used even though $\tau^{**} < \tau^*$. In such sectors, trade liberalization leads to trade expansion. For this to happen, low α is a sufficient but not a necessary condition: high feasible values of α and t may also entail no quotas. In other industries (high α and low t), quotas are prohibitive, increasing protection with respect to τ^*.[13] When quotas are binding,

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[13] The Italian quota on Japanese automobiles (2,000 cars per year), and the prohibition to import certain types of vessels in the US are well-known examples of (quasi) prohibitive quotas.

it can be shown that, for most (α, t) pairs, the combined effect of $\bar{q}$ and τ^{**} yields more trade than τ^*. It is only near the border separating the prohibitive from the binding quotas that protection increases with quotas.

Although positive non-cooperative tariffs are used over much of the parameter space, once they are reduced through cooperative agreements, quotas will be applied to a substantially smaller set of industries (Result 2(iii)). Hence, tariff liberalization, even though it may bring quotas for some industries, will be effective over most of the parameter space. This result depends on our assumption that quota rents are lost to foreign firms. If instead quotas were licensed off, using the logic of Hwang and Mai (1988), then quotas would be set so as to return to the effective tariff rate τ^* and the set of industries affected would be unchanged.

Clearly trade negotiations following imposition of quotas would eliminate the quotas and leave intact the cooperative tariff τ^{**}. The incentive to distort the terms of trade is still present though, and we now investigate where antidumping measures may be applied. We show in the Appendix that an antidumping constraint either causes the foreign firm to abandon its export market (if $T^{**} > T_l \approx 0.175$), or to still serve both markets (for $T^{**} < T_u \approx 0.168$). In the latter case there are still imports in the protected market but at a much lower level since $p^* = p - T^{**}$.

The regions of the parameter space for which either country prefers to invoke an antidumping constraint (given the other does not) are shown by the regions I and II in Figure 4. In region II, the constraint still involves bilateral trade, while the foreign firm is effectively debarred in region I.[14] These two regions depend on T^{**} and thus on τ^{**}. In region II, $\tau^{**} = 0$, whereas τ^{**} is either zero or small in region I. The use of antidumping measures is associated with intermediate values of T^{**}. The intuition is the following. When T^{**} is low, the dumping margin is too low to compensate for the distortionary effect of an antidumping constraint. When T^{**} is high (and thus when t is high), the foreign firm responds by discontinuing exports. This creates a monopoly at home and a significant loss in consumer benefits that cannot be offset by the resulting increase in domestic firm profit, at least for intermediate values of α. There is clearly an equilibrium *without* antidumping measures outside these two regions. Inside the regions, equilibrium involves one or both

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[14] Cases of antidumping constraints eliminating trade have been noted in the literature. Hansen and Prusa (1995) cite the case of imports of Mexican fresh-cut flowers in the United States and Braga and Silber (1993) discuss the case of imports of Brazilian frozen concentrated orange juice in Australia.

20

countries using the constraint, or else a mixed strategy equilibrium in constraints,[15] and trade is significantly curtailed. Inspection of Figure 4 yields the following results:

Result 3:
(i) Antidumping measures may be not used even when quotas would be prohibitive.
(ii) Antidumping measures that eliminate trade may be used when the quota equilibrium involves binding or prohibitive quotas.

Obviously, antidumping constraints are used over a small subset of the parameter space as compared to quotas. This is because antidumping restrictions have a strong negative effect on the domestic firm's profit from export, while quotas imposed unilaterally do not change export profits.

5. Conclusions

In this paper we have taken a simple view of how the pattern and the degree of protectionism have evolved. The analysis is based on a model of governments that resolve trade-offs between surpluses of various interest groups. Our broad view clearly neglects many of the details of particular industries. The model still affords a characterization of how different industries are affected by the various waves of protectionism, and it tracks the stylized facts quite well.

Governments have no incentive to use quotas or antidumping restrictions when they unilaterally choose from a menu of trade policies that includes tariffs. However, once tariffs are set cooperatively, governments may then wish to introduce NTBs. If they have the choice, policymakers prefer quotas to antidumping restrictions. Antidumping constraints may be used only when the use of quotas is sufficiently restricted. The set of parameter values over which non-cooperative tariffs are positive is wider than that where quotas are used which, in turn, is wider than for antidumping restrictions. Hence, the model exhibits both a progression from non-cooperative tariffs to quotas and antidumping restrictions, and a convergence to freer trade as each trade tool is associated with a smaller set of parameter

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[15] For example, it is straightforward (but lengthy) to show that the equilibrium in region I involves both countries imposing antidumping constraints. Regarding region II, there cannot exist an equilibrium in pure strategies at which both countries impose a constraint and both firms trade.

values where it will be used. Fourth, as shown in the empirical literature, net protection may increase in some sectors and decrease in others.

Clearly, without knowledge of the empirical distribution of industries over the parameter space, the model cannot predict whether tariff liberalization will ultimately lead to a net expansion or a net contraction in aggregate trade. However, the model suggests that tariff liberalization will be associated with an overall trade expansion despite the endogenous emergence of NTBs for a relatively even distribution of industries over the parameter space (α, t). There is thus no law of constant protection in this model.

The highest degrees of tariff liberalization are associated with low transport cost, t, and high policymaker sensitivity to firms, α. It is also in this region that the endogenous replacement by NTBs is the strongest, particularly with quotas. If one interprets low t as reflecting high competition, the model predicts a strong degree of replacement, and even overshooting, between NTBs and tariffs for more competitive industries (that governments are sensitive about). By contrast, when competition within an industry is lower (t is higher), tariff liberalization is lower, and the endogenous response of NTBs is in general more modest and even nonexistent with antidumping: NTBs serve to partially offset tariff liberalization and, in some cases to increase net protection. These predictions are in line with the empirical evidence, especially that of Marvel and Ray (1983). These authors also find that NTBs are predominantly found in more competitive industries. Our explanation for this result is that trade is efficient in such industries, which induces governments to jointly set a low cooperative rate. This creates a strong incentive for individual countries to use NTBs, especially if governments weigh firm profits quite heavily.

The model is deliberately simple and some of its features are instrumental to the results while others are less so. The international duopoly framework simplifies the analysis. While there are many highly concentrated industries where NTBs have been used, our main results do not seem to depend on a duopoly market structure. In particular, both the progression of trade instruments and the narrowing of affected industries should hold with an arbitrary number of domestic and foreign firms since, for a Cournot game among firms, these results depend only on the nature of the trade instruments. However, the results may be sensitive to the model of strategic interaction among firms. Cournot rivalry implies that quotas are equivalent to tariffs and this is helpful to get the progression of trade tools. Had we assumed Bertrand rivalry, the equivalence of tariffs and quotas would no longer hold and it

is possible that quotas would be used in addition to tariffs at a non-cooperative equilibrium; however antidumping would still be less efficient than quotas. A possible extension of the present model would be to work with a more elaborate model of government preferences and in particular with one involving trade-offs in consumer surplus across industries. Still, the present model with its quasiconcave policymaker's objective function provides a useful benchmark allowing for strategic complementarity in the tariff game, interior solutions with NTBs and capturing well stylized facts. Our analysis also suggests that, even if future rounds of negotiations succeed in curbing the use of antidumping measures, other tools, possibly even less efficient than antidumping restrictions, are likely to emerge.

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Appendix: Antidumping

An antidumping measure by A forces Firm 2 either to satisfy the constraint in order to sell in A, or else to stop exporting to A. We derive the parameter values under which each of these two cases arises.

i) Antidumping with trade: Firm 2's problem is

$$\max_{x_2, y_2} \quad \pi_2 = (1 - y_1 - y_2)y_2 + (1 - x_1 - x_2 - T)x_2 \quad \text{s.t.} \quad 1 - y_1 - y_2 \le 1 - x_1 - x_2 - T. \quad (A.1)$$

Firm 1 solves its unconstrained Cournot problem. The solution to this game is $x_2 = \frac{1 - 5T}{3}$, $y_2 = \frac{1 + 4T}{3}$, $x_1 = \frac{2 + 5T}{6}$, $y_1 = \frac{2 - 7T}{6}$ with $\pi_2 = 2(1 - y_1 - y_2)^2 = \frac{2}{9}(2 - 4T - 3y_1)^2$. This is an equilibrium if Firm 2 does not prefer to deviate and sell in F only, given Firm 1's outputs x_1 and x_2 above. Firm 2's profit if it sells only in F is $\frac{(1 - y_1)^2}{4}$. Given $y_1 = \frac{2 - 7T}{6}$, Firm 2 finds it more profitable to trade (i.e., $\frac{2}{9}(2 - 4T - 3y_1)^2 > \frac{(1 - y_1)^2}{4}$) if $T \le T_u = \frac{4}{41}(-11 + \sqrt{162}) \approx .1685$.

Using (1), note that $x_1 + x_2 < \hat{x}_1 + \hat{x}_2 < y_1 + y_2$, so that an antidumping measure introduced by A decreases total output in A and increases total output in B. Moreover, $y_2 > \hat{y}_2 \; (= \hat{x}_1)$ and $x_2 < \hat{x}_2$: an antidumping restriction on Firm 2 reduces its sales to A and increases them in B (Firm 2's domestic market).

ii) Antidumping without trade: Firm 2's problem is to maximize $\pi_2 = (1 - y_1 - y_2)y_2$ with respect to y_2. (Firm 1's problem is the same as above.) Hence, $y_2 = \frac{1 - y_1}{2}$ and $\pi_2 = \frac{(1 - y_1)^2}{4} = \frac{(1 + T)^2}{9}$ since Firm 1 sells its unconstrained Cournot quantity $y_1 = \frac{1 - y_2 - T}{2} = \frac{1 - 2T}{3}$ in B and is a monopolist $(x_1 = \frac{1}{2})$ in A. This is an equilibrium if Firm 2 has no incentive to deviate and satisfy the antidumping constraint given the outputs sold by Firm 1 when Firm 2 does not trade. Solving problem (A.1) given $y_1 = \frac{1 - 2T}{3}$ and $x_1 = \frac{1}{2}$, $\pi_2 = \frac{(7 - 2T)^2}{288}$. This is less than $\frac{(1 + T)^2}{9}$ if $T > T_l$ where $T_l = \frac{9\sqrt{8} - 23}{14} \approx 0.175$.