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RETALIATORY MECHANISMS FOR ELIMINATING TRADE BARRIERS: AGGRESSIVE UNILATERALISM VS. GATT COOPERATION

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This paper derives retaliatory mechanisms in response to imperfectly observable non-tariff barriers. We find that when only one country retaliates in response to foreign barriers (unilateralism), free trade cannot be achieved although world welfare will be higher than without any retaliation. Multilateral retaliatory mechanisms produce higher welfare levels, but the highest welfare level is obtained through the cooperative choice of retaliatory mechanisms (GATT Cooperation). This result is due to the fact that the non-cooperative choice of retaliatory tariffs results in excessive punishment for detected barriers.

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1 INTRODUCTION

The lack of effective mechanisms for the enforcement of international treaty obligations has become a major obstacle to the success of the General Agreement on Trade and Tariffs (GATT). While multilateral trade negotiations have reduced tariff levels to historic lows, non-tariff barriers (NTB's) have emerged as one of the major impediments to trade flows. Since NTB's often vary in form across countries and products, adjudicating an alleged violation of a GATT obligation is often a long and difficult process. The GATT's virtual inability to enforce sanctions against those countries that violate GATT obligations has resulted in laws, such as Section 301 of the Omnibus Trade Act of 1988, that permit unilateral retaliation as a means of resolving these disputes.[1]

Much of the difficulty of eliminating non-tariff barriers to trade arises from the fact that these barriers defy conventional classification schemes. For example, until the US threatened to retaliate under Section 301, Japan prevented foreign firms from bidding on public construction projects through a harsh prerequisite: each bidder was required to have already won a government contract within the past two years. Thus, a foreign firm without this credential was caught in a "Catch 22." Japan is not alone in exploiting these types of trade barriers. Jackson [1992] discusses a French requirement that government inspectors examine the production facilities of all pharmaceutical firms that sell domestically without allowing its inspectors to travel abroad, a German ban on the import of non-fizzy mineral water, and a Belgian requirement that margarine must be imported in cubes and not sticks.

Much of the frustration over NTB's arises from the fact that they cannot be eradicated simply by signing an international treaty but must be handled on a case-by-case basis. Moreover there is a lack of consensus on how to design sanctions against countries that erect these barriers.

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[1] Section 301 enables the United States Trade Representative to set retaliatory tariffs against countries that engage in unfair trade practices.

Should an aggrieved country be free to determine the appropriate response to violations, or should sanctions be controlled by an international organization? The debate over whether retaliatory mechanisms should be designed cooperatively or non-cooperatively has brought into sharp focus the question of which approach is most likely to lead to free trade. Advocates of a non-cooperative, unilateral approach see US laws specifying retaliation in response to foreign barriers as the best way to open foreign markets [see, for example, Dornbusch, 1990]. Critics, however, allege that unilateral action on the part of the US undermines the GATT and may result in a trade war.[2]

This paper derives retaliatory mechanisms when NTB's are not perfectly verifiable–they may only be detected with noise. For simplicity, we consider a two country model and examine three cases. In the first case, one country may unilaterally commit to a retaliatory mechanism that specifies a retaliatory tariff if a foreign NTB is detected (Unilateralism). In the second, both countries simultaneously pick retaliatory mechanisms (Non-Cooperative Multilateralism), and in the third, the mechanisms are chosen cooperatively (GATT Cooperation). This framework generates a welfare ordering of retaliatory regimes: the cooperative mechanism is most efficient, followed by non-cooperative multilateralism, unilateralism, and finally no mechanism at all. Thus, in terms of the debate over Section 301, we come out decidedly in the middle, arguing that while unilateralism probably is better than nothing, it should not be seen as a substitute for a functioning multilateral dispute resolution mechanism.

Free trade is unattainable when a country can unilaterally commit to a retaliatory mechanism: the country will exploit its power, and impose NTB's on its trading partner. This creates an incentive for the trading partner to cheat on its obligations too. Although the non-cooperative usage of retaliatory mechanisms can completely eliminate these NTB's, it is inferior to a centralized GATT-based dispute resolution mechanism. The main reason is that the decentralized choice of retaliatory mechanisms gives a country an incentive to punish its partner too harshly for perceived violations. Another problem with decentralized mechanisms is that they create an

[2] This viewpoint was expressed in a letter signed by 40 economists opposing Section 301 [Bhagwati and Patrick, 1990].

incentive for countries to adopt procedures with higher rates of false convictions.[3] In sum, decentralized mechanisms create "kangaroo courts:" they tend to find against foreign countries too frequently and punish too severely relative to the social optimum.

Our finding that the cooperative selection of retaliatory mechanisms generates the highest level of welfare should not be seen as a validation for the existing GATT dispute resolution system. Proponents of Section 301 convincingly argue that the lengthy and uncertain GATT dispute process often means that without unilateral retaliation, there is no response at all. For example, actual GATT cases are often left unresolved because defendants must consent to their punishments. Since a barely functioning dispute resolution system is little better than no system at all, Section 301 may be justifiable as a mechanism to reduce NTB's until the GATT system is improved. However, as we illustrate, Section 301 is suboptimal within the broader class of retaliatory mechanisms. Unfortunately, there has been little effort on the part of the US and other industrialized nations to make the GATT a viable alternative to unilateral measures [Hudec, 1990].

Most of the optimal retaliation literature has focused upon the decentralized determination of retaliatory mechanisms (see, for example, Johnson [1954], Riezman [1982], Riezman [1991], and Eaton and Ono [1992]). These papers do not address the differences between unilateral, non-cooperative, and cooperative retaliatory mechanisms, and therefore cannot fully address the debate over Section 301. Furthermore, they do not address the issue of how the cooperative choice of trade rules differs from the non-cooperative choice. In particular, one should expect countries to be less enthusiastic about strong enforcement mechanisms if they feel that they may be the defendant in a dispute. Hence, one should expect non-cooperative unilateral mechanisms to impose harsher penalties than cooperative mechanisms.

The hesitance by the US to move from a unilateral to a GATT-based system may be partly due to a reluctance to be judged by other countries. This resistance has hindered the reform of the GATT dispute resolution system. Part of this reluctance may come from the knowledge that while the US often has legitimate complaints against other countries, the US is not always innocent of

[3] There is another effect, however: processes that generate frequent false convictions are undesirable because they are likely to result in trade wars.

erecting barriers either. During the 1980's more legal complaints were filed against the US than against the EC or Japan. Since the rate of adverse findings of cases against the US was roughly the same as that of other countries, these actions probably were not the result of efforts to simply harass the US. Rather, US mistrust of a multilateral approach may reflect an unwillingness to have its own NTB's judged by other nations while the US has the capability to respond to foreign barriers.

The organization of the rest of the paper is as follows. In Section 2 we outline the model. Section 3.1 considers the case in which only one country has a retaliatory mechanism ("Unilateralism") The next section examines the case in which both counties can implement retaliation ("Non-Cooperative Multilateralism") in the event that foreign barriers are detected. Finally, in section 3.3, we consider a case in which retaliatory mechanisms are decided on a cooperative basis (GATT Cooperation).

2 THE MODEL

Consider a world composed of two countries, A and B. Each country has a single product market, and the demand in each market is denoted by the following linear inverse demand curve,

$$P^i = 1 - Q^i,$$

where P^i is the price in market i and Q^i is total sales in market i. We assume that there is one firm in each country, and that each firm's cost function is of the form

$$C(q_i^i, q_i^j) = cq_i^i + cq_i^j,$$

where q_i^j is firm i's sales in market j, and c is the firm's marginal cost.

Countries can interfere with trade in two ways. First, they can impose non-tariff barriers on the imports into their domestic market. Specifically, if country i imposes an NTB of S_i on firm j, then firm j's marginal cost is raised by S_i in market i.[4] Each country's choice of S_i will produce a signal $\sigma_i \in \{0,1\}$ which indicates to the other country whether non-tariff cheating has taken place. $\sigma_i = 1$ corresponds to a positive signal that cheating has occurred, while $\sigma_i = 0$ corresponds to a

[4] The NTB may be thought of as a bureaucratic cost imposed on the importer that does not yield revenue for the country.

negative signal. Second, each country may impose punitive tariffs on the imports. These tariffs are assumed to be unit value, i.e. based upon the quantity sold. Although we assume that the tariff rates are set by international agreement to be 0 when no NTB's are detected, if country j detects cheating in the foreign market (i.e. $\sigma_i = 1$) it may assess punitive tariffs of T_j on firm i's sales in the domestic market.

If NTB's were easily observed and verified, then the signal would be perfect: σ_i would equal 1 if and only if cheating occurred. However, there is often a fair degree of uncertainty associated with the determination of whether some foreign practice constitutes a trade barrier or a bona fide domestic policy. We model this uncertainty by assuming that while countries can always detect actual barriers (i.e. $\sigma_i = 1$ when $S_i > 0$), there is a probability θ of a false positive occurring when no barrier exists. Our focus on false positive signals reflects our interest in the countries' incentives to engage in unfair retaliatory practices.

Countries choose their NTB's and punitive tariffs to maximize domestic welfare, i.e. the sum of consumer surplus and domestic firm profits. In stage 1, countries simultaneously commit to retaliatory tariff threat levels, T_A and T_B, that will be imposed when they detect a positive signal of an NTB erected by their trading partner. In stage 2, the countries simultaneously choose NTB levels S_A and S_B. In the third stage, signals are observed, and retaliatory tariffs are imposed. In the fourth stage, the firms simultaneously choose quantities in the two markets. The equilibrium concept is subgame perfect Nash equilibrium. Since the outcome may not be unique, we will apply the following refinement:

Assumption (A1) When there are multiple subgame perfect Nash equilibria that are rankable according to Pareto dominance, we select the most efficient equilibrium.

T_i constitutes a complete import ban when $T_i \geq (1-c)/2$, so without loss of generality we restrict $T_i \leq (1-c)/2$. Let τ_A and τ_B denote the tariffs actually imposed, and assuming for a moment that $S_A + \tau_A$ and $S_B + \tau_B$ are both smaller than $(1-c)/2$, we can write the total profits of firm i as

$$\pi^i = \left(\frac{1-c+S_i+\tau_i}{3}\right)^2 + \left(\frac{1-c-2S_j-2\tau_j}{3}\right)^2.$$

The first term represents the profits that firm i receives in its domestic market and the second term represents profits in the foreign market.[5] Country i's payoff function can now be written as,

$$\Pi^i = \pi^i + \frac{1}{2}\left(\frac{2-2c-S_i-\tau_i}{3}\right)^2 + \tau_i\left(\frac{1-c-2S_i-2\tau_i}{3}\right),$$

where the first term is domestic firm profits, the second term is domestic consumer surplus, and the last term represents the tariff revenue collected from the imposition of retaliatory duties. If $S_i + \tau_i$ is greater than $(1-c)/2$, then the firm facing these barriers will not produce at all. This is equivalent to having a total import ban, and the payoffs are the same as if $S_i = (1-c)/2$ and $\tau_i = 0$.

Taking the second derivative of country i's payoff function reveals that the function is increasing and convex with respect to S_i. This implies that if country i sets $S_i > 0$ (thereby sending a signal of $\sigma_i = 1$ to country j) then regardless of T_i and T_j, country i will set S_i at its maximal level. The fact that all equilibria involving cheating have the cheater set the NTB level at its maximum value greatly simplifies the analysis. At stage 2, country i chooses either $S_i = 0$ or $S_i = (1-c)/2$. (In the latter case, the punitive tariffs are completely unprofitable for country i.)

Using this simplification, we can now represent the continuation game payoffs as functions of T_A and T_B. Table 1 describes the payoffs for each country in the stage 2 subgame that occurs after each country has committed to the mechanism for punishing detected cheating. If both sides pick $T_i = 0$ (and hence have no means of punishing a foreign country that cheats) then the second stage becomes a standard prisoner's dilemma game in which both countries elect to erect non-tariff barriers to trade. This will result in the sub-optimal outcome of $\Pi^A = \Pi^B = \frac{3}{8}(1-c)^2$.[6]

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[5] Actual tariffs are ad valorem, but assuming unit value tariffs greatly simplifies the algebra.
[6] θ does not appear off the diagonal because cheating precludes the ability to retaliate.

		B: No Cheat $S_B=0$	B: Cheat $S_B=\frac{1-c}{2}$
A	No Cheat $S_A=0$	$\left\{\frac{4}{9}(1-c)^2+\theta\left[\frac{T_A(1-c)}{3}-\frac{T_A^2}{2}\right]-\frac{4\theta}{9}T_B(1-c-T_B),\ \frac{4}{9}(1-c)^2+\theta\left[\frac{T_B(1-c)}{3}-\frac{T_B^2}{2}\right]-\frac{4\theta}{9}T_A(1-c-T_A)\right\}$	$\left\{\frac{1}{3}(1-c)^2-\frac{T_A^2}{2}+\frac{T_A(1-c)}{3},\ \left(\frac{3}{8}+\frac{1}{9}\right)(1-c)^2-\frac{4}{9}T_A(1-c-T_A)\right\}$
	Cheat $S_A=\frac{1-c}{2}$	$\left\{\left(\frac{3}{8}+\frac{1}{9}\right)(1-c)^2-\frac{4}{9}T_B(1-c-T_B),\ \frac{1}{3}(1-c)^2-\frac{T_B^2}{2}+\frac{T_B(1-c)}{3}\right\}$	$\left\{\frac{3}{8}(1-c)^2,\ \frac{3}{8}(1-c)^2\right\}$

TABLE 1

3.1 UNILATERALISM

Suppose only country A has a mechanism enabling it to commit to retaliatory tariffs in stage 1, but both countries may impose non-tariff barriers on their imports. At first one might think that this would result in an equilibrium where country B removes its tariff barriers in response to threatened retaliation. In fact, no pure strategy equilibrium exists. To see this, first note that country A's ability to retaliate depends on the level of its own NTB's: if country A closes its domestic market through NTB's, retaliation against cheating by B will be meaningless. Now suppose that country A never cheats, i.e. never imposes non-tariff sanctions, but has a high retaliatory duty. Given this, B will not cheat either, because the penalty is large. But if B does not cheat, then A is strictly better off cheating when θ (the probability of a false positive signal) is sufficiently small, since the tariff revenue will be small. But if A's market is closed, then B will certainly cheat as well. To complete the circle, if A expects B to cheat, then A prefers not to cheat and receive a large tariff revenue. Hence the unilateral use of section 301 cannot produce free trade.

The equilibrium that arises involves a mix of cheating and retaliation. This outcome is socially preferable to both countries erecting non-tariff barriers to trade. The optimal retaliatory tariff, T_A, and the equilibrium of the continuation game are described in the following proposition.

Proposition 1: (Unilateralism) There exists a θ^* such that if $\theta < \theta^*$ then in the first stage country A commits to retaliate to observed cheating with tariff, T_A, of $(1-c)/3$. In the second stage, both countries mix between cheating and not cheating with country A cheating less frequently than country B. Moreover, the probability that each country cheats declines with θ.

Proof: See Appendix II.

When the probability of false positives rises, country A is more strongly deterred from cheating because its expected tariff revenue when it imposes retaliatory duties rather than cheats is higher. In other words, as a retaliatory procedure becomes less fair, the country using that procedure cheats less because its retaliatory mechanism generates tariff revenues and domestic protection with a higher probability.

The noisiness of country A's detection mechanism produces a counter-intuitive impact on country B's behavior. One might suspect that if country A falsely retaliated against B too frequently, B would cheat more often because it would face retaliation regardless of its actions. However, as θ becomes larger, A's usage of NTB's declines and therefore A's capacity to retaliate becomes greater. This effect dominates the added burden of unjustified retaliations that B faces and actually reduces B's incentive to cheat. Hence, cheating by both countries actually declines as the probability of false retaliation increases.

Proposition 1 also implies that a country using a unilateral retaliatory mechanism is less likely to use NTB's than a country without such a mechanism because retaliation is a substitute for other less lucrative forms of protection. However, it is also important to note that a country with a unilateral mechanism is still likely to occasionally use NTB's. For all θ for which Proposition 1 is valid country A will continue to employ NTB's because when B's market is open, NTB's generate higher expected domestic welfare than retaliatory duties.

Although in our model θ is exogenously specified, in reality countries have the ability to choose procedures that are likely to increase or diminish the number of false retaliations. For example, the fact that Section 301 sometimes raises barriers in the same sectors in which foreign barriers are detected creates strong incentives for companies to falsely accuse foreign nations of unfair practices as a means of obtaining domestic protection. Proposition 1 suggests that if country A could increase θ by adopting a less fair procedure, it would have an incentive to do so. The reason is not that A prefers to impose the tariff more often; the mixed strategies tell us that A's payoff coming from the home market is equal to the payoff from a prohibitive tariff. More accurately, higher θ's reduce the likelihood that country B cheats, and thereby increase the payoff from the foreign market.

3.2 NON-COOPERATIVE MULTILATERALISM

When both countries simultaneously commit to mechanisms specifying retaliatory sanctions, cheating is eliminated in the stage two continuation game. By cheating, a country gains relatively little in its own market since non-tariff barriers generate no revenues and necessarily result in costly retaliatory duties abroad. These two effects are sufficiently large to deter countries from cheating in equilibrium.

Proposition 2: Under (A1), the unique symmetric subgame perfect Nash equilibrium involves no NTB's, and tariff rates are given by $T_A = T_B = \frac{1}{3}(1-c)$.

Proof: See Appendix II.

Although Proposition 2 indicates that the countries never impose NTB's in equilibrium, free trade is not actually achieved because countries will retaliate in response to false positives. However, if the detection message never errs, non-cooperative adoption of retaliatory mechanisms can produce free trade. Non-cooperative multilateralism improves world welfare relative to unilateralism because each country's retaliatory mechanism serves as a disciplining device for the other country's choice of NTB. This can most clearly be seen in the case when $\theta = 0$. In the unilateral case, each country mixes between cheating and not cheating, but in the non-cooperative case, all barriers to trade would be eliminated. Finally, as in the unilateral case, it is clear that each country would like its own signal to be less precise, since that would generate more tariff revenue.

3.3 GATT COOPERATION

Although non-cooperative adoption of retaliatory mechanisms can eliminate NTB's, it is not an efficient mechanism for doing so. Since each country ignores the negative externality that its retaliatory tariffs place on the foreign firm, the countries have an incentive to impose sanctions that are too harsh. If the countries could cooperate in the selection of tariffs, they would have an incentive to implement tariffs that simultaneously deterred cheating but minimized the social loss due to false retaliations. This notion is formalized below. Since GATT rules are non-discriminatory, we restrict attention to symmetric retaliatory mechanism, $T_A = T_B = T$.

Proposition 3: (GATT Cooperation) Under (A1), if countries cooperatively choose retaliatory tariffs, they will never impose NTB's and will choose lower tariffs than in the non-cooperative multilateral and unilateral cases, i.e. the tariff level will be $T < \frac{1}{3}(1-c)$.

Proof: See Appendix II.

If cheating could be perfectly detected, then the cooperative and non-cooperative mechanisms described in Propositions 2 and 3 would be equally efficient. However, the cooperatively chosen mechanism is superior to the decentralized mechanism if there is uncertainty in the detection of barriers. Uncertainty generates random retaliation in both cases, but since the level of retaliation is lower when the mechanism is cooperatively chosen, welfare is higher due to lower trade distortions.

Similarly, the incentives to influence θ are different in the cooperative case from in the unilateral and non-cooperative cases. Since random retaliation uniformly lowers world welfare, contracting parties to a GATT mechanism would have an incentive to use mechanisms that reduced the chance of false positives. In this sense, the cooperative mechanism might appear to some observers as "less tough" than non-cooperative mechanisms; it detects barriers less frequently and retaliates against detected barriers with lower tariffs.

4 CONCLUSION

Our model suggests several ways in which existing and future mechanisms can be improved. On both a theoretical level and on an empirical level there is reason to believe that unilateral mechanism, such as Section 301, may be an excessively severe tool for opening foreign markets. It seems reasonable to believe that the current usage of retaliatory duties which are often set at 100% may punish foreign countries too harshly. Furthermore, changes in the Omnibus Trade Act of 1988 that seek to restrict membership on the Section 301 committee so that the agencies most favorably disposed to retaliatory action constitute a substantial share of the members may bias Section 301 determinations. Efforts should be made to eliminate these biases and reduce the incentives for false accusations by eliminating retaliation in the same sectors in which foreign barriers are detected.

Our model also suggests directions that GATT reforms should take. Clearly, GATT reform of the dispute resolution mechanism is in order, but one should not expect a multilateral retaliatory mechanism to impose penalties equally severe as Section 301. We show that cooperative mechanisms can represent a welfare improvement over non-cooperative mechanisms by reducing retaliatory duties. In this sense, one should not view cooperative mechanisms as excessively weak, but rather unilateral and non-cooperative mechanisms excessively aggressive.

APPENDIX I

Derivation of Table 1

Suppose that in equilibrium neither country cheats, and hence $S_A = S_B = 0$. In this case, the probability that neither country receives a false positive can be written as $(1-\theta)^2$, the probability that both countries receive false positives is θ^2, and the probability that only country A (or only country B) receives a false positive is $\theta(1-\theta)$. Country A's expected profits can now be written as

$$\Pi^A = (1-\theta)^2\left[4\left(\frac{1-c}{3}\right)^2\right] + \theta(1-\theta)\left[\left(\frac{1-c}{3}\right)^2 + \left(\frac{1-c-2T_B}{3}\right)^2 + 2\left(\frac{1-c}{3}\right)^2\right] +$$
$$\theta(1-\theta)\left[\left(\frac{1-c+T_A}{3}\right)^2 + \left(\frac{1-c}{3}\right)^2 + \frac{1}{2}\left(\frac{2-2c-T_A}{3}\right)^2 + T_A\left(\frac{1-c-2T_A}{3}\right)\right] +$$
$$\theta^2\left[\left(\frac{1-c+T_A}{3}\right)^2 + \left(\frac{1-c-2T_B}{3}\right)^2 + \frac{1}{2}\left(\frac{2-2c-T_A}{3}\right)^2 + T_A\left(\frac{1-c-2T_A}{3}\right)\right].$$

Similarly, in the event that country A cheats but country B does not, A's expected payoff can be written as

$$\Pi^A = \left(\frac{1-c}{2}\right)^2 + \frac{1}{2}\left(\frac{1-c}{2}\right)^2 + \left(\frac{1-c-2T_B}{3}\right)^2,$$

and country B's payoff can be written as

$$\Pi^B = \left(\frac{1-c+T_B}{3}\right)^2 + \frac{1}{2}\left(\frac{2-2c-T_B}{3}\right)^2 + T_B\left(\frac{1-c-2T_B}{3}\right).$$

Finally, if both countries cheat, then each country will receive a payoff of

$$\tfrac{3}{8}(1-c)^2.$$

These expressions may be simplified, and are summarized in Table 1 in the text.

APPENDIX II

Proof of Propositions

Proof of Proposition 1: Fix T_A, and consider all continuation equilibria. We refer to the payoffs given in Table 1. Let α and β denote the probabilities that country A and country B, respectively, cheat in the second stage.

First we establish that the only possible pure strategy equilibrium of the stage 2 game has both countries cheating. If $\alpha = 1$, B strictly prefers "Cheat" (since 3/8 > 1/3). If $\beta = 1$, A prefers "Cheat" when,

(1) $$\frac{3}{8}(1-c)^2 \geq \frac{1}{3}(1-c)^2 - \frac{1}{2}T_A^2 + \frac{1}{3}T_A(1-c)$$

which is true if an only if $T_A < \frac{1}{6}(1-c)$. Therefore $\alpha = \beta = 1$ is a Nash equilibrium (NE) for tariffs this range. If $\beta = 0$, A prefers "No Cheat" when its gains from retaliation exceed its gains from cheating:

(2) $$\frac{4}{9}(1-c)^2 + \theta\left[\frac{1}{3}T_A(1-c) - \frac{1}{2}T_A^2\right] \geq \left(\frac{3}{8} + \frac{1}{9}\right)(1-c)^2.$$

or

$$3T_A^2 - 2T_A(1-c) + \frac{1}{4\theta}(1-c)^2 \leq 0.$$

A root exists only if $\theta > 3/4$, implying $\alpha = \beta = 0$ is not an equilibrium when $\theta < 3/4$. $\beta = 0$, $\alpha = 1$ cannot be a NE either since B would deviate. $\beta = 1$, $\alpha = 0$ is an equilibrium when A prefers "No Cheat" (or $T_A > \frac{1}{6}(1-c)$ from above), and B prefers "Cheat." B will prefer to cheat if its loss from retaliatory tariffs is less than its gain from cheating or:

$$\frac{4}{9}(1-c)^2 - \frac{4\theta T_A(1-c-T_A)}{9} \leq \left(\frac{3}{8} + \frac{1}{9}\right)(1-c)^2 - \frac{4T_A(1-c-T_A)}{9},$$

which implies

(3) $$T_A \leq (1-c)\left(\frac{1}{2} - \frac{1}{2}\sqrt{1 - \frac{3}{8(1-\theta)}}\right)$$

But this implies $T_A < \frac{1}{6}(1-c)$ for all $\theta < .325$. However, as we have shown if $T_A < \frac{1}{6}(1-c)$, then A strictly prefers to cheat. Hence if $\theta \leq .325$, then $\beta = 1$ and $\alpha = 0$ cannot be an equilibrium.

Next we characterize all mixed strategy equilibria.

i) $\alpha = 1, \beta \in (0,1)$ is not a NE because B prefers "Cheat."

ii) $\alpha = 0, \beta \in (0,1)$. (3) must hold with equality, and therefore $T_A < \frac{1}{6}(1-c)$ for $\theta < .325$. Given β, A prefers "No Cheat" when

(4)
$$\beta\left[\frac{1}{3}(1-c)^2 - \frac{1}{2}T_A^2 + \frac{1}{3}T_A(1-c)\right] + (1-\beta)\left[\frac{4}{9}(1-c)^2 + \theta\left(\frac{1}{3}T_A(1-c) - \frac{1}{2}T_A^2\right)\right]$$
$$\geq \frac{3}{8}\beta(1-c)^2 + (1-\beta)\left[\left(\frac{3}{8}+\frac{1}{9}\right)(1-c)^2\right]$$

which implies

$$T_A \geq \frac{(1-c)}{3}\left(1 - \frac{1}{2}\sqrt{4 - \frac{3}{\beta + \theta(1-\beta)}}\right).$$

But the right hand side is greater than $\frac{1}{6}(1-c)$ which is a contradiction.

iii) $\beta = 0, \alpha \in (0,1)$. Given $\beta = 0$, A cannot be indifferent for $\theta < 3/4$ (as we saw from equation (2)).

iv) $\beta = 1, \alpha \in (0,1)$. Given $\beta = 1$, we know from equation (1) that A is indifferent if and only if $T_A = \frac{1}{6}(1-c)$. Given α, B prefers "Cheat" when

(5)
$$\frac{3}{8}\alpha(1-c)^2 + (1-\alpha)\left[\left(\frac{3}{8}+\frac{1}{9}\right)(1-c)^2 - \frac{4}{9}T_A(1-c-T_A)\right]$$
$$\geq \frac{\alpha}{3}(1-c)^2 + \frac{4}{9}(1-\alpha)\left[(1-c)^2 - \theta T_A(1-c-T_A)\right]$$

Plugging in $T_A = \frac{1}{6}(1-c)$, we have $\alpha > 1 - 27/[40(1-\theta)]$.

(*v*) If $\alpha \in (0,1)$ and $\beta \in (0,1)$, we have from (5) and (4)

(6)
$$\alpha = 1 - \frac{3(1-c)^2}{32(1-\theta)T_A(1-c-T_A)}, \text{ and } \beta = \frac{(1-c)^2}{4(1-\theta)\left[2T_A(1-c) - 3T_A^2\right]} - \frac{\theta}{1-\theta}$$

It is easy to show that $\beta < 1$ when $T_A > \frac{1}{6}(1-c)$, and $\beta > 0$ for all $\theta < .75$. Similarly, $\alpha < 1$ for all θ and $\alpha > 0$ for all $T_A > \frac{1}{6}(1-c)$. We conclude that this is a Nash equilibrium whenever $T_A >$

$\frac{1}{6}(1-c)$ and $\theta < .325$.

In the two types of mixed strategy equilibria, country A is receiving monopoly profits in its home market. Country A can increase its profits by reducing the probability that B cheats, which is accomplished by $T_A = (1-c)/3$. Substituting this value of T_A into equation (6) yields $\alpha = (.58 - \theta)/(1-\theta)$, and $\beta = (.75-\theta)/(1-\theta)$ when $\theta < \theta^* = 0.325$.

Proof of Proposition 2: First, we let $T_A = T_B = T$, and characterize the equilibrium of the stage 2 subgame.

i) $\alpha = \beta = 0$ is a NE when $T > \gamma^*(1-c)$ where $\gamma^* < 1/6$.

Given $\alpha = 0$, B prefers "No Cheat" when

(7) $$\frac{4}{9}(1-c)^2 - \frac{\theta}{18}\left[T^2 + 2T(1-c)\right] \geq \left(\frac{3}{8}+\frac{1}{9}\right)(1-c)^2 - \frac{4}{9}T(1-c-T),$$

which is true if and only if $T \geq \gamma^*(1-c)$ where

(8) $$\gamma^* = \frac{8-2\theta-\sqrt{40-35\theta+4\theta^2}}{16+2\theta}.$$

ii) $\alpha = \beta = 1$ is a NE if and only if $T < \frac{1}{6}(1-c)$.

Given $\alpha = 1$, B prefers "Cheat" when

(9) $$\frac{3}{8}(1-c)^2 \geq \frac{1}{3}(1-c)^2 - \frac{T^2}{2} + \frac{T(1-c)}{3}$$

which implies $T < \frac{1}{6}(1-c)$.

iii) $\alpha = 1, \beta = 0$ is not a NE.

Country B prefers "No Cheat" when $T > \frac{1}{6}(1-c)$ (from equation (9)), and country A prefers "Cheat" when $T < \gamma^*(1-c)$ (from equation (7)), a contradiction.

iv) A mixed strategy equilibrium exists when

$$\gamma^*(1-c) < T < \tfrac{1}{6}(1-c).$$

It is straightforward to compute:

$$1-\alpha = 1-\beta = \frac{\frac{3}{4}(1-c)^2 + 9T^2 - 6T(1-c)}{(1-\theta)\left[T^2 + 2T(1-c)\right]},$$

where α and β are between 0 and 1 if and only if T is in the range given above.

In summary, by assumption (A1) the countries play the Pareto dominant Nash equilibrium. Therefore when $T < \gamma^*(1-c)$ we have $\alpha = \beta = 1$, and when $T \geq \gamma^*(1-c)$ we have $\beta = 0$.

Now consider the choice of T_A and T_B. First we verify that every $T > \frac{1}{3}(1-c)$ and $T < \frac{1}{3}(1-c)$ are not NE's. Then we verify that $T = \frac{1}{3}(1-c)$ is a NE.

i) $T \geq \gamma^*(1-c)$. Suppose A deviates to $T_A = T + \Delta$ (for Δ small, certainly $\alpha = \beta = 0$ is the NE of the continuation subgame). When $T < \frac{1}{3}(1-c)$, A is better off with $\Delta > 0$, and when $T > \frac{1}{3}(1-c)$, A is better off with $\Delta < 0$.

ii) $T < \gamma^*(1-c)$. We have $\alpha = \beta = 1$. Suppose A deviated to $T_A = \frac{1}{3}(1-c)$, $\alpha = 0$. A's payoff is higher in the home market, and cannot be lower inn the foreign market.

(iii) $T = \frac{1}{3}(1-c)$. We have $\alpha = \beta = 0$. The payoffs are greater than or equal to $.401(1-c)^2$. If following the deviation $\alpha = 1$ and $\beta = 0$, then A's payoff is $.387(1-c)^2$. If $\alpha = 0$, $\beta = 1$, A's payoff is smaller than $.389(1-c)^2$, and if $\alpha = \beta = 1$, A's payoff is $.375(1-c)^2$.

Proof of Proposition 3: Following the proof of Proposition 2, when $T < \gamma^*(1-c)$ the NE of the stage 2 game is $\alpha = \beta = 1$. When $T \geq \gamma^*(1-c)$, the Pareto dominant equilibrium of the stage 2 games is $\alpha = \beta = 0$. Since the imposition of tariffs is inefficient *ex post*, the GATT would choose T as low as possible without destroying the incentive to cooperate at stage 2. Hence, the GATT will set $T = \gamma^*(1-c)$.

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