

Recurrent trade agreements and the value of external enforcement

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Abstract

This paper presents a theory of dynamic trade agreements in which external institutions, such as the WTO, play a central role in supporting credible enforcement. In our model, countries engage in ongoing negotiations, and, as a consequence, cooperative agreements become unsustainable in the absence of external enforcement institutions. By using mechanisms such as delays in dispute resolution and direct penalties, enforcement institutions can restore incentives for cooperation, despite the lack of coercive power. The occurrence of costly trade disputes, and the feasibility of mechanisms such as escape clauses, depend on the degree to which enforcement institutions can verify, and condition on, events that may lead to trade disputes.

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1. Introduction

The postwar history of international economic relations has been characterized by a growing reliance on international legal systems to resolve conflicts that arise within the context of bilateral and multilateral trade agreements. The GATT/WTO dispute resolution system, for example, has seen a large increase in the number of dispute cases reviewed annually over this period, and these cases often lead to reversal of trade-inhibiting actions.² In many instances, trade disputes trigger aggressive battles between countries to influence the findings of dispute resolution panels, as well as efforts to avoid compliance with rulings.

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² According to Brewer and Young (1999), the mean number of dispute cases reviewed annually by GATT/WTO dispute-settlement panels have increased from 5.2 during the period of 1948-1959 to 41 in 1998. This increase is not only due to the growing membership of the GATT/WTO. The mean number of filings per year per member has risen from 0.208 during the period of 1948-1959 to 0.307 in 1998. According to Hudec (1993), 88 percent of 139 dispute settlement complaints with a valid legal claim filed in the years 1942-1990 led to full or partial reversal of the trade-inhibiting measures.

Although official institutions for enforcement of international trade agreements are obviously important empirically, they are little understood from the theoretical standpoint. Trade agreements have been modeled as subgame-perfect equilibria of repeated games, in which violations are punished by reversion to an equilibrium with high tariffs and low trade volume. Since such agreements are completely self-enforced, countries have no need to appeal to any external legal system when a violation occurs. Thus, international legal systems are theoretically redundant, and their empirical predominance remains a puzzle. Furthermore, the literature has yet to explain the rationale for countries in a self-enforcing agreement to turn over administration of that agreement to an international agency such as the WTO, or a regional agreement secretariat.³

This paper proposes a theory of trade agreements in which an external legal institution facilitates cooperation by defining the manner in which negotiation between countries is conditioned on the history of their policy interaction. Our point of departure is that actual trade relations are characterized by ongoing negotiations over the terms of agreement.⁴ Ongoing negotiation can severely restrict the countries' ability to sustain cooperation because, following an episode in which one of them violates an agreement, the countries may renegotiate to avoid a mutually harmful punishment sequence. To sustain cooperation, the punishment sequence must be credible in that the countries are not able to jointly ignore that the violation occurred. That is, the negotiation problem that countries face following a "dispute history" (where a violation occurred) must be different than the negotiation problem that countries face after a "cooperative history." These labels are meaningful, and they support cooperation, only if the countries cannot arbitrarily assign them. We associate with an *institution* the ability to make a distinction between cooperative and dispute histories.⁵

The basic idea analyzed here – that an institution can facilitate cooperation by defining how parties condition their negotiation on the history – was initially developed by Ramey and Watson (2002). Here we elaborate the theory and use it to examine a two-country model of international trade policy cooperation. At the core of our model is a repeated game in which countries choose tariff policies in each period. We suppose that negotiation also occurs in each period, prior to the countries' tariff selections. Negotiation is modeled using a bargaining solution in which

- (i) the disagreement point entails the myopic stage-game equilibrium followed by the continuation value implied by negotiating anew in the next period;
- (ii) the countries maximize their joint value by selecting a continuation from among those feasible in their institutional context; and
- (iii) the countries divide the surplus of negotiation according to fixed bargaining weights (the Nash solution).

We define a *recurrent agreement* to be a subgame perfect equilibrium in which, in each period, the continuation value is consistent with this theory of negotiation.⁶ Thus, recurrent agreements satisfy intertemporal consistency of negotiations in the same manner that subgame perfect equilibria satisfy intertemporal consistency of individual incentives.

We show that, in the absence of an institution that distinguishes among histories, cooperation is unsustainable in a recurrent agreement because ongoing negotiation interferes with self enforcement. Specifically, following a deviation, each country can still exercise its bargaining power to obtain a particular share of the joint surplus. Moreover, the countries have a joint incentive to disregard their history and return to a cooperative path, where their relationship has its highest possible value. This makes punishments incredible.

On the other hand, we show that cooperation can be sustained in the context of a dispute settlement institution (DSI) that distinguishes between "cooperative" and "dispute" histories and imposes some friction on the process of switching from one history designation to another. Specifically, in our normative model of the international trade legal system, the DSI distinguishes among histories of past tariff choices and carries out dispute resolution when countries violate their tariff

³ Repeated non-cooperative game models of trade agreements have been considered by McMillan (1986,1989), Dixit (1987), Bagwell and Staiger (1990, 1997a,b, 2002), Riezman (1991), Kovenock and Thursby (1992), Maggi (1999) and Ederington (2001). Maggi's paper suggests that institutions such as the WTO may play a role in assisting self-enforcement by disseminating information about violations of agreements.

⁴ The history of GATT and its successor, the WTO agreement, includes not only regular rounds of multilateral trade negotiations, but also "local episodes" of renegotiations between the rounds when individual members states try to alter their obligations on specific trade issues. Such renegotiations of market-access concessions are permitted by the Article XXVIII of the GATT.

⁵ Technically, historical distinctions can be viewed in terms of a partition of the set of histories of play at any given period of time. Histories in the same element of the partition are not distinguished from one another in the sense that players expect the negotiation problem from these histories to be the same. In our benchmark "no institution" case, the partition is the coarsest possible one, meaning that, at the time of negotiation, all histories are indistinguishable from one another. An institution is identified with a finer partition of histories.

⁶ For simplicity we allow countries to make transfers to one another as part of bargaining.

agreements. When a country violates an agreement, a complaint is filed with the DSI about nullification and impairment of the trade partner-country benefits, and the DSI records countries as being in a state of dispute. Resolution of the dispute means that the DSI restores the cooperative designation. The countries' negotiation is conditioned on the DSI's designation.

The key to the DSI's effectiveness in supporting cooperation is that dispute resolution occurs with delay; importantly, the countries' ability to reduce the delay is limited because the operation of the dispute resolution process is external to the countries. In our basic model, the DSI does not condition dispute resolution on policies implemented by the countries during the dispute period. Thus, during a dispute the countries will select the static Nash-equilibrium tariffs rather than lower tariffs that might be supported in times of cooperation. Therefore, as long as the countries utilize the DSI, they realize that a dispute will impose a cost in terms of delay in restoring cooperation. This cost, in turn, supports incentives to cooperate on lower tariff levels than arise in the static Nash equilibrium.

In our model, the DSI has no direct coercive power over the countries involved.⁷ Countries can freely choose whether to submit to the DSI or ignore it. Submitting to the DSI means that bilateral negotiation between them is conditioned on the institution's designation, which limits the countries' ability to jointly restore cooperation during a dispute. Thus, the DSI does not need to provide any technology (such as monitoring) that the countries do not already have. Instead, countries rely on the DSI only as a credible way of conditioning agreements and future behavior on their history of interaction. With the DSI, dispute resolution entails only restoration of the balance of market access concessions that existed before the dispute, with no additional sanctions.

Importantly, the countries could not duplicate such a dispute resolution process on their own, since they would always renegotiate to reduce the amount of delay and restore cooperation more quickly. External enforcement is valuable precisely because the countries are unable to manipulate the parameters of the enforcement process.

To place our notion of recurrent agreement in the context of the repeated-game literature, it is useful to note that there are two avenues for punishing a player who deviates from the cooperative regime. These punishment avenues are best understood in terms of the continuation payoff vector from the period after the deviation occurs. One avenue (which can be called a *frontier punishment*) involves moving to a continuation value that is worse for the deviator than is the cooperative continuation value, but is at or close to the frontier of supported repeated-game payoffs. In other words, this is a shift along the frontier that disfavors the deviator but maintains the joint value of the relationship. The second avenue for punishment (which can be called a *joint value punishment*) involves moving to a continuation value that is significantly within the frontier, so that both the deviator and the other player get less than the cooperative continuation value.

Both avenues of punishment may be disrupted by renegotiation. A frontier punishment can be interpreted as the players' bargaining powers changing as a function of the history. For example, if player 1 deviates from the cooperative path, this player's bargaining power is reduced and he must then accept less of the joint value in the continuation. Renegotiation becomes a problem if bargaining powers are fixed over time. Likewise, a joint value punishment is unworkable if the set of supportable continuation values is independent of the history of interaction, because then the players both gain by abandoning the punishment sequence.

The "renegotiation-proofness" concept advanced by [Bernheim and Ray \(1989\)](#) and [Farrell and Maskin \(1989\)](#) takes the view that joint value punishments are infeasible; their analysis thus relies to some extent on history-dependent bargaining power. On the other end of the spectrum is [Pearce's \(1987\)](#) concept, elaborated by [Abreu, Pearce, and Stacchetti \(1993\)](#), which lays out a criterion for joint value punishments. Our notion of recurrent agreement goes beyond these treatments of renegotiation proofness by incorporating a more detailed account of bargaining power (here represented by the disagreement outcome and bargaining weights) and by considering an institutional element. Our interest is in showing how a DSI can help make joint value punishments viable. We thus make strong assumptions about fixed bargaining power that rule out frontier punishments and allow our model to cleanly isolate the benefit of having institutional designations of cooperative and dispute histories. This benefit of the DSI would still be present, only less needed, with weaker bargaining assumptions under which frontier punishments were also possible. For our applied setting, however, we are drawn to the notion of fixed bargaining power, for it seems that a defecting country would have little incentive to voluntarily relinquish its bargaining power.⁸

⁷ Our model does not include an expulsion possibility, which itself may fail to hold up under ongoing negotiation. Such non-coercive interpretation of the DSI is consistent with the sources of authority of many international judicial institutions. For example, the jurisdiction of the WTO legal bodies is based on consent, which the WTO member countries provide in advance through treaty obligations.

⁸ In a related model of dynamic sovereign debt, [Kletzer and Wright \(2000\)](#) posit that the defecting country has reduced bargaining power in future negotiations. In [Ludema \(2001\)](#), defections from a cooperative agreement are assumed to imply a subsequent choice from a smaller set of agreements (e.g., the static Nash equilibrium must be selected for some number of periods), but the reason for the smaller set is not modeled.

The existing GATT/WTO legal system has some of the features that our model identifies. For example, the WTO's dispute settlement process involves the formation of an independent legal experts' panel, which considers at least two rounds of testimony, determines the facts, establishes which law is applicable, applies law to the facts, and fashions a remedy according to the terms of the trade agreement. The standing Appellate Body hears appeals from panel decisions. At the top level of the WTO judicial hierarchy, the Dispute Settlement Body administers the overall rules of dispute settlement, establishes panels, adopts panel and Appellate Body reports, maintains surveillance over the implementation of its rulings and keeps official records about the dispute and its settlement. These functions of the WTO legal system, which we review in greater detail in the next section, are broadly consistent with our notion of the DSI as an independent institution designating when disputes have occurred and when they are resolved.

At the same time, we emphasize that our analytical framework should not be interpreted as a positive model of the existing international trade legal system. Rather it is a normative model suggesting the directions for the evolution of this system in the long-run. As the next section demonstrates, the recent Uruguay Round reforms of the GATT/WTO legal system are broadly consistent with the directions suggested by our model of the DSI.

In our basic model, frictions in the dispute resolution process are due to delays. As an alternative to delay, the DSI can rely on *direct penalties*, going beyond reciprocal withdrawal of concessions, that are imposed on countries that unilaterally violate trade agreements. We show that direct penalties can substitute for delays in providing credible enforcement, allowing enforcement agencies to reduce delays without undermining incentives. In our setting, penalties are effective even though the DSI has no coercive power. Offending countries are willing to pay penalties in order to restore cooperation, since they share in the benefits.

We extend our model by introducing a noise term that alters incentives to adhere to agreements, in a manner similar to the models of Bagwell and Staiger (1990), Riezman (1991), Hungerford (1991) and Kovenock and Thursby (1992). When the DSI is “non-contingent” (i.e., it does not condition the parameters of dispute resolution on the noise term because it is unable to make use of the information regarding the uncertainty in the countries' economic situations), trade disputes are shown to arise with positive probability on the equilibrium path. Moreover, in this case the countries never negotiate a zero-tariff agreement, since a small increase in tariffs would reduce welfare only slightly, while providing greater benefits by reducing the probability of costly disputes.

In contrast, when the DSI is “fully contingent” (that is, conditions the parameters of dispute resolution on the noise term), countries can completely avoid disputes by altering tariff agreements after the noise variable is realized; this can be interpreted as a complete state-contingent escape clause. The important point is that the feasibility of such beneficial mechanisms hinges on the ability of the enforcement institution to verify, and condition rulings on, events that affect the countries' welfare. Institutional rigidity can serve as a barrier to otherwise desirable arrangements.⁹

Section 2 provides motivating evidence and examples. Section 3 reviews the standard repeated tariff model, and Section 4 introduces our notion of recurrent agreements and applies the concept to the standard model without external enforcement. The DSI is introduced in Section 5, where the value of delays and direct penalties in providing credible enforcement is discussed. Section 6 considers the environment with short-run shocks (a noise term) and compares contingent and non-contingent DSIs. Section 7 concludes.

2. Motivating evidence

In this Section, we review some of the aspects and examples of GATT/WTO mediated dispute settlement that motivate and illustrate the main assumptions of our analytical framework. In its present state the GATT/WTO dispute resolution system provides for both diplomatic (conciliatory) and legal (judicial or rule-based) means of settling disputes. For example, Article 4 of the Uruguay Round's Understanding on Rules and Procedures Governing the Settlement of Disputes (DSU) provides for a period of “consultations” (up to 60 days) that must occur before the establishment of the panel provided for in Article 6 of the DSU. During this period of time, the disputing countries bilaterally control any resolution of the dispute. However, a number of important legal innovations introduced during the Uruguay Round of multilateral trade negotiations have increased the reliance on the judicial mechanism of dispute settlement, taking it out of hands of the disputing parties (e.g., see Petersmann (1997)). The most important changes include (i) automatic adoption of panel and

⁹ Bagwell and Staiger (1990, 2005) and Rosendorff and Milner (2001) argue that flexibility in choosing tariff levels is important for achieving valuable agreements. Our results demonstrate that the scope for such flexibility depends in turn on the characteristics of external enforcement institutions.

appellate body reports unless there is a negative consensus not to adopt them and (ii) the right of third-party WTO members to challenge bilateral settlements reached through conciliation (DSU Article 6).¹⁰ These changes illustrate the gradual evolution of the international legal system toward greater reliance on the adjudicatory (i.e., external rule-based) system of dispute settlement which is broadly consistent with our model.¹¹

Actual trade disputes brought to the GATT and WTO vary greatly in their particulars, but three commonly observed features are central to the interpretation of our model. First, WTO mediated settlement of many (but not all) disputes entails lengthy delays, often lasting several years, during which countries incur costs due to lost benefits of trade.¹² An example is the Banana case, which was initiated in 1995 when the United States, joined by Ecuador, Guatemala, Honduras and Mexico, brought a WTO challenge to the EU banana import regime. Two years later the WTO panel and Appellate Body recommended that the E.U. brings its measures into conformity with its WTO obligations and gave the E.U. 15 months to comply. However, another dispute arose over the terms of implementation of the panel's ruling by the E.U. As a result, it was not until mid-1999 that the U.S. received the legal right to retaliate against the E.U.'s illegal measure.¹³

The second feature of the GATT/WTO dispute settlement mechanism relevant to the interpretation of our model has to do with the policies adopted by the countries while they are in dispute. While there is no disagreement among students of international trade organizations that the GATT/WTO dispute resolution involves costly delays, there are different interpretations of what happens during those delays. Some authors believe that during most of dispute resolution process offended countries honor their market access commitments vis-à-vis their offenders.¹⁴ In this paper we adopt a different view. While it is true that explicit retaliation unauthorized by the WTO is rare, there are many ways in which countries can retaliate implicitly while awaiting for the official WTO's authorization for explicit withdrawal of concessions in response to the violation by the offending country. For example, offended countries can (and often do) pursue official grievance proceedings in the WTO and simultaneously retaliate by disguising their reprisal as an unfair trade remedy (under GATT Article VI) or as a safeguard measure (Article XIX) that may be superficially unrelated to the original offenses against them. Thus the reciprocal trade-inhibiting actions (i.e., the 'defect–defect' outcome in the underlying Prisoners' Dilemma game) are typically taken by both parties from the start of disputes.¹⁵

¹⁰ Busch and Reinhardt (2006) observe that third-party governments participated in 64% of the WTO disputes filed from 1995 through 2002. They find that by increasing the bargaining costs (i.e., time and informational requirements) of pretrial negotiations, participation of third parties undermines the prospects for early settlement and makes it more likely that the dispute will go through all the stages of the formal dispute settlement process ending in a ruling. Assuming that in the presence of third parties, the WTO judicial bodies render verdicts reflecting the wider interests of the membership as a whole, the empirical results of Busch and Reinhardt (2006) can be interpreted as a confirmation of the earlier idea of Bagwell and Staiger (2004) that one of the objectives of multilateral dispute settlement mechanism is to prevent the disputants from reaching a settlement that is discriminatory to the WTO members who are not primary parties in the dispute.

¹¹ Another new rule-based mechanism for monitoring of compliance with the negotiated agreements is the Trade Policy Review Mechanism (TPRM) of the WTO. The TPRM is essentially a peer review system, which allows the WTO members to evaluate one another's trade policies in adhering to commitments taken under the WTO agreements. However section A(i) of the TPRM indicates that it is not "... intended to serve as a basis for the enforcement of specific obligations under the Agreement or for dispute settlement procedures..." As a result a Panel, which adjudicated the *Canada — Aircraft* case, declined to attach any importance to the TPRM analyses of the governmental measures of the responding party. (See Waincymer (2002), p. 598).

¹² Although some trade disputes are resolved at the pre-panel consultations stage, if the panel is formed and its proceedings result in granting an offending party "a reasonable period of time" during which to comply with the panel ruling, a total of 31 or 32 months would elapse before the complainant receives authorization to suspend benefits. Importantly, changes under the Uruguay Round's Understanding on Rules and Procedures Governing the Settlement of Disputes seem to have merely shifted delays from panel deliberation and appeal to the compliance stage. At the implementation stage, the delays are often caused by corollary disputes over the compliance of the responding party with panel rulings and over the timing and scope of the appropriate retaliation by the complaining state. (See Hudec, 1993 and Valles and McGivern, 2000).

¹³ Another example of a WTO case mired in procedural delays and legal wrangling is the latest round of the recurrent transatlantic dispute over civil aircraft subsidies, which began in October, 2004 after the United States and the EU filed tit-for-tat complaints over the government support for Boeing and Airbus. Since the beginning of the latest round of the dispute, the WTO established four panels to adjudicate the complaints about various types of state aid to both Boeing and Airbus and conducted two separate 90-day investigations of illegal subsidies on both sides. However, in March, 2006, the adjudication of the dispute was delayed again after the EU, unhappy with information the U.S. had submitted to the WTO dispute panel, asked for the scope of the Boeing's investigation to be expanded.

¹⁴ For example, such interpretation of the dispute settlement process and the reasons for the complainants' patience while awaiting official authorization of retaliation is analyzed by Kovenock and Thursby (1992).

¹⁵ The assumption of reciprocity during the dispute stage in our model is consistent with the role played by the reciprocity norm in the model of Bagwell and Staiger (1999). In their paper, the reciprocity norm is efficiency-enhancing since it neutralizes the terms-of-trade externality characterizing unilateral trade policies. Interestingly, Bown (2005) finds empirical evidence of "vigilante justice" among some exporting countries that are affected by the U.S.-imposed antidumping or related trade remedies and choose to target their U.S. competitors directly with retaliatory antidumping actions, in lieu of seeking the removal of the disputed U.S. trade remedy measure by filing a formal complaint at the WTO.

Moreover, when an offended country retaliates outside of the current case, it often causes a counter-lawsuit by the offender that is itself investigated by the WTO panel for the case that initiated the conflict. Researchers point out a tit-for-tat pattern between countries not only in suspension of market-access concessions but also in suing one another for such suspensions. Tit-for-tat lawsuits were especially common among the “big three” litigants — the U.S., Canada, and the E.C. For example, on the same day in 1988, Canada and the U.S. filed complaints accusing each other of illegal quantitative restrictions on import of ice cream and yogurt (see Hudec, 1993).¹⁶ Interestingly, Reinhardt (1999) found that the chance a country files a complaint in the WTO against a trading partner increased by up to 55 times if this country was named in a complaint by the partner in the previous year. Prusa (2001) found that two-thirds of all antidumping complaints are tit-for-tat responses to antidumping actions by other countries.

The third feature of the GATT/WTO legal system is that dispute settlement generally involves simple reversal of the actions that generated the complaints. Sanctions aimed at punishing transgressor countries beyond reciprocal withdrawal of concessions, such as strongly asymmetric concessions or financial indemnities, are seldom specified.¹⁷

3. Standard repeated tariff model

3.1. Stage game

The stage game is derived from the basic two-country, two-good framework previously considered by Johnson (1953/54), Mayer (1981) and Dixit (1987). We provide only a terse review of the main elements of this framework. The countries, labeled $i=1, 2$, exchange two similarly labeled goods. Country 1 exports good 1 in exchange for imports of good 2 from Country 2. Both countries are large enough to affect the terms of trade through the import tariff, which is the only policy instrument available to the countries' governments. The countries are assumed to have symmetric single-period welfare functions. The welfare of Country i , given tariff choices τ_i and τ_j , is written $W(\tau_i, \tau_j)$. We make a number of common assumptions on $W(\tau_i, \tau_j)$ to ensure the existence of static best response functions that generate a unique non-autarkic Nash equilibrium in tariffs.¹⁸ Very large levels of τ_1 or τ_2 lead to the autarky outcome, in which welfare levels are taken to be zero. For lower levels of τ_1 and τ_2 , trade volume is positive, and the welfare function of Country i is strictly positive, differentiable and strictly quasi-concave in τ_i . Let $\tau_i^R(\tau_j)$ be the value of τ_i that maximizes $W(\tau_i, \tau_j)$ in this case. We assume there is a unique Nash equilibrium with non-prohibitive tariffs and that this equilibrium is symmetric and given by $\tau_1 = \tau_2 = \tau^N > 0$. The Nash equilibrium welfare level is $W^N \equiv W(\tau^N, \tau^N) > 0$.¹⁹ There is also an autarky equilibrium in which no trade occurs and welfare is zero.

¹⁶ More examples of the tit-for-tat litigation can be found in the international trade law literature. Valles and McGivern (2000) discuss the mutual accusations by Canada and Brazil regarding export subsidies for aircraft manufacturers. Hudec (1993) describes tit-for-tat exchanges of retaliatory measures and lawsuits between the U.S. and E.C. One example concerns U.S. complaints against the E.C. in the Pasta and Citrus cases of the 1980s. In both cases, the GATT dispute settlement panels ruled in favor of the U.S., but the E.C. blocked the GATT Council from adopting the panels' reports. In the Citrus case, the U.S. retaliated without GATT authorization by raising pasta tariffs, using the E.C.'s failure to comply with the earlier Pasta panel's ruling as justification. The E.C. then counter-retaliated by increasing tariffs on U.S. walnuts and lemons and filed its own complaints. The disputes were resolved the following year on the basis of the panels' rulings.

¹⁷ While proposals for the adoption of additional punitive sanctions, such as financial indemnities, have been discussed at different rounds of multilateral trade negotiations, they have never been formally incorporated in the GATT/WTO dispute settlement mechanism. However, Lawrence (2003) emphasizes that while the WTO legal system as a whole is not designed to be punitive, its individual elements clearly exhibit punitive behavior. As examples, he cites a number of disputes involving export subsidies whose resolutions are governed by the special provisions of the Agreement on Subsidies and Countervailing Measures (SCM) rather than by the DSU rules (e.g., *United States — FSC*, *Brazil — Aircraft*, and *Canada — Aircraft II*). He concludes that when it comes to export subsidies, the WTO has implicitly moved away from the paradigm of reciprocity which is central to the rest of the WTO agreements. We should also mention that some regional and bilateral trade agreements provide for direct sanctions for violations of trade agreements. For example, NAFTA's environmental side agreement allows a dispute settlement panel to impose a fine on the offending state by making it pay a “Monetary Enforcement Award” to the complaining state (see Reisman and Wiedman, 1995). In section 5 of this paper, we analyze a dispute-resolution mechanism which can impose on violators of trade agreements penalties in excess of reciprocal withdrawal of concessions.

¹⁸ For example, following Dixit (1987) we assume that balanced-trade and Marshall-Lerner conditions are satisfied. This ensures that one country's unilaterally-optimal tariff creates a negative terms-of-trade externality for the other country. Although the phrase “terms-of-trade externality” is rarely used in the parlance of real-world trade-policy negotiators, as Bagwell and Staiger (2002) demonstrate in their recent monograph, the concepts “terms-of-trade gain” and “market-access restriction” describe the single economic experience that occurs when the importing country government raises its import tariff and restricts foreign access to its market.

¹⁹ By assuming symmetric preferences and symmetric Nash equilibrium tariffs $\tau_1 = \tau_2 = \tau^N$, we are essentially assuming that the two countries have symmetric endowments and, therefore, symmetric economies. This is for technical simplicity only. Our concepts extend to cases with asymmetric trade partners, but the more general environment requires more notation and additional modeling details.

The joint welfare of the two countries is given by $V(\tau_1, \tau_2) \equiv W(\tau_1, \tau_2) + W(\tau_2, \tau_1)$. Assume $V_{\tau_i} < 0$, so that the free trade outcome $\tau_1 = \tau_2 = 0$ maximizes joint welfare. Define $V^N \equiv V(\tau^N, \tau^N) = 2W^N$. Finally, assume that the set

$$\{W(\tau_1, \tau_2) + W(\tau_2, \tau_1) | \tau_1, \tau_2 \geq 0\}$$

is convex.

3.2. Repeated game

The static model is assumed to be repeated over periods $t=0, 1, 2, \dots$. The tariff choices in each period generate a path (τ_{1t}, τ_{2t}) , $t=0, 1, 2, \dots$. Country i 's payoff from period t of the repeated game is the discounted sum of welfare levels from the static model:

$$g_i = \sum_{s=t}^{\infty} \delta^{s-t} W(\tau_{is}, \tau_{js}),$$

where $\delta < 1$ is the discount factor. Payoff profiles for the two countries are given by vectors (g_1, g_2) .

Histories of past tariff choices are assumed to be publicly observable when choices are made in the current period. Tariff choice strategies are given by mappings from histories of past tariff choices to current choices. We focus on the set of payoff profiles (g_1, g_2) that can arise in subgame perfect equilibria (SPE). Let G^P denote the set of all SPE payoff profiles. G^P can be characterized as follows (see [Abreu, 1988](#)):

Definition 1. The set of SPE payoff profiles G^P is the largest set with the following property. $(g_1, g_2) \in G^P$ if and only if there exist tariffs $\hat{\tau}_1, \hat{\tau}_2$ and profiles $(\hat{g}_1, \hat{g}_2), (g_1^1, g_2^1), (g_1^2, g_2^2) \in G^P$ such that, for $i=1, 2$:

$$g_i = W(\hat{\tau}_i, \hat{\tau}_j) + \delta \hat{g}_i \geq W(\tau^R(\hat{\tau}_j), \hat{\tau}_j) + \delta g_i^j. \tag{1}$$

Condition (1) contains two parts. The first part states that the payoff g_i is equal to the static welfare generated by equilibrium path choices $\hat{\tau}_i$ and $\hat{\tau}_j$, followed by the discounted payoff \hat{g}_i arising in the continuation. The second part requires g_i to exceed the payoff that Country i could obtain by deviating to $\tau^R(\hat{\tau}_j)$ in the current period, where the deviation leads to continuation payoff of g_i^j for Country i and g_j^i for Country j . Here g_i^j serves to punish Country i for the deviation. The continuation payoffs are credible in that they are themselves SPE payoffs.

4. Recurrent agreements

The set G^P represents the set of feasible trade agreements, in that the countries have private incentives to adhere to the agreement following any history. Trade negotiations may then be regarded in terms of making a selection from G^P . Standard approaches to trade negotiation, such as [Riezman \(1982\)](#), [Bagwell and Staiger \(1990, 1997a,b\)](#), [Maggi \(1999\)](#), [Bond et al. \(2003\)](#), and others, posit that countries make their selection in a jointly efficient manner.

The Nash bargaining solution, discussed by [Riezman \(1982\)](#), exemplifies the idea of efficient negotiation. Riezman's analysis can be adapted to the current dynamic setting in the following way. The set G^P is indicated by the area under the X_1X_2 curve in [Fig. 1](#). Point O in the figure emerges from infinite repetition of the autarchy outcome (which is a Nash equilibrium of the static model), while the other points in G^P may be sustained by the credible threat of reversion to autarchy.

Point N corresponds to infinite repetition of the positive trade Nash equilibrium (τ^N, τ^N) . Assume that if the countries are unable to agree in the current period, then the countries select the SPE consisting of infinite repetition of this Nash equilibrium; i.e., point N is the disagreement point. Then the bargaining set consists of the subset of G^P that lies above point N given by the shaded area S^A . The Nash solution selects (assuming the countries have equal bargaining power) the outcome at point A . Thus, point A constitutes the trade agreement.

This analysis explains the selection of a SPE at period $t=0$. An important further consideration, however, is that the agreement itself should be intertemporally consistent. Since negotiation between countries is ongoing, agreement must be reached in each period in the same manner as it was reached in period zero. That is, in each period, the countries will select a SPE for the continuation game, represented by a continuation payoff vector from some set S . Their selection will be sensitive to the disagreement point, which we assume consists of the stage-game Nash-equilibrium tariffs (τ^N, τ^N) in the current period followed by new negotiation in the succeeding period. In other

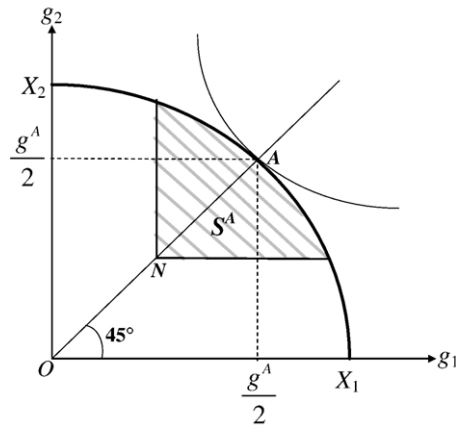


Fig. 1.

words, in a condition of disagreement, the countries’ tariff choices today do not affect the anticipated outcome of tariff negotiation tomorrow, so the countries select the static Nash-equilibrium tariffs today. Whether or not the countries agree today, and regardless of today’s tariff choices, the countries anticipate negotiating again tomorrow. The bargaining set S incorporates the future negotiation.

A *recurrent agreement* is a selection of a SPE that satisfies the Nash bargaining solution in every period, as just described. We shall let G^A denote the set of payoff profiles that can arise in recurrent agreements. Points in G^A are supported by (i) tariffs to which the players agree for the current period, plus (ii) a continuation value for the start of the next period that is conditioned on the current-period tariffs. The current-period tariffs are subject to individual incentive constraints; continuation values from the start of the next period are, in turn, selected from G^A . The disagreement point for negotiation in the current period has Country i obtaining a payoff of $W^N + \delta g_i^j$, where $(g_1^j, g_2^j) \in G^A$ indicates the continuation payoff vector from the agreement that is reached in the next period.

To keep the analysis simple, we will allow the countries to make transfers to one another as part of Nash bargaining. This serves to modify the original repeated game in an inessential way (in particular, with transfers, the countries are able to obtain payoff vectors that are not in the original G^P set when this set has a non-linear frontier). However, the bargaining analysis becomes much more transparent in the presence of transfers, even though transfers do not actually occur in the basic model (because of symmetry and convexity of the welfare possibilities set).²⁰ Moreover, this assumption can be motivated by the fact that trade negotiations frequently involve cross-country linkages amongst a large number of issues. In such cases, it is appropriate to assume that countries use these linkages to effectively make transfers.²¹

Because agreement is recurrent, future payoff profiles must be elements of G^A no matter what tariffs are chosen in the current period.

Definition 2. Given a set of payoff profiles G , the payoff profile (g_1, g_2) is *supportable* if there exist tariffs $\hat{\tau}_1, \hat{\tau}_2$ and profiles $(\hat{g}_1, \hat{g}_2), (g_1^1, g_2^1), (g_1^2, g_2^2) \in G$ such that

$$g_1 + g_2 = V(\hat{\tau}_1, \hat{\tau}_2) + \delta(\hat{g}_1 + \hat{g}_2), \tag{2}$$

and, for $i=1, 2$,

$$W(\hat{\tau}_i, \hat{\tau}_j) + \delta \hat{g}_i \geq W(\tau^R(\hat{\tau}_j), \hat{\tau}_j) + \delta g_i^j. \tag{3}$$

Let the set of supportable payoff profiles be denoted by $S(G)$.

Supportable payoff profiles are similar to SPE profiles, except that continuation payoffs must be drawn from the given set G , rather than from the full set of SPE payoffs G^P . This reflects the fact that the countries will negotiate a new

²⁰ In the extension of section 5.3 transfers are actually made.

²¹ Hoekman (1993), for example, points out that negotiating countries exchange concessions both within and across issues. Cross-issue linkages may allow agreement even if within-issue exchange of concessions proves insufficient to generate an improvement on the status quo for all concerned.

agreement in the following period (represented by points in G). Further, note that the equality in (1) has been replaced by condition (2). Since transfers between the countries are allowed during bargaining, any division of the joint payoff is possible, and so the definition of supportable payoffs determines only the joint payoff.

Ongoing negotiation means that, in each period, the countries select an element from $S(G^A)$ that is consistent with the Nash bargaining solution. This idea completes our notion of recurrent agreement, which is formalized as follows.

Definition 3. G^A constitutes a set of recurrent agreements if the following is true for each $(g_1, g_2) \in G^A$:

- I. (g_1, g_2) maximizes the sum of the countries' payoffs on the set $S(G^A)$; and
- II. There exists $(g'_1, g'_2) \in G^A$ such that the following holds for $i = 1, 2$:

$$g_i = \frac{1}{2} [g_1 + g_2 - (V^N + \delta(g'_1 + g'_2))] + W^N + \delta g'_1. \tag{4}$$

Condition I is equivalent to the usual requirement of joint efficiency in the presence of transfers. Condition II states that each country obtains an even share of the joint surplus, where surplus is defined relative to a disagreement point that is consistent with agreement in the following period.

Consider now any particular set of recurrent agreements, G^A , along with the associated set of supportable payoff profiles, $S(G^A)$. It is important to note that neither the set G^A nor the bargaining solution is affected by the history of past tariff choices. In other words, the bargaining problem that the countries face following one history is the same as the bargaining problem they face following any other history, which is the defining characteristic of our “no institution” case. This property gives rise to the following strong result. Let

$$g^A = \max\{g_1 + g_2 | (g_1, g_2) \in S^A\};$$

i.e., g^A is the value of the joint payoff that satisfies the maximization problem in condition I.

Lemma 1. If $(g_1, g_2) \in G^A$, then $g_1 = g_2 = g^A/2$.

Proof. Condition I of Definition 3 implies that $g_1 + g_2 = g^A$ for any $(g_1, g_2) \in G^A$. Also recall that $V^N = 2W^N$. These facts allow us to rewrite (4) as follows:

$$g_i - \frac{g^A}{2} = \delta \left(g'_i - \frac{g^A}{2} \right). \tag{5}$$

The stage game and SPE conditions imply that G^P is bounded from above and below. Since $G^A \subset G^P$, this implies that G^A is also bounded. Thus, the supremum of $|g_i - g^A/2|$ over both i and $(g_1, g_2) \in G^A$ is finite. Combining this with (5) implies that $g_i = g^A/2$ for all $(g_1, g_2) \in G^A$. □

The lemma follows from the fact that when agreement is recurrent, the countries evenly divide the surplus in the current and future periods, irrespective of the history of past tariff choices. In particular, in (3) we must have $\hat{g}_i = g^i = g^A/2$, and thus (3) becomes:

$$W(\hat{\tau}_i, \hat{\tau}_j) + \delta \frac{g^A}{2} \geq W(\tau^R(\hat{\tau}_j), \hat{\tau}_j) + \delta \frac{g^A}{2}. \tag{6}$$

Only $\hat{\tau}_i = \hat{\tau}_j = \tau^N$ can satisfy (6) for $i = 1, 2$. This proves:

Proposition 1. There is a unique set of recurrent agreements in the standard repeated tariff game with transfers. This set contains only the SPE in which the static Nash equilibrium (τ^N, τ^N) is chosen in every period.

In other words, when countries negotiate recurrently, cooperative tariff agreements become unsustainable in the standard model.²² This is because imposing intertemporal consistency on negotiation procedures undercuts the

²² Recall that we assume countries coordinate on the positive-trade Nash equilibrium of the stage game in the disagreement condition. An alternative assumption would be that, in disagreement, the countries coordinate on the autarky equilibrium of the stage game. The alternative assumption would lead to the same results, although one could then say that there is a functional cooperative trade agreement (getting the countries from autarky to the interior Nash equilibrium of the stage game).

countries' ability to punish defections from cooperative agreements. The intuition for this result is illustrated in Fig. 1. The figure posits, contrary to Proposition 1, that the supportable set S^A , shown as the shaded area, admits payoff profiles that improve on the static Nash outcome N . Because of recurrent agreement, however, in each period the countries are lead to select a jointly efficient element of S^A , at point A , irrespective of tariff history. Since recurrent agreement undercuts the ability to punish defections from the agreement, payoff profiles that improve on N cannot actually be elements of S^A .

Unlike the existing models that consider renegotiation-proof trade policies, our analytical framework assumes that, in the absence of external enforcement institutions, past tariff choices do not affect the *parameters of the negotiation process*. In particular, the bargaining set, disagreement point, and bargaining solution – and thus, the countries' ability to exercise bargaining power – remain history invariant. As Proposition 1 shows, without any credible way to condition the negotiation process on past tariff choices, each country's bargaining power and ability to hold up the relationship undermines the credibility of standard repeated-game punishments.

5. External enforcement

5.1. Dispute settlement institution

We have shown that when countries can exercise fixed bargaining power in their ongoing negotiation, they are unable to achieve cooperative agreements on their own. Third-party participation therefore becomes important for sustaining credible enforcement. This section extends the standard repeated tariff model by adding a dispute settlement institution (DSI) that captures the salient features of trade disputes and enforcement activities that we discussed in Section 2. Specifically, we assume that the DSI, which cannot be directly manipulated by the countries involved in a dispute, keeps records of the negotiated agreements, complaints, and violations, and also settles disputes when agreements are violated. To keep things simple, we suppose that the DSI's records are kept in terms of just two possible designations of the trade relationship, “cooperative” and “dispute”, as follows. At the start of any period, it is assumed that either there is no dispute pending, or else the DSI is in the process of resolving a dispute triggered by a violation in some prior period. We refer to the former situation as the “cooperative state,” or state C . If a dispute is pending, then the period begins in the “dispute state,” or state D . When a tariff agreement is violated, the DSI switches the state from C to D , and a dispute resolution process (DSP) begins, as described below. When settlement is achieved, the DSI switches the state from D back to C . Countries continue to negotiate agreements and choose tariffs as before, except their negotiation can be conditioned on the DSI's state. Therefore, the negotiation problem that countries face following a dispute history may be different than the negotiation problem they face following a cooperative history.²³

Note that in our model the DSI switches to the dispute state immediately after the agreement is violated whereas in reality an explicit filing decision of the offended party precedes the adjudication procedures by the WTO. We are thus implicitly assuming that the offended party always files a complaint with the DSI. There are two justifications of this modeling choice. First, if the offended party were not to file a complaint after a violation, then it would induce the setting analogous to Section 4 of this paper, where cooperation cannot be sustained. That is, the presence of the DSI makes a difference for the equilibrium outcome only if the parties are actively utilizing it. Second, this modeling choice is consistent with Article 23.1 of the DSU, which obliges offended countries to bring any dispute arising under the WTO agreements to the WTO dispute settlement system. Furthermore, membership of the WTO constitutes consent to, and acceptance of, the *compulsory jurisdiction* of the WTO dispute settlement system.²⁴

Rather than developing a detailed model of the DSP, it suffices for our purposes to treat the DSP as a “black box,” where the key feature is that settlement occurs with delay. For a period that begins in the D state, the dispute is resolved, and the state is switched to C , with probability p . This probability is exogenous and is meant to capture the idea that

²³ The model could allow for multiple dispute states, reflecting violations that occur while a prior dispute is pending. We focus on a single dispute state in the interest of simplicity.

²⁴ Interestingly, the Panel in *US — Section 301 Trade Act*, ruled that Article 23.1 of the DSU imposes on all Members a requirement that “when they seek the redress of a WTO inconsistency... Members have to have recourse to the DSU dispute settlement system to the exclusion of any other system.... This, what one could call “exclusive dispute resolution clause”, is an important new element of Members' rights and obligations under the DSU”. (Panel Report, *US — Section 301 Trade Act*, para. 7.43. WTO Document WT/DS200/8. This and later citations to official WTO documents use only the unique WTO document number. Most are publicly available at <http://docsonline.wto.org/>.)

dispute resolution may entail costs including delay.²⁵ Importantly, the countries cannot take actions to raise p and hasten dispute resolution; this is the sense in which the DSP is external to the countries.²⁶ Dispute resolution occurs at the very start of the period, prior to negotiation by the countries.

The timing of actions is illustrated in Fig. 2. If the countries are in state C at the start of period t , they choose an agreement from a feasible set G^C and communicate the agreement to the DSI. As long as their tariff choices adhere to the agreement, they remain in state C at the start of period $t+1$. If one or both countries defect from the agreement, however, a dispute arises, and the state is switched to D at the start of period $t+1$.

If the countries are in state D at the start period t , then dispute settlement may occur at the start of the period. With probability p , the dispute is settled and the state switches back to C . In this case, the countries immediately negotiate a selection from G^C and communicate it to the DSI. With probability $1-p$, the dispute is unresolved and the state remains D through the start of period $t+1$, irrespective of what tariffs the countries select in the current period. In this event, the countries choose an agreement from a feasible set G^D . In principle, G^D can be identical to G^C , since the countries are free to ignore the DSI when negotiating agreements and selecting tariffs.

The definitions from the preceding section will now be extended to incorporate the DSI. For given sets G^C and G^D , define the following set of expected payoff profiles:

$$G^E = \{p(g_1, g_2) + (1-p)(g'_1, g'_2) | (g_1, g_2) \in G^C, (g'_1, g'_2) \in G^D\}.$$

This is the set of possible expected continuation payoff profiles, conditional on entering the following period in the D state. With probability p , the dispute is resolved and (g_1, g_2) is selected from G^C in the next period; with probability $1-p$, the dispute is not resolved and (g'_1, g'_2) is selected from G^D .

Definition 4. Given sets of payoff profiles G^C and G^D , the payoff profile (g_1, g_2) is supportable in state $s, s=C, D$, if there exist tariffs $\hat{\tau}_1, \hat{\tau}_2$ and profiles $(\hat{g}_1, \hat{g}_2), (g_1^1, g_2^1), (g_1^2, g_2^2)$ such that (2) and (3) are satisfied, where:

$$\begin{aligned} \text{for } s=C: & (\hat{g}_1, \hat{g}_2) \in G^C, \text{ and } (g_1^1, g_2^1), (g_1^2, g_2^2) \in G^E; \text{ and} \\ \text{for } s=D: & (\hat{g}_1, \hat{g}_2), (g_1^1, g_2^1), (g_1^2, g_2^2) \in G^E. \end{aligned}$$

Let the set of payoff profiles that are supportable in state s be denoted by $S^s(G^C, G^D)$.

Intuitively, in state C any defection from the agreed tariffs $\hat{\tau}_1$ and $\hat{\tau}_2$ triggers the dispute state. Continuation payoffs are then elements of G^E , which builds in the probability of dispute settlement at the start of the following period. As before, the continuation payoff that is meant to “punish” Country i for deviating gives Country i g_i^j and gives Country j g_j^i . State D indicates an ongoing dispute, and all continuation payoffs in state D are drawn from G^E .

Definition 5. G^C and G^D constitute *state-dependent sets of recurrent agreements* if, for $s=C, D$, the following is true for each $(g_1, g_2) \in G^s$:

- I. (g_1, g_2) maximizes the sum of the countries’ payoffs on the set $S^s(G^C, G^D)$; and
- II. There exists (g'_1, g'_2) such that (4) holds for $i=1, 2$, where:
 - for $s=C: (g'_1, g'_2) \in G^C$; and
 - for $s=D: (g'_1, g'_2) \in G^E$.

²⁵ The “coin-flipping” nature of dispute resolution is assumed for modeling convenience. A more general (but harder to model) assumption would be a delay of T periods and the settlement probability which increases in the number of periods since the start of the dispute.

²⁶ Legal scholars note that the WTO’s dispute settlement process has both conciliation (i.e., diplomatic) and adjudication (i.e., rules-based) functions (see *Trebilcock and Howse, 1999* and *Jackson, 1997*). Our model emphasizes its adjudicative role. The diplomatic/conciliatory provisions of the WTO’s dispute settlement process might be viewed as allowing countries to switch the state from D back to C costlessly if they choose. The key issue is whether, after such informal dispute settlement, countries can costlessly and informally agree to close off all future appeals to the DSI. In this case, cooperation would not be sustainable (the countries would always restore the C state costlessly following a dispute), and our model would not provide a role for the external institution. Alternatively, if after agreeing to switch back to the C state, either country could still decide to dredge up the dispute at a later time and go back to the DSI, then renegotiation in the informal C state would be different than in the formal C state, and the informal C state would be equivalent to the D state. The recent history of the WTO dispute settlement system shows that appeals typically do not end until the panel or Appellate body issues its formal judicial opinion (see *Petersmann (1997)*). Prior to this, countries often claim that others have not followed through on the terms of an informal agreement, that information was incorrect or misleading, or that new information has been revealed. The key feature of the DSI is that its ruling is public and resolves the issues once and for all.

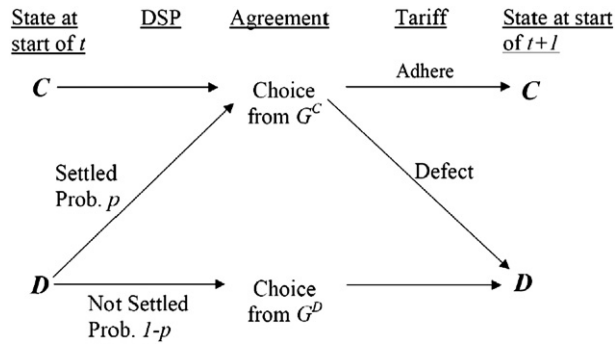


Fig. 2.

According to condition I, countries agree to do as well as possible in each state. Agreement is recurrent, in that continuation payoffs are always drawn from G^C or G^D , but the countries are unable to alter the state as part of their agreement.²⁷

5.2. Recurrent agreements with external enforcement

We now demonstrate that cooperative outcomes become sustainable as recurrent agreements once the DSI is added to the model. Let the maximized value of the joint payoff for $s=C, D$ be written

$$g^s = \max\{g_1 + g_2 | (g_1, g_2) \in S^s\}.$$

Lemma 2. *If $(g_1, g_2) \in G^s$, then $g_1 = g_2 = g^s/2$.*

Proof. In Appendix. □

We may now derive the tariff choices in a recurrent agreement with external enforcement. For $s=D$, applying Lemma 2 to the supportability condition (3) gives

$$W(\hat{\tau}_i, \hat{\tau}_j) + \delta \left(p \frac{g^C}{2} + (1-p) \frac{g^D}{2} \right) \geq W(\tau^R(\hat{\tau}_j), \hat{\tau}_j) \delta \left(p \frac{g^C}{2} + (1-p) \frac{g^D}{2} \right). \tag{7}$$

Thus, $\hat{\tau}_i = \hat{\tau}_j = \tau^N$ must be selected when $s=D$. As long as a dispute is pending, the disposition of the DSI is not affected by current tariff choices, and only the static Nash outcome can be sustained.

For $s=C$, the supportability condition (3) becomes:

$$W(\hat{\tau}_i, \hat{\tau}_j) + \delta \frac{g^C}{2} \geq W(\tau^R(\hat{\tau}_j), \hat{\tau}_j) + \delta \left(p \frac{g^C}{2} + (1-p) \frac{g^D}{2} \right), \tag{8}$$

which may be rewritten as

$$\Omega(\hat{\tau}_i, \hat{\tau}_j) \equiv W(\tau^R(\hat{\tau}_j), \hat{\tau}_j) - W(\hat{\tau}_i, \hat{\tau}_j) \leq \frac{\delta(1-p)}{2} (g^C - g^D). \tag{9}$$

The function $\Omega(\hat{\tau}_i, \hat{\tau}_j)$ indicates Country i 's within-period gain when it defects from the tariff agreement $(\hat{\tau}_i, \hat{\tau}_j)$. This gain is strictly positive for at least one of the countries whenever the agreement improves on the static Nash outcome. The right-hand side of (9) indicates the punishment that derives from delays induced by the DSP. As long as $p < 1$, defection initiates a dispute that may take time to resolve. The term $g^C - g^D$ gives the loss in joint surplus that the countries endure while the dispute is being resolved.

²⁷ As condition II is stated, if there is disagreement in state C , the state remains C , since we have assumed that in this event the countries do not communicate any agreement to the DSI. The results would not be affected if the model instead specified that disagreement triggered state D .

Since the outcome is (τ^N, τ^N) when $s=D$, we may apply supportability condition (2) in state D , along with the definition of G^E , to obtain

$$g^D = V^N + \delta(pg^C + (1 - p)g^D). \tag{10}$$

Combining (9) and (10) gives

$$\Omega(\hat{\tau}_i, \hat{\tau}_j) \leq \frac{\delta(1 - p)}{1 - \delta(1 - p)} \left(\frac{(1 - \delta)g^C}{2} - W^N \right). \tag{11}$$

Further, condition (2) in state C implies

$$g_1 + g_2 = V(\hat{\tau}_1, \hat{\tau}_2) + \delta g^C. \tag{12}$$

Condition I of the definition of a recurrent agreement indicates that $\hat{\tau}_1$ and $\hat{\tau}_2$ are chosen to maximize $g_1 + g_2$ subject to (2) and (3). Based on (12), this is equivalent to maximizing $V(\tau_1, \tau_2)$ subject to (11). The maximized joint payoff is thus given by

$$\psi(g^C) \equiv \max_{\hat{\tau}_1, \hat{\tau}_2} \frac{V(\hat{\tau}_1, \hat{\tau}_2)}{1 - \delta} \text{ subject to (11)}. \tag{13}$$

It follows that we have a recurrent agreement at any point where $g^C = \psi(g^C)$. This proves the following proposition.

Proposition 2. G^C and G^D give state-dependent sets of recurrent agreements if and only if the following are true.

- a. For $s = C, D$, the set G^s consists of a single element $(g^s/2, g^s/2)$.
- b. The value g^C satisfies $g^C = \psi(g^C)$, and tariff choices in state C are solutions to problem (13) for this value of g^C .
- c. The value of g^D satisfies (10), and tariff choices in state D are $\hat{\tau}_1 = \hat{\tau}_2 = \tau^N$.

The workings of a recurrent agreement in the presence of the DSI are depicted in Fig. 3. The set S^D (G^C, G^D) of supportable payoffs in state D contains only the point D, which lies above point N as long as $p > 0$ and cooperation occurs in state C. The shaded area indicates the set S^C of supportable payoffs in state C, given the values g^C and g^D . The bargaining solution selects point C in state C, which corresponds to the joint value g^C .

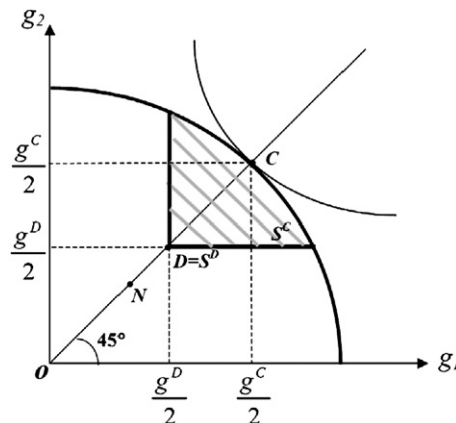


Fig. 3.

It is possible that (13) is satisfied by multiple values of g^C , with each solution supporting a recurrent agreement. For concreteness, we focus on the *maximal recurrent agreement*, which is the recurrent agreement giving the highest value of g^C . Let \bar{g}^C denote this highest value.²⁸ The following proposition characterizes \bar{g}^C .

Proposition 3. *There exists a maximal recurrent agreement, whose value \bar{g}^C is determined by*

$$\bar{g}^C = \max_{\hat{\tau}_1, \hat{\tau}_2} \frac{V(\hat{\tau}_1, \hat{\tau}_2)}{1 - \delta} \text{ subject to} \quad (14)$$

$$\Omega(\hat{\tau}_i, \hat{\tau}_j) \leq \frac{\delta(1-p)}{1 - \delta(1-p)} \left(\frac{V(\hat{\tau}_i, \hat{\tau}_j)}{2} - W^N \right). \quad (15)$$

Proof. In Appendix. □

From (14) and (15), it may be seen that the maximal recurrent agreement maximizes the discounted value of the equilibrium path joint payoff subject to the supportability conditions. Using Proposition 3, we may easily relate the value of the maximal recurrent agreement to the delay induced by the DSP.

Proposition 4. *The value \bar{g}^C is strictly decreasing in p , and $\bar{g}^C = V^N/(1 - \delta)$ when $p = 1$.*

Proof. In Appendix. □

Proposition 4 assures that, whenever $p < 1$, cooperation is attained in the maximal re-current agreement. Further, the maximal recurrent agreement captures the features of actual trade disputes discussed above: a dispute leads to the static Nash equilibrium, reflecting violations by both countries and a mutual suspension of cooperative policies; delays in dispute resolution are built into the DSP; and settlement involves restoration of the cooperative tariff levels. When $p = 1$, all disputes are resolved immediately, so that any cooperative agreement could be reinstated without delay. This undermines incentives to maintain cooperation, in the same manner as in the model with no DSI, and repetition of the static Nash equilibrium is the unique outcome. When $p = 0$, in contrast, the DSI never resolves disputes, and cooperative agreements cannot be restored. This corresponds to the “grim trigger” specification that imposes the positive-trade static Nash outcome in every period following defection.

Our results demonstrate the connection between dispute resolution costs and incentives to honor agreements. In particular, high dispute resolution costs lead to the greatest incentive for countries to cooperate. We would hesitate to make an extreme practical judgment based on Proposition 4, however, because our model to this point does not address some obvious elements that favor *lowering* dispute resolution costs. When agreements are made in an uncertain environment, for example, disputes may arise in equilibrium and then high costs may hurt welfare. Furthermore, dispute resolution costs may be tied to the costs of other institutional activity, such as facilitating negotiation in cooperative times. Thus, depending on the starting point, it may be optimal to lower dispute resolution costs — an important theme in the development of international institutions such as the WTO.²⁹ In Section 6, we study a noise term that affects the countries’ incentives and causes disputes to occur in equilibrium.

Note that cooperation is sustained despite the fact that the DSI has no coercive powers. The key point is that when a dispute is triggered, the countries cannot avoid delays in restoring the cooperative state, since the DSP operates externally. This makes the cooperative state valuable, which in turn provides the incentive to preserve cooperation. It is important to note that the countries could not implement the DSP internally through an implicit agreement: whenever the D state arose, the countries would mutually benefit by redesigning the DSP to set $p = 1$, thereby undercutting the enforcement mechanism. External mechanisms are critical for credible enforcement because countries cannot manipulate the DSP in this way.³⁰

In reality, the countries may have some influence over the DSP, even though the DSP is managed externally. Naturally, countries embroiled in a dispute would have the incentive to hasten dispute resolution — that is, to raise p .

²⁸ The maximal recurrent agreement is also uniformly best over the states, in that it maximizes g^D over recurrent agreements as well; that is, in both states, the countries prefer the maximal recurrent agreement.

²⁹ Our theoretical setting is not broad enough for analysis of the “optimal” cost, but in the least, we warn against making the cost too small.

³⁰ To say this more strongly, the defining characteristic of the multilateral institution is that it cannot be freely manipulated by pairs of countries, and it is this characteristic that enables the enforcement of bilateral agreements.

However, with some procedural delays inherent in the DSI, the probability of dispute resolution could not get raised to one. The proper interpretation of p in our model is, therefore, the resulting probability of dispute resolution given what is specified in the DSP and the influence activities of the countries.

The pace and nature of dispute resolution in reality also may depend on the countries' tariff levels during disputes, which goes beyond our model's assumption that the DSI does not condition dispute resolution on these tariff levels. For example, dispute resolution is usually hastened if the country, which violated the agreement, restores the agreed upon tariff level. Clearly, if a country could obtain the short-run gain of a tariff deviation and then quickly withdraw the offensive tariff before the other country could respond, then the offending country would not be punished and cooperation would break down. Effective punishment relies on some delay or direct penalties in the dispute resolution process. We believe that some delay is intrinsic to the DSP and so the offended country has an opportunity to respond.

In addition, the offended country's response may, in reality, influence dispute resolution. For example, this country may take actions (perhaps discretely) that induce a counter-lawsuit, or this country may maintain the cooperative tariff level.³¹

5.3. Direct penalties

Although not often used in practice, direct penalties imposed on unilateral violators represent a potentially useful mechanism for sustaining cooperation. In this section we show that direct penalties can substitute for delays, making it possible to expedite dispute resolution without undercutting incentives. Further, enforcement institutions can require direct penalties even though they have no coercive power.³²

We introduce direct penalties into the model in the following way. Suppose Country 1 unilaterally deviates from an agreement; i.e., following an agreement in state C , Country 1 chooses $\tau_1 \neq \hat{\tau}_1$, while Country 2 selects $\tau_2 \neq \hat{\tau}_2$. In this case, we assume that the DSI requires Country 1 to pay a penalty of $m > 0$ to Country 2 at the point of dispute resolution, as a condition for resolving the dispute and returning the state to C . Payment of this penalty is voluntary, but if the transgressor fails to pay it, then the DSI refuses to switch the state back to C .³³ Thus, if state D has been triggered by a unilateral deviation by Country 1, then the set of expected continuation payoffs becomes

$$G_1^E = \{p(g_1 - m, g_2 + m) + (1 - p)(g'_1, g'_2) | (g_1, g_2) \in G^C, (g'_1, g'_2) \in G^D\}.$$

Similarly, expected continuation payoffs in state D following a unilateral deviation by Country 2 are given by

$$G_2^E = \{p(g_1 + m, g_2 - m) + (1 - p)(g'_1, g'_2) | (g_1, g_2) \in G^C, (g'_1, g'_2) \in G^D\}.$$

Assume that no penalties are imposed if the countries deviate simultaneously from a cooperative agreement (such joint deviations are never relevant for assessing the supportability of payoff profiles, however).

³¹ We can extend our model by increasing the number of "dispute" states so that there is a distinction between "tit-for-tat" disputes and "one-sided" disputes, the former applying when the offended country responds by increasing its own tariff (possibly inducing a counter-lawsuit) and the latter applying when the offended country maintains the cooperative tariff. In this case, we can make a realistic assumption that the exogenous probability of resolving a "tit-for-tat" dispute is lower than the probability of resolving a "one-sided" dispute. While such an extension will certainly be complicated, it will not fundamentally alter our conclusions about the role of external state designation in sustaining cooperation. By having just one dispute state D , we essentially simplified the model by "collapsing" several possible dispute states into one state. This is done for analytical convenience and also because in reality a large number of disputes are "tit-for-tat" (as we illustrated earlier).

³² We should mention an important difference between the two types of remedies which the DSU can authorize while the injured party awaits for the withdrawal of the WTO-inconsistent measure, namely, compensation and suspension of concessions or other obligations. Grossman and Mavroidis (2003) discussed the difference between these remedies in the context of the *United States — Section 110(5) of the US Copyright Act* case and pointed out that unlike in cases resulting in the authorization of the suspension of concessions, the DSU places no restrictions on the size of any compensation payment, and in particular does not limit compensation to the amount of the benefits that have been nullified or impaired and remains silent on the issue of punitive compensation.

³³ The direct penalties in our model play a similar role to the international obligation analyzed by Kovenock and Thursby (1992). In their paper, the country that deviates from the GATT-determined tariff level, or retaliates without a sanction of the GATT, faces a cost in the form of a loss of goodwill in the international arena — a loss that is automatic and unmodeled. In our model, the offending country willingly pays the DSI-imposed penalty because it is in the country's interest to do so.

With the addition of direct penalties, Lemma 2 is modified as follows.

Lemma 3. a. If $(g_1, g_2) \in G^C$, then $g_1 = g_2 = g^C/2$.

b. If $(g_1, g_2) \in G^D$ and the dispute was triggered by unilateral deviation by Country i , then

$$g_i = \frac{g^D}{2} - \frac{\delta pm}{1 - \delta(1 - p)}, \tag{16}$$

$$g_j = \frac{g^D}{2} + \frac{\delta pm}{1 - \delta(1 - p)}. \tag{17}$$

Proof. In Appendix. □

With direct penalties, dispute settlement implies that Country i must pay a penalty to Country j before a new cooperative agreement is negotiated. This lowers the value of the disagreement point for Country i in state D . Thus, although the bargaining procedures are unchanged following its deviation, Country i obtains a lower payoff than does Country j .

Next consider the tariff choices in recurrent agreements with direct penalties. As before, only the choices $\hat{\tau}_1 = \hat{\tau}_2 = \tau^N$ are possible in state D . Tariff choices in state C are altered, however. Treating Country i as the unilateral deviator, the supportability condition (3) becomes, using (16):

$$W(\hat{\tau}_i, \hat{\tau}_j) + \delta \frac{g^C}{2} \geq W(\tau^R(\hat{\tau}_j), \hat{\tau}_j) + \delta \left[p \left(\frac{g^C}{2} - m \right) + (1 - p) \left(\frac{g^D}{2} - \frac{\delta pm}{1 - \delta(1 - p)} \right) \right],$$

or

$$\Omega(\hat{\tau}_i, \hat{\tau}_j) \leq \frac{\delta(1 - p)}{2} (g^C - g^D) + \frac{\delta pm}{1 - \delta(1 - p)}. \tag{18}$$

Combining (18) with (10) yields

$$\Omega(\hat{\tau}_i, \hat{\tau}_j) \leq \frac{\delta(1 - p)}{1 - \delta(1 - p)} \left(\frac{(1 - \delta)g^C}{2} - W^N \right) + \frac{\delta pm}{1 - \delta(1 - p)}, \tag{19}$$

and $\psi(g^C)$ is now defined subject to (19). Comparing (19) with (11), it may be seen that when $p > 0$, direct penalties serve to weaken the incentive constraints, thereby expanding the set of supportable payoff profiles. Thus, for any g^C , the value of $\psi(g^C)$ is strictly greater. More precisely, $\psi(g^C)$ is increasing in m and decreasing in p , which proves:

Proposition 5. If $p > 0$, then the use of direct penalties raises the value of the maximal recurrent agreement. Further, direct penalties and delay are substitutes in sustaining cooperative agreements, in that \bar{g}^C is strictly decreasing in p and strictly increasing in m .

From this it follows that direct penalties can potentially substitute for delays in sustaining cooperative agreements. We must still check, however, that countries are willing to comply with the penalties, since the DSI has no coercive power. Voluntary compliance occurs when restoration of cooperation conveys benefits that exceed the penalty. Thus, the size of the direct penalty is constrained by the following “voluntary compliance” condition:

$$\frac{g^C}{2} - m \geq \frac{g^D}{2} - \frac{\delta pm}{1 - \delta(1 - p)}.$$

Taking the largest value of m that satisfies this condition, and combining this value with (18) and (10), yields:

$$\Omega(\hat{\tau}_i, \hat{\tau}_j) \leq \delta \left(\frac{g^C}{2} - \frac{W^N}{1 - \delta} \right). \tag{20}$$

The right-hand side of (20) indicates the largest punishment that can be imposed in a recurrent agreement with direct penalties that satisfy the voluntary compliance condition. Observe that the punishment value is equivalent to the grim

trigger strategy that uses infinite repetition of the static Nash tariffs (τ^N, τ^N) to punish deviations. Thus, we have proven the following proposition.

Proposition 6. *Suppose the DSI imposes the largest direct penalty consistent with voluntary compliance. Then the punishment for deviation is equivalent to the use of a grim trigger strategy in which deviation leads to infinite repetition of the positive-trade static Nash equilibrium.*

As may be seen from (20) and (11), use of the largest direct penalty yields the same incentive constraint as does setting $p=0$ in the absence of direct penalties. In particular, penalties make possible the same level of punishment as would be the case with grim trigger strategies, but with no delay in dispute resolution.

Note that in the case of $p=1$, direct penalties punish by shifting down the frontier of the set of attainable continuation payoff vectors to the offending country’s disadvantage. With $p<1$, dispute resolution also involves short-run inefficiency. In other words, delay punishes both countries (including the victim), whereas a direct penalty punishes only the offending country. By shifting across the payoff frontier, direct penalties emulate how punishment occurs under the renegotiation-proofness concept of [Bernheim and Ray \(1989\)](#) and [Farrell and Maskin \(1989\)](#). However, here the efficacy of direct penalties relies on the DSI’s management of the state; without the DSI, the countries’ bargaining power would interfere with punishments.

6. Dispute adjudication in an environment with noise

6.1. Standard tariff model with noise

In the preceding analysis of external enforcement, trade disputes never actually arise on the equilibrium path, since countries negotiate agreements that satisfy the supportability conditions. In this section we extend the model to incorporate a noise term that alters the countries’ incentives to adhere to their agreements, similar to the specification considered by [Bagwell and Staiger \(1990\)](#). If the DSI is uninformed about realizations of this random variable, or is unable to use this information in adjudicating disputes, then trade disputes occur periodically on the equilibrium path.

Let the random element be denoted by θ . Fluctuations in θ may represent factors that lead to variations in trade volume, for example. We assume that countries are able to observe past and current realizations of θ when they make their tariff choices in a given period. The payoff of Country i is now given by $W(\tau_i, \tau_j, \theta)$. Assume $W_{\tau_i \theta} > 0$, so that higher θ raises the incentive to choose high tariffs. To simplify the technical arguments, we assume further that

$$\lim_{\theta \rightarrow \infty} W_{\tau_i}(\tau_i, \tau_j, \theta) = \infty$$

for any τ_i, τ_j, θ such that $W(\tau_i, \tau_j, \theta) > 0$; i.e., the incentive to choose higher tariffs may be made as large as desired by taking large enough θ .

The reaction function and Nash equilibrium now depend on θ ; let these be denoted by $\tau^R(\tau_j, \theta)$ and $\tau^N(\theta)$, respectively. Let $W^N(\theta) \equiv W(\tau^N(\theta), \tau^N(\theta), \theta)$ and $V^N(\theta) \equiv V(\tau^N(\theta), \tau^N(\theta), \theta) = 2W^N(\theta)$. Moreover, in this section we will assume that $V_{\tau_i}(0, 0, \theta) = 0$; i.e., the marginal effect of tariffs on the joint payoff is zero at the free trade point.

In the repeated game, θ is drawn independently in each period according to the density function $f(\theta)$. Assume $f(\theta) = 0$ for $\theta < 0$ and $f(\theta) > 0$ for $\theta \geq 0$. Repeated game payoffs from period t are now given by

$$W(\tau_{it}, \tau_{jt}, \theta_t) + E \left[\sum_{s=t+1}^{\infty} \delta^{s-t} W(\tau_{is}, \tau_{js}, \theta_s) \right],$$

where expectation is taken with respect to the future path of θ realizations and tariff choices.

Let G^P now denote the set of *expected* payoff profiles that may arise in SPE of the extended model.

Definition 6. The set of SPE expected payoff profiles G^P is the largest set with the following property: $(g_1, g_2) \in G^P$ if and only if there exist mappings $(\hat{\tau}_1(\theta), \hat{\tau}_2(\theta))$ and $(\hat{g}_1(\theta), \hat{g}_2(\theta))$, where $(\hat{g}_1(\theta), \hat{g}_2(\theta)) \in G^P$ for each θ , such that, for $i=1, 2$:

$$g_i = \int_0^\infty \left[W(\hat{\tau}_i(\theta), \hat{\tau}_j(\theta), \theta) + \delta \hat{g}_i(\theta) \right] f(\theta) d\theta. \quad (21)$$

Moreover, for each θ and for $i=1, 2$, there exists $(g_1^i(\theta), g_2^i(\theta)) \in G^P$ such that

$$W(\hat{\tau}_i(\theta), \hat{\tau}_j(\theta), \theta) + \delta \hat{g}_i(\theta) \geq W(\tau^R(\hat{\tau}_j(\theta), \theta), \hat{\tau}_j(\theta), \theta) + \delta g_1^i(\theta). \quad (22)$$

This definition extends Definition 1 by requiring that the incentive compatibility condition hold for each θ .

6.2. Non-contingent DSI

As before, countries can make use of the DSI by communicating tariff agreements to the DSI when they are in state C . We first consider the case in which the DSI is non-contingent, meaning that it cannot make use of the current period realization of θ in adjudicating a dispute. Thus, for periods in which the countries begin in state C , the timing is as follows. First, the countries negotiate a selection from G^C at the beginning of the period, prior to realization of θ , and communicate the agreed tariff bindings to the DSI. Let τ_1^* and τ_2^* denote the agreed tariff bindings in this case. Second, θ is realized. Finally, the countries observe θ and make their actual tariff choices. As long as the tariff choices satisfy $\hat{\tau}_i \leq \tau_i^*$ for both countries, the state remains C , while $\hat{\tau}_i > \tau_i^*$ for either i triggers state D . For periods beginning in state D , the model works as before: with probability p , the DSI resolves the dispute, and the countries immediately select an agreement from G^C , involving choices of τ_1^* and τ_2^* , as discussed. With probability $1-p$, the dispute remains unresolved, and the countries select their agreement from G^D . To avoid complications, we do not consider direct penalties in the extended model.

The earlier definitions are extended as follows.

Definition 7. Take as given sets of payoff profiles G^C and G^D . For the noise model with non-contingent DSI, the payoff profile (g_1, g_2) is *supportable in state s* , $s=C, D$, if there exist tariffs τ_1^* , τ_2^* , tariff mappings $\hat{\tau}_1(\theta)$, $\hat{\tau}_2(\theta)$, and a payoff profile mapping $(\hat{g}_1(\theta), \hat{g}_2(\theta))$, such that

$$g_1 + g_2 = \int_0^\infty \left[V(\hat{\tau}_1(\theta), \hat{\tau}_2(\theta), \theta) + \delta (\hat{g}_1(\theta) + \hat{g}_2(\theta)) \right] f(\theta) d\theta, \quad (23)$$

and, in addition, there exist mappings $(g_1^i(\theta, \tau_i), g_2^i(\theta, \tau_i))$ for $i=1, 2$ such that, for each θ and each deviation τ_i of Country i , the following holds:

$$W(\hat{\tau}_i(\theta), \hat{\tau}_j(\theta), \theta) + \delta \hat{g}_i(\theta) \geq W(\tau_i, \hat{\tau}_j(\theta), \theta) + \delta g_1^i(\theta, \tau_i), \quad (24)$$

where

for $s=C$: (a) $(\hat{g}_1(\theta), \hat{g}_2(\theta)) \in G^C$ for θ such that $\tau_i(\theta) \leq \tau_i^*$ for both i , and otherwise $(\hat{g}_1(\theta), \hat{g}_2(\theta)) \in G^E$; (b) $(g_1^i(\theta, \tau_i), g_2^i(\theta, \tau_i)) \in G^C$ if $\tau_i \leq \tau_i^*$, and otherwise $(g_1^i(\theta, \tau_i), g_2^i(\theta, \tau_i)) \in G^E$; and

for $s=D$: $(\hat{g}_1(\theta), \hat{g}_2(\theta)) \in G^E$ and $(g_1^i(\theta, \tau_i), g_2^i(\theta, \tau_i)) \in G^E$ for all θ and τ_i , $i=1, 2$.

Let $S^s(G^C, G^D)$ denote the set of payoff profiles that are supportable in state s .

The extended definition of supportable payoff profiles allows for a switch to state D only for equilibrium path choices and deviations that involve increases in tariffs above the agreed bindings τ_1^* and τ_2^* . No dispute is triggered if the countries depart from their agreement by lowering tariffs.

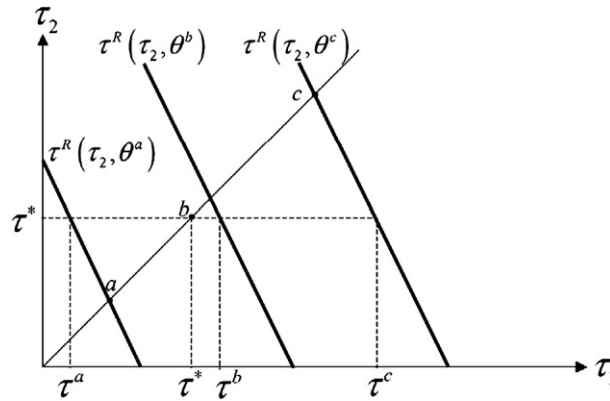


Fig. 4.

Definition 8. For the noise model with non-contingent DSI, G^S constitutes a *state-dependent set of recurrent agreements* if, for $s=C, D$, the following is true for each $(g_1, g_2) \in G^S$:

- I. (g_1, g_2) maximizes $g_1 + g_2$ on $S^s(G^C, G^D)$; and
- II. There exists a mapping $(g'_1(\theta), g'_2(\theta))$ such that

$$g_i = \frac{1}{2} \left(g_1 + g_2 - \int_0^\infty [V^N(\theta) + \delta(g'_1(\theta) + g'_2(\theta))] f(\theta) d\theta \right) + \int_0^\infty [W^N(\theta) + \delta g'_i(\theta)] f(\theta) d\theta, \tag{25}$$

where

- for $s=C$: $(g'_1(\theta), g'_2(\theta)) \in G^C$ for all θ ; and
- for $s=D$: $(g'_1(\theta), g'_2(\theta)) \in G^E$ for all θ .

Observe that disagreement leads to the static Nash equilibrium contingent on θ , followed by a selection from the appropriate set of recurrent agreements in the following period.

Lemma 2 extends to this case, and it remains true that only the static Nash outcome may be supported in state D ; i.e., $\hat{\tau}_1(\theta) = \hat{\tau}_2(\theta) = \tau^N$ for all θ in state D . Let the expected private and joint payoffs be written:

$$\bar{W}^N \equiv \int_0^\infty W^N(\theta) f(\theta) d\theta, \quad \bar{V}^N \equiv \int_0^\infty V^N(\theta) f(\theta) d\theta.$$

Next consider tariff choices in state C . For simplicity, we focus on symmetric agreements, having $\tau_1^* = \tau_2^* = \tau^*$; the results may be straightforwardly extended to the asymmetric case. Determination of equilibrium tariff choices is illustrated in Fig. 4. For low values of θ , such as θ^a in the figure, we have $\tau^a = \tau^R(\tau^*, \theta^a) < \tau^*$, and (24) is violated as a consequence of the desirability of low tariffs. In this case, the static Nash tariff levels are chosen, at point a . A dispute is not triggered, however, since the tariff choices lie below the agreed level τ^* . For larger θ , such as θ^b , we have $\tau^b = \tau^R(\tau^*, \theta^b) > \tau^*$, and thus defections from the agreement involve tariff increases. Since τ^b is close to τ^* , however, (24) holds and the tariff choices adhere to the agreement, at point b . Finally, very large values of θ , such as θ^c , give rise to a large value $\tau^c = \tau^R(\tau^*, \theta^c) > \tau^*$, and (24) is violated at $\tau_i = \tau^c$. In this case, the tariff choices correspond to the static Nash outcome, this time at point c . A dispute is triggered in this last case.

The ranges of θ that support these three outcomes may be characterized as follows. First, the upper bound of the lower range, denoted by $\underline{\theta} \geq 0$, satisfies $\tau^N(\underline{\theta}) = \tau^*$. As for the lower bound of the upper range, denoted by $\bar{\theta}$, we have, using (24) and Lemma 2:

$$\Omega(\tau^*, \tau^*, \bar{\theta}) = \frac{\delta(1-p)}{2} (g^C - g^D), \tag{26}$$

where

$$\Omega(\hat{\tau}_i, \hat{\tau}_j, \theta) \equiv W(\tau^R(\hat{\tau}_j), \hat{\tau}_i, \theta) - W(\hat{\tau}_i, \hat{\tau}_j, \theta).$$

Note that under our assumptions, $\Omega(\tau^*, \tau^*, \theta)$ may be made unboundedly large for sufficiently large θ . Thus, for any τ^*, g^C , and g^D , there will be a nonempty upper range of θ such that $\Omega(\tau^*, \tau^*, \theta)$ exceeds the right hand side of (26). If this is true for every θ (i.e., if equality never holds in (26)), then for convenience we set $\theta = -1$. It follows that the equilibrium tariff choices for given values of τ^*, g^C and g^D satisfy

$$\hat{\tau}_i(\theta) = \begin{cases} \tau^N(\theta), & \theta < \underline{\theta}, \\ \tau^*, & \underline{\theta} \leq \theta \leq \bar{\theta}, \\ \tau^N(\theta), & \theta > \bar{\theta}. \end{cases} \tag{27}$$

Since the outcome is $(\tau^N(\theta), \tau^N(\theta))$ when $s=D$, we have

$$g^D = \bar{V}^N + \delta(pg^C + (1-p)g^D). \tag{28}$$

Combining (26) and (28) gives

$$\Omega(\tau^*, \tau^*, \bar{\theta}) = \frac{\delta(1-p)}{1-\delta(1-p)} \left(\frac{(1-\delta)g^C}{2} - \bar{W}^N \right). \tag{29}$$

Further, making use of (27), the equality (23) for state C may be written

$$g_1 + g_2 = \int_0^{\underline{\theta}} V^N(\theta)f(\theta)d\theta + \int_{\underline{\theta}}^{\bar{\theta}} V(\tau^*, \tau^*, \theta)f(\theta)d\theta + \int_{\bar{\theta}}^{\infty} V^N(\theta)f(\theta)d\theta + \delta[g^C F(\bar{\theta}) + (pg^C + (1-p)g^D)(1-F(\bar{\theta}))], \tag{30}$$

where $F(\theta)$ indicates the cumulative distribution function. Thus, condition I of the definition of a recurrent agreement requires that τ^* be chosen to solve the following problem (using (28)):

$$\psi(g^C) = \max_{\tau^*} \left\{ \int_0^{\underline{\theta}} V^N(\theta)f(\theta)d\theta + \int_{\underline{\theta}}^{\bar{\theta}} V(\tau^*, \tau^*, \theta)f(\theta)d\theta + \int_{\bar{\theta}}^{\infty} V^N(\theta)f(\theta)d\theta + \frac{\delta(1-p)((1-\delta)g^C - \bar{V}^N)}{1-\delta(1-p)} F(\bar{\theta}) \right\}, \text{ subject to Eq. (29) and } \tau^N(\underline{\theta}) = \tau^*. \tag{31}$$

As before, a recurrent agreement must satisfy $g^C = \psi(g^C)$. We summarize with

Proposition 7. G^C and G^D give sets of recurrent agreements of the noise model with non-contingent DSI if and only if the following are true.

- a. For $s=C, D$, G^s consists of a single element $(g^s/2, g^s/2)$.
- b. The value of g^C satisfies $g^C = \psi(g^C)$, the tariff agreement in state C is the solution to problem (31) for this value of g^C , and the realized tariff choices are given by (27).
- c. The value of g^D satisfies (28), and tariff choices in state D are $\hat{\tau}_1(\theta) = \hat{\tau}_2(\theta) = \tau^N(\theta)$.

Observe from (30) that in state C of the recurrent agreement, the countries raise tariffs and trigger a dispute with strictly positive probability. Equivalently, the term $F(\bar{\theta})$ in the objective of problem (31) is strictly positive. Thus, even in environments where countries can renegotiate their agreements every period, trade wars occur periodically if the DSI cannot condition on the noise term when designating whether there is a dispute.

The solution to (31) for given g^C represents a tradeoff between beneficial agreement and costly trade war. The first-order condition for maximization may be written

$$-\int_{\underline{\theta}}^{\bar{\theta}} \frac{d}{d\tau^*} V(\tau^*, \tau^*, \theta) f(\theta) d\theta = \left[V(\tau^*, \tau^*, \bar{\theta}) - V^N(\bar{\theta}) + \frac{\delta(1-p)((1-\delta)g^C + \bar{V}^N)}{1-\delta(1-p)} \right] f(\bar{\theta}) \frac{\partial \bar{\theta}}{\partial \tau^*}. \quad (32)$$

The left side of (32) is the marginal loss of joint value due to raising τ^* that occurs when the countries select a higher tariff agreement (effective for intermediate values of θ where the countries choose tariff τ^*). The right side is the marginal gain in cooperation value occurring because the upper bound $\bar{\theta}$ increases. Under our assumptions, the gain on the right is strictly positive for $\bar{\theta} > 0$ and any τ^* , because trade wars occur with positive probability and raising τ^* implies a higher $\bar{\theta}$. The left side is zero when $\tau^* = 0$, based on the assumption based on the assumption $V_{\tau_i}(0, 0, \theta) = 0$, while the right-hand side remains strictly negative. Thus, with a non-contingent DSI the free trade outcome can never be supported as a recurrent agreement.

This completes the proof of the following proposition.

Proposition 8. *In any recurrent agreement of the noise model with non-contingent DSI, the following is true.*

- a. *When the state is C, the countries violate their tariff agreement and trigger a dispute with strictly positive probability.*
- b. *The agreement $\tau^* = 0$ is never selected.*

Intuitively, when the DSI is non-contingent, countries realize that trade disputes become unavoidable under certain circumstances. Since the marginal loss from a tariff increase is zero at the free trade point, countries find it beneficial to give up some benefits of free trade in order to reduce the probability of trade disputes. The assumption that $V_{\tau_i}(0, 0, \theta) = 0$ is stronger than is needed for Proposition 8b. The result would still hold if $V_{\tau_i}(0, 0, \theta)$ were negative but relatively small compared to the right side of (32) evaluated at $\tau^* = 0$ (in particular, the derivative of $\bar{\theta}$ with respect to τ^*). We have not found a weaker condition that is simple and straightforward to present.

To see how the tariff agreement τ^* relates to the probability that a dispute is triggered, consider the following thought exercise under the assumption that $\Omega(\tau, \tau, \theta)$ is decreasing in τ for $\tau < \tau^N(\theta)$ (where $\tau^R(\tau) > \tau$).³⁴ Suppose that the countries anticipate selecting τ^* optimally (achieving the maximal recurrent agreement) from the start of period 2, but in period 1 the countries happen to agree on a tariff level $\tau' < \tau^*$. Then there is a higher probability of a dispute in period 1 with agreement τ' than there would have been with agreement τ^* .

To see this, note that, since continuation values g^C and g^D from period 2 are not affected by the tariff agreement in period 1, we can consider the right side of (29) to be fixed when calculating the upper cutoff $\bar{\theta}$ for the cases of τ' and τ^* . We assumed earlier that W is supermodular in τ_i and θ , which implies that $\Omega(\tau, \tau, \theta)$ is increasing in θ for all τ such that $\tau < \tau^N(\theta)$. Thus, lowering the first-period tariff agreement from τ^* to τ' causes Ω to increase; restoring Ω to satisfy (29) requires that θ be lowered, which implies a higher probability of initiating a dispute in period 1.

6.3. Fully contingent DSI

We now consider the case of a *fully contingent* DSI, which can freely utilize all information (including θ). In this case, the countries can communicate an entire mapping $(\hat{\tau}_1(\theta), \hat{\tau}_2(\theta))$ to the DSI. It is not necessary to distinguish between upward and downward tariff deviations, and so we specify that the dispute state is triggered if and only if $\tau_i \neq \hat{\tau}_i(\theta)$ for some i when θ is realized. The definition of supportable payoffs is now altered: for $s = C$, we have $(\hat{g}_1(\theta), \hat{g}_2(\theta)) \in G^C$ for every θ , reflecting the fact that the agreement itself may be tailored to the circumstances that arise ex post.

³⁴ This assumption does not require that tariffs be strategic substitutes or that tariffs be strategic complements, although the former is sufficient.

The analysis of this case proceeds in a manner analogous to that of the original model. Restricting attention to symmetric agreements, problem (31) becomes:

$$\psi(g^C) = \int_0^\infty \left(\max_{\hat{\tau}(\theta)} V(\hat{\tau}(\theta), \hat{\tau}(\theta), \theta) + \delta g^C \right) f(\theta) d\theta, \quad (33)$$

subject to $\Omega(\hat{\tau}(\theta), \hat{\tau}(\theta), \theta) \leq \frac{\delta(1-p)}{1-\delta(1-p)} \left(\frac{(1-\delta)g^C}{2} - \bar{W}^N \right)$ for all θ .

It is easy to verify that (33) gives a strictly higher maximized value than does (31) for all g^C such that the solution to (31) satisfies $\psi(g^C) > \bar{V}^N$; i.e., such that the solution improves on the static Nash outcome (note that (27) satisfies the constraints in (33)). Further, tariffs in the fully contingent case will always be adjusted to avoid costly disputes. Thus, we have proven the following:

Proposition 9. *In any recurrent agreement of the noise model with fully contingent DSI, the following is true.*

- In equilibrium, the countries do not violate their tariff agreement in any contingency, so the dispute state is never triggered.*
- The maximal recurrent agreement with a fully contingent DSI gives a strictly higher joint payoff than does the maximal recurrent agreement with a non-contingent DSI.*

Thus, the use of information by the DSI is important for sustaining agreements that avoid costly trade disputes and convey higher value. The adjustment of tariff agreements following realizations of θ constitutes a complete, state-contingent escape clause that heads off disputes. Importantly, such an attractive mechanism is feasible only to the extent that enforcement institutions are able to make use of information to adjudicate finely-tuned escape clauses. This suggests that it may be necessary to overcome rigidities in enforcement institutions before the full benefits of escape clauses can be attained.

We close this section by briefly discussing the relationship between Propositions 8 and 9 and the findings of Bagwell and Staiger (1990), Riezman (1991), Hungerford (1991) and Kovenock and Thursby (1992). All of these papers consider trade agreements negotiated and enforced in the presence of uncertainty about either the trade volume or terms of trade. Bagwell and Staiger (1990) consider a framework that is similar to ours and point out that self-enforced trade agreements will unravel unless countries implement more protectionist policies during periods of trade volume surges to lessen their own incentives to defect. They do not consider ongoing tariff negotiation and, furthermore, they do not consider how the information about the realizations of the stochastic trade volume can be utilized by the parties (either those involved in the dispute or third parties external to the dispute) in achieving and maintaining the cooperative trade policies. The latter issue is the focus of Riezman (1991), who considers sustainability of international trade cooperation when there is uncertainty over the volume of imports and when a protectionist policy variable chosen by a country can be either observable or non-observable to its trade partner. Riezman (1991) shows that free trade is unsustainable in the long run in both cases and periodic trade wars occur. Also related are the results of Hungerford (1991), who considers the possibility that parties involved in the dispute can undertake costly investigation to learn whether terms of trade have deteriorated because of the stochastic shock or unobserved protection. Kovenock and Thursby (1992) consider that a third party provides this information. The key distinction between Propositions 8 and 9 and the results of these papers is that our analysis characterizes the role of the third party's information about the stochastic trade volume or terms of trade when countries constantly renegotiate their trade agreement.

7. Conclusion

We have developed a theory of recurrent trade agreements that explains why external enforcement institutions, such as the GATT/WTO legal system, are essential for sustaining cooperative agreements. The key idea is that ongoing negotiations between countries undermine the credibility of repeated game punishments. External legal systems, utilizing mechanisms such as delays and direct penalties, can ensure credibility, since countries cannot manipulate for their mutual benefit the parameters of dispute resolution processes. When enforcement institutions cannot condition their rulings on all events that affect the countries' welfare and incentives, the model generates periodic trade disputes

that capture important properties of actual disputes. The feasibility of beneficial arrangements to avoid disputes, such as escape clauses and safeguards, is shown to hinge on whether enforcement institutions can make effective use of information.

Our model can be viewed as a first step toward a more complete analysis of trade institutions and policy. In future work, it would be useful to consider the DSP in greater detail. The use of information in dispute resolution, and moral hazard on the part of countries, could be modeled explicitly as part of a multistage DSP, incorporating discovery, settlement and compliance stages. Feedbacks between the structure of the DSP, tariff agreements, and the nature of disputes can be explicitly considered within our framework.

The structure of escape clauses could also be analyzed more fully. It may be worthwhile to consider settings intermediate to the non-contingent DSI and fully contingent DSI cases. The degree to which the DSI conditions rulings on relevant events would influence the nature of escape clauses available to the countries. We conjecture that the DSI's ability to take into consideration more dispute-relevant details when making rulings would offer countries a richer constellation of escape clauses and would increase the value of trade agreements.

In addition to conditioning directly on relevant economic variables, the DSI could also respond to messages that the countries send about their circumstances. For example, the countries could send messages to the DSI such as “The shock is high today, so we will select tariff τ' rather than the lower tariff τ^* to which we previously agreed; consider us in breach only if we select a tariff other than τ' .” The DSI would not directly observe the shock, but would condition the state designation as directed by the countries' messages. Calculating the maximal recurrent agreement in this setting requires a mechanism-design analysis (there are incentive conditions regarding what countries want to individually say) that is potentially quite interesting but we should not conjecture about. Another possibility is that the countries have time to negotiate and make joint declarations after observing the shock in each period. This setting appears technically equivalent to the “fully contingent DSI” case analyzed in the paper.

With regard to the bargaining component of our model, note that our model takes a relatively extreme view on the disagreement point and bargaining weights, when compared to the literature on renegotiation-proofness. We established our model in this way for two reasons. First, we believe that, generally, insights will be garnered from a more careful account of the negotiation process than has been typical in the literature, and we wish to encourage further research along these lines. Second, we have aimed for a model that simply and starkly demonstrates the usefulness of an institution that helps enforce agreements by managing the designation of dispute. To make the point most clearly, we have made assumptions (on bargaining power and the like) under which cooperation cannot be sustained without external enforcement. We do not believe, however, that in reality countries would fail to sustain any measure of cooperation on their own.

There are three ways in which our model could be generalized to represent how countries may attain limited amounts of cooperation on their own. First, in the event of disagreement in the current period, the countries might condition their selection of a stage-game Nash equilibrium on whether they are in a dispute and on which country triggered it. Selection among multiple equilibria in the stage game (in particular Pareto-unranked ones) would allow some positive punishment. Second, in disagreement in the current period, it may be that the countries coordinate in a way that makes the agreement in the next period conditioned on current-period tariff choices. Third, the countries' bargaining weights could somehow shift intrinsically as a function of history. While one might debate the extent to which these extensions are realistic, they will help to increase the degree to which the countries can sustain cooperation on their own. Still, the DSI's presence provides additional benefit.

Finally, our concept of recurrent agreement, which makes the bargaining aspects of renegotiation explicit, could be applied to obtain a more coherent understanding of the problem of renegotiation in general games. In particular, we think that it is important to examine, in various real settings, (i) the extent to which parties credibly make distinctions between histories at the time of negotiation and (ii) the extent to which visible institutions help to create these distinctions. Our intent here has been to articulate why the distinctions matter and to suggest that they are characterized by an institution that is external to a given bilateral relationship. It is an open empirical question as to the degree of bargaining power that parties exercise in various ongoing relationships and the role that institutions play in distinguishing between histories to facilitate cooperation. As a possible motivating question, one could ask whether, in any particular setting, parties can partially replicate on their own what we associate with an external institution. Case studies and experimental work may be revealing in this regard. While some experimental work shows that subjects respond to the history of play, experimentalists have generally not studied settings with active and recurrent negotiation. Doing so would be instructive.

Appendix

Proof of Lemma 2. Note that, from Condition I of Definition 5, $(g'_1, g'_2) \in G^C$ implies $g'_1 + g'_2 = g^C$. From Condition II for the case of $s=C$, we can rewrite (4) as:

$$g_i - \frac{g^C}{2} = \delta \left(g'_i - \frac{g^C}{2} \right). \tag{34}$$

Proceeding just as in the proof of Lemma 1, we obtain $g_i = g^C/2$ for all $(g_1, g_2) \in G^C$. As for the case of $s=D$, (4) can be rewritten as

$$g_i - \frac{g^D}{2} = \delta \left[p \left(g'_i - \frac{g^C}{2} \right) + (1-p) \left(g''_i - \frac{g^D}{2} \right) \right] = \delta(1-p) \left(g''_i - \frac{g^D}{2} \right). \tag{35}$$

Here we have used the fact that $(g'_1, g'_2) \in G^D$ implies $g_1 + g_2 = g^D$. The method employed above can then be applied again, yielding $g_i = g^D/2$ for all $(g_1, g_2) \in G^D$. □

Proof of Proposition 3. For any $g^C \geq V^N/(1-\delta)$, the values $\hat{\tau}_i = \hat{\tau}_j = \tau^N$ satisfy (11) for $i=1, 2$. Thus, $\psi(g^C) \geq V^N/(1-\delta)$ for any $g^C \geq V^N/(1-\delta)$. Further, $\psi(g^C) \leq V(0, 0)/(1-\delta)$ for any g^C . It follows that $g^C = \psi(g^C)$ for at least one g^C , and also there is a largest g^C such that this is true. The constraint (15) is implied by the fact that the constraint (11) is relaxed as $V(\hat{\tau}_i, \hat{\tau}_j)$ rises. □

Proof of Proposition 4. The result follows directly from (13): higher p strictly lowers the right-hand side of (11), and the right-hand side is zero for $p=1$. □

Proof of Lemma 3. Part a follows exactly as in Lemma 2. As for part b, note that (4) and the definition of G_i^E imply

$$g_i - \frac{g^D}{2} = \delta \left[p \left(g'_i - m - \frac{g^C}{2} \right) + (1-p) \left(g''_i - \frac{g^D}{2} \right) \right] = \delta(1-p) \left(g''_i - \frac{g^D}{2} \right) - \delta pm, \tag{36}$$

where $(g'_1, g'_2) \in G^C$, $(g''_1, g''_2) \in G^D$ and $g'_1 = g^C/2$ is invoked. Suppose first that

$$g_i < \frac{g^D}{2} - \frac{\delta pm}{1 - \delta(1-p)}. \tag{37}$$

Then using (36) we have that $g''_i < g_i$. Let $g_i^1 = g''_i$. Continuing inductively, we obtain a sequence $(g_i^k, g_i^k) \in G^D$, $k=1, 2, \dots$, with $g_i^{k+1} < g_i^k$ and

$$g_i^k - \frac{g^D}{2} = \delta(1-p) \left(g_i^{k+1} - \frac{g^D}{2} \right) - \delta pm. \tag{38}$$

Further, $g_i^k \geq 0$. But then it is necessary that the sequence have a limit point, in which case (38) is inconsistent with (37) and $g_i^k < g_i$. Assume next that

$$g_i > \frac{g^D}{2} - \frac{\delta pm}{1 - \delta(1-p)}.$$

In this case, we may construct a sequence $(g_i^k, g_i^k) \in G^D$, $k=1, 2, \dots$, with $g_i^{k+1} > g_i^k > g_i$. Further, $g_i^k \leq V(0, 0)/(1-\delta)$. As above, existence of a limit point then yields a contradiction. This demonstrates that (16) must hold, and (17) then follows from (16) and $g_1 + g_2 = g^D$. □

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