Abstract

We develop a model of trade agreements with renegotiation and imperfectly verifiable information. In equilibrium, trade disputes can occur and can be resolved in a variety of ways: governments may settle “early” or trigger a court ruling, and in the latter case, they may implement the ruling or reach a post-ruling settlement. The model yields predictions on how the dispute outcome depends on the contracting environment and how it correlates with the optimal contract form. We find initial support for our model’s predictions in light of data on the outcomes of actual trade disputes in the GATT/WTO.
1. Introduction

Unlike the sporadic trade wars of past eras (see Coneybeare, 1987), international trade disputes are now a regular feature of the world trading system. Their resolution poses important questions for economists. Consider the recent World Trade Organization (WTO) dispute between the United States and the EU over launch-aid subsidies that the EU provides to Airbus. On September 24 2012, the New York Times reported that “[t]he EU says it has obeyed WTO rulings by eliminating the harmful effect of government loans to Airbus, but Washington disagrees and is threatening up to $10 billion in sanctions.” This may sound like the outbreak of a non-cooperative U.S.-EU trade war, but it is not: the trade sanctions that Washington is threatening are WTO-authorized sanctions by which the United States would achieve compensation for the harmful trade effects of EU subsidies. Hence the Times report describes the current status of a legal process of dispute resolution within the WTO. And there is clearly much at stake in the resolution of this dispute: Will the EU remove the trade effects of its subsidies, or will the two governments negotiate a settlement, or will the United States follow through on its threat to impose WTO-authorized tariffs on $10 billion of imports from the EU?

In fact, while trade disputes have erupted with increasing frequency in recent decades, especially within the WTO and its predecessor, the General Agreement on Tariffs and Trade (GATT), even to the casual observer it is apparent that there is wide variation in the outcomes of these disputes. Often governments reach an “early settlement” without triggering a ruling by the court/dispute settlement body (DSB), but there are also significant numbers of cases where the governments “fight it out” and the dispute goes all the way to a DSB ruling; and in these latter cases, sometimes the DSB ruling is implemented, while at other times governments “renegotiate the ruling” and reach a post-ruling settlement. This variation in dispute outcomes has been well documented empirically (see for example Busch and Reinhardt, 2000, 2006).

In the economics literature on trade agreements, however, there is a surprising paucity of models that can explain the occurrence of trade disputes, let alone the diversity in dispute outcomes that we observe in reality. In this paper we develop a simple model of trade agreements that generates a rich set of possibilities for the outcomes of trade disputes as an equilibrium.

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1Over the history of the GATT (1948-1994), there were on average approximately 5 initiated trade disputes per year (see for example Hudec, 1993), while since the 1995 creation of the WTO there have been on average approximately 25 trade disputes initiated each year (see Horn et al, 2011). Of course, there are many reasons for this increase, including the rise in membership in the GATT/WTO over the period.
phenomenon – including outcomes in which governments settle early, or settle after the DSB has issued a ruling, or implement the ruling – and yields predictions on how the dispute outcome depends on the contracting environment and how it correlates with the optimal contract form. We also offer an initial assessment of our model’s predictions in light of data on the outcomes of actual trade disputes in the GATT/WTO.

In our model, governments contract over trade policy in the presence of ex-ante uncertainty about the joint benefits of trade protection (which can be positive or negative). Ex post governments observe the joint benefits of protection, but these benefits are only imperfectly verifiable by the court/DSB: if invoked, the DSB conducts an investigation and observes a noisy signal of the joint benefits of protection, and it issues a ruling based on this imperfect information. Thus, at the time when governments can invoke the DSB, they are uncertain about the DSB ruling. Against this backdrop, governments can negotiate at two ex-post stages: after uncertainty about the joint benefits of protection is resolved but before any DSB ruling (bargaining “in the shadow of the law”), and after a DSB ruling is reached (bargaining “after the court has spoken”). A final and important feature of our model is that these ex-post negotiations are subject to a key transaction cost, namely that government-to-government compensation entails a deadweight loss; this assumption seems warranted because, as the Airbus example above suggests, the typical means by which a government achieves compensation in the context of a trade dispute is by imposing trade sanctions.²

These three features of our model – the inefficiency of government-to-government transfers, the possibility that governments negotiate an early settlement under uncertainty about the DSB ruling, and the possibility of a later settlement in which the DSB ruling is renegotiated – are key to the model’s predictions. Allowing governments to be uncertain about the DSB ruling is important because it allows for the possibility that the governments may not settle early; the reason is that, with costly transfers, the uncertainty in the DSB ruling can help governments share the expected surplus. As a consequence, our model generates a variety of predictions regarding when governments settle early or a dispute arises in equilibrium, and how the disputes

²This type of transaction cost is surely not the only one present in trade disputes. For example, private information and other bargaining frictions are probably very relevant as well. Indeed, there is a vast law and economics literature that analyzes domestic contracting problems in the presence of the latter type of transaction cost. We focus on costly transfers as the key transaction cost because this is a distinctive feature of international contracting settings, and sets it apart from domestic contracting settings, where cash transfers are typically available. An interesting question that we do not address here is why cash transfers are almost never used in the context of trade agreements and disputes. For models that highlight possible shortcomings with the use of cash transfers, see Harstad (2007) and Bagwell and Staiger (2010, especially note 10).
are resolved. And allowing for the possibility of later settlement generates predictions about the circumstances under which a DSB ruling is not implemented in equilibrium.

We consider a class of menu contracts that specify a baseline commitment to free trade but may allow the importing country to “breach” this commitment by compensating the exporting country with a certain amount of damages, where the level of damages can be contingent on the DSB signal. This class of contracts is simple but flexible enough to allow for a variety of interesting contractual forms, including a “property rule” with or without “escape” and a “liability rule” with or without escape. In the former case the commitment to free trade is treated like a property right which can only change hands by mutual consent, while in the latter case the importer can buy out of this commitment by paying the contractually specified damages. Legal scholars (e.g., Jackson, 1997, Pauwelyn, 2008) emphasize variation across issue areas and over time in the use of these rules in the GATT/WTO. A novel and key feature of our approach is that we jointly determine the optimal contract and the trade dispute outcome, and as a result, we generate testable predictions on how trade dispute outcomes should differ depending on whether the dispute concerns a property or rather a liability rule.

We focus on the degree of ex-ante uncertainty and the accuracy of the DSB information as the key determinants of the optimal contract and possible dispute outcomes. If ex-ante uncertainty is small or if the DSB can gather precise information, we show that the optimal contract is a property rule, possibly with escape; and when such a contract is optimal and if a dispute over the contract arises, we show that neither early nor post-ruling settlement is possible. That is, according to our model, disputes over optimally chosen property rules will proceed all the way to a DSB ruling, and the ruling will be implemented. By contrast, if ex-ante uncertainty is large and the DSB information is imprecise, we show that the optimal contract is a liability rule (again possibly with escape), and if there is a dispute over such a rule, then any of the dispute outcomes are possible: governments may settle early or proceed to a DSB ruling, and in the latter case they may implement the ruling or negotiate a post-ruling settlement. An implication of these results is that early and post-ruling settlement rates should be lower for disputes over property rules than for disputes over liability rules; and if the optimal contract evolves from a liability to a property rule, we should observe a drop both in the probability of early settlement and in the probability of post-ruling settlement.\(^3\)

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\(^3\)The case of a shift from liability to property rules is particularly relevant because, as we later discuss, a number of legal scholars have argued that there has been such a shift in moving from GATT to the WTO.
To understand intuitively the forces at work, consider first the case of large uncertainty and a highly inaccurate DSB. In this case, where large DSB errors are possible, a liability rule is optimal. It might be thought that this is so because governments will then not be held rigidly to free trade in the event of a large DSB error, where the DSB rules against protection when in fact protection is highly efficient. But in the event of such a ruling, governments would not be held to free trade even under a property rule, because they would renegotiate the ruling and agree on protection in exchange for (costly) compensation/trade sanctions. Hence, achieving the “right” policy in the presence of large DSB errors is not the appeal of a liability rule. Rather, as we demonstrate, the liability rule is optimal when large DSB errors are possible because in such an environment a liability rule can keep to a minimum the magnitude of trade sanctions that governments will impose on one another in the context of dispute settlement.

Next consider the case of small uncertainty and/or high DSB accuracy. In this case large DSB errors are not possible, and a property rule is optimal. The reason is that, as we demonstrate, in such an environment a property rule avoids the equilibrium use of trade sanctions while permitting policy mistakes with only minor efficiency consequences, whereas a liability rule involves the use of trade sanctions whenever protection is implemented. And disputes over optimal property rules never result in settlement, because the efficiency consequences of correcting the possible DSB errors with a settlement can never be high enough to justify the costly trade sanctions that would have to accompany the settlement.

We also show that for intermediate degrees of ex-ante uncertainty and DSB accuracy, a safeguards-type contract which combines property and liability aspects and which is reminiscent of the WTO rules on escape clause actions may be optimal. And we demonstrate that the optimal level of damages is weakly increasing in the harm caused by trade protection to the exporter, and weakly decreasing in (the DSB’s estimate of) the benefit garnered by the importer. An interesting aspect of this result is that, contrary to the logic of “efficient breach,” according to which the level of damages should simply compensate the affected party for the harm done, we find that the optimal level of damages should be responsive also to the (estimated) benefit for the party breaching the obligation.

Finally, motivated by the fact that in practice contracts such as the GATT/WTO contract can be changed only infrequently, we consider the impact of changes in DSB accuracy on settlement behavior for a fixed (liability rule) contract. We refer to this as the “short run” impact, to distinguish it from the “long run” impact that takes into account the effect of the
change on the optimal contract. As we argue further below, in reality it seems likely that the accuracy of DSB rulings has increased over time, both because of judicial learning and because of the introduction with the inception of the WTO of a formal appeals process. In the short run, we find that an increase in DSB accuracy tends to make early settlement more likely. Intuitively, when DSB rulings are more accurate, governments are less uncertain about the direction of the DSB ruling, and thus have a higher propensity to settle. But the short-run impact of an increase in DSB accuracy on the likelihood of post-ruling settlement can go in either direction. When we consider the long run impact of an increase in DSB accuracy, our earlier results immediately imply that, if this leads to a switch from a liability (or mixed) rule to a property rule, then it will lead to a drop in the rates of early and post-ruling settlement.

When viewed together, our results on the impacts of changes in DSB accuracy suggest an additional interesting prediction. If one believes that the accuracy of DSB rulings has increased over time, and that there has been a shift from liability to property rules in moving from GATT to the WTO, as many legal scholars have argued, we should observe a non-monotonic path of the early-settlement rate: within the GATT period this rate should trend upwards, but it should then drop considerably after the inception of the WTO. On the other hand, the model predicts no particular pattern for the rate of post-ruling settlement within the GATT years, but again it predicts a drop in this rate after the inception of the WTO.

In this paper we cannot offer a definitive investigation of our model’s empirical content, but we can offer an initial assessment of our model’s predictions in light of data on the outcomes of actual trade disputes in the GATT/WTO. To accomplish this, we focus on two key predictions of our model. First, comparing across rules, the rate of early and post-ruling settlement should be lower in disputes over property rules than in disputes over liability (or mixed) rules; and if there is an evolution in certain issue areas from liability (or mixed) rules to property rules, then we should observe a drop in the probability of early and post-ruling settlement in these issue areas. And second, assuming that the accuracy of the DSB increases through time, then holding the contract fixed, the probability of early settlement should rise. Our empirical findings broadly support these predictions. In particular, looking both across rules and within rules that evolved over time, we find evidence of a significantly lower settlement rate for disputes over property rules than for disputes over liability rules. And looking across the GATT and WTO eras, we find evidence of a non-monotonicity in settlement rates that our model can explain as reflecting the impacts of increasing DSB accuracy in the short run coupled with the evolution.
of contracts from liability to property rules over the long run.

For the questions we consider here, the relevant economics literature on trade agreements is somewhat sparse. A close paper is Maggi and Staiger (2012), but in that paper we assume that the DSB can obtain no information on the state of the world, and as a consequence the model featured in that paper does not predict disputes in equilibrium. There are models of trade agreements that imply disputes in equilibrium and have an explicit role for the DSB, including Beshkar (2010, 2011), Maggi and Staiger (2011), Staiger and Sykes (2013) and Park (forthcoming). But none of these models is capable of predicting the rich dispute outcome possibilities that we describe above.⁴

By contrast, the law-and-economics literature has long had models of settlement (see for example Bebchuck, 1984 and Reinganum and Wilde, 1986). And there is a vast law-and-economics literature on property/liability rules and specific-performance/damages (see Calabresi and Melamed 1972, Schwartz, 1979, Shavell, 1984, Ulen, 1984 and Kaplow and Shavell, 1996, to name just a few). But as argued in Maggi and Staiger (2011, 2012), those literatures assume the existence of cash transfers between disputants and so are not directly applicable to the trade agreements setting where, as we have already observed, such transfers are rarely available to help settle disputes.

Finally, there exists a sizable literature on contract design with renegotiation, two prominent examples being Segal and Whinston (2002) and Watson (2007). Relative to this class of models, we allow the court to conduct a noisy investigation ex post, which in turn implies that the parties may go to court in equilibrium; we allow the court ruling itself to be renegotiated; and we assume costly government-to-government transfers, whereas the typical models of contracting with renegotiation assume transferable utility. At the same time, however, we impose some restrictions to make the model tractable. First, we focus on a binary policy; this is a price paid for tractability, although as we later observe this assumption captures many trade-related policies that are discrete in practice. And second, we focus on a class of menu contracts, which as we noted includes the contractual forms most relevant for the GATT/WTO; but this is not the most general class of feasible mechanisms.⁵

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⁴A related paper in the international law literature is Guzman and Simmons (2002), who focus on the issue of settlement versus ruling in the context of trade agreements. We discuss this paper at various points below.

⁵In particular we do not consider mechanisms based on messages sent by the disputing players, but it is an open question whether or not such mechanisms can improve upon menu contracts in our setting. In a related though different setting, Segal and Whinston (2002) show that a (continuous) mechanism based on two-sided messages may or may not improve upon a menu contract, depending on the specifics of the contracting
The rest of the paper proceeds as follows. Section 2 lays out the basic model. Section 3 characterizes the optimal contract. Section 4 focuses on the outcome of disputes. Section 5 confronts several key predictions of the model with evidence from GATT/WTO disputes. Section 6 concludes. An Appendix contains proofs not included in the body of the paper.

2. The Model

We begin by describing the economic environment, which is similar to Maggi and Staiger (2012). We consider a single industry in which the Home country is the importer and the Foreign country is the exporter. The Home government chooses a binary level of trade policy intervention for the industry, which we denote by \( T \in \{ FT, P \} \): “Free Trade” or “Protection.” Many trade disputes in the GATT/WTO focus on non-tariff policy choices that are discrete in practice, such as regulatory regimes or product standards, and our assumption of a binary policy instrument is a simple way to capture this property. In the Conclusion, we discuss how our results can be extended to include the case of continuous policies.\(^6\) Finally, we assume that the Foreign government is passive in this industry.

When the Home government makes its trade policy choice, a transfer may also be exchanged between the governments, but we assume that such transfers are costly to orchestrate, i.e., they entail a deadweight loss. With this assumption we attempt to capture an important feature of real-world trade disputes: their resolution rarely involves cash transfers.\(^7\) Yet in the GATT/WTO countries do sometimes achieve compensation indirectly through the “self-help” method of tariff-retaliation in other sectors, and disputes that are settled by a “mutually agreed solution” may involve a variety of indirect and imperfect compensation mechanisms. To capture this feature of trade disputes in a simple way, we let \( b \) denote a (positive or negative) transfer from Home to Foreign, and we let \( c(b) \) denote the deadweight loss associated with the transfer level \( b \). For tractability we impose a linear cost of transfers: \( c(b) = c \cdot |b| \). The role of this assumption will become clear below. We assume as well that the marginal cost of transfers is problem. In any case, as we argue elsewhere (Maggi and Staiger, 2012), in practice trade policies are applied on a continuing basis, so it would be very costly to run message games with high frequency in response to potentially changing states of the world.

\(^6\)In their empirical study of WTO disputes, Guzman and Simmons (2002) draw a similar distinction between issues such as health and safety standards that have an “all or nothing” character and policies that are continuous and more “flexible” in nature such as tariffs. We discuss their empirical findings further in the Conclusion.

\(^7\)For example, with two exceptions (the US-Copyright case – see WTO, 2007, pp. 283-286 – and the Brazil-Cotton case – see Schnepf, 2010), the resolution of GATT/WTO disputes has never involved cash transfers.
less than one, or \( c \in (0,1) \), and that the Home country always bears the deadweight loss \( c(b) \). These two assumptions assure that Home’s total cost of the transfer inclusive of deadweight loss, \( b + c(b) \), is increasing for all \( b \).\(^8\)

With the policies and transfer costs defined, we represent the Home government’s payoff by \( \omega = v(T) - b - c(b) \), where \( v(T) \) is the Home government’s valuation of the policy \( T \), which can be interpreted as corresponding to a weighted sum of producer surplus, consumer surplus and revenue, with the weights possibly reflecting political economy concerns (along the lines of e.g., Baldwin, 1987, and Grossman and Helpman, 1994). As noted, the Foreign government is passive in this industry, and so its payoff is simply \( \omega^* = v^*(T) + b \), where \( v^*(T) \) is the Foreign government’s valuation of foreign surplus associated with policy \( T \). The joint payoff of the two governments is given by \( \Omega \equiv v(T) + v^*(T) - c(b) \).

Home is assumed always to gain from protection, with the gain interpreted as arising from some combination of terms-of-trade and political considerations. We denote this gain as \( \gamma \equiv v(P) - v(FT) \geq 0 \). Foreign is assumed to always lose from protection, and we denote this loss as \( \gamma^* \equiv v^*(FT) - v^*(P) \geq 0 \). The joint (positive or negative) gain from protection is then \( \Gamma \equiv \gamma - \gamma^* \). In this setting, the joint-surplus maximizing outcome – which we will refer to simply as the “first best” – is easily described: if \( \Gamma > 0 \) (or \( \gamma > \gamma^* \)), the first best is \( T = P \) and \( b = 0 \), and if \( \Gamma < 0 \) (or \( \gamma < \gamma^* \)), the first best is \( T = FT \) and \( b = 0 \). Notice that \( b \) is always zero under the first best, because transfers are costly to execute.

Governments are ex-ante uncertain about the joint gains from protection \( \Gamma \), but they observe \( \Gamma \) ex post. If \( \Gamma \) were perfectly verifiable (i.e., observed ex post by the court/DSB), of course the governments could write a complete contingent contract. Actual trade agreements, however, seem very far from the complete-contract ideal, and so we are interested instead in an imperfect-contracting scenario, where such a complete contingent contract cannot be written.\(^9\) For simplicity, we assume that \( \gamma^* \) is known ex-ante, so that all the uncertainty in \( \Gamma \) originates from \( \gamma \), which as we describe further below is only imperfectly verifiable.\(^{10}\) The

\(^{8}\)If the deadweight loss were instead borne by the Foreign country, none of our qualitative results would change, provided \( b - c(b) \) is increasing for all \( b \). But this is assured by our assumption on \( c \).

\(^{9}\)In addition to Maggi and Staiger (2012) on which we build here, other papers that also model trade agreements as incomplete contracts include Copeland (1990), Bagwell and Staiger (2001), Horn (2006), Costinot (2008), Horn, Maggi and Staiger (2010) and Maggi and Staiger (2011).

\(^{10}\)Whether uncertainty over \( \gamma \) reflects underlying uncertainty about \( v(FT) \) or \( v(P) \) or both is immaterial for our results, but for simplicity (and without loss of generality) we normalize \( v(FT) \) to be the same across states of the world. We note that our informational assumptions – that uncertainty is one-dimensional and that the uncertain parameter is observed by both parties but not verifiable by the court – are relatively standard.
ex-ante distribution of $\gamma$ is common knowledge and has density $h(\gamma)$, defined over $\gamma \in [0, \infty)$. We let $\underline{\gamma}$ and $\overline{\gamma}$ denote the bounds of the support of $\gamma$: that is, $\underline{\gamma} = \inf\{\gamma : h(\gamma) > 0\}$ and $\overline{\gamma} = \sup\{\gamma : h(\gamma) > 0\}$. To make the problem interesting, we assume $\underline{\gamma} < \gamma^* < \overline{\gamma}$, so that the first best is $P$ in some states (when $\gamma > \gamma^*$, and hence $\Gamma > 0$) and $FT$ in some states (when $\gamma < \gamma^*$, and hence $\Gamma < 0$).

We will focus on a simple class of menu contracts that allow the Home government to choose between (i) setting $FT$ and (ii) setting $P$ and compensating the Foreign government with a contractually specified payment $b^C$ (“damages”). In Maggi and Staiger (2012) we assume that the DSB can obtain no information on $\gamma$, and that the contract specifies a fixed amount of damages. Here we depart from that setup and allow $\gamma$ to be imperfectly verifiable, in the sense that the DSB can observe a noisy signal of $\gamma$, denoted $\gamma^{dsb}$, which we interpret as the outcome of an independent investigation. And given that $\gamma$ is imperfectly verifiable, it is natural to allow the level of damages to be contingent on the DSB’s signal $\gamma^{dsb}$. In particular, we suppose that the contract specifies a contingent compensation schedule $b^C(\gamma^{dsb})$, and that the DSB is instructed, if invoked, to draw its signal and announce the compensation level according to $b^C(\gamma^{dsb})$ evaluated at the realized signal.\textsuperscript{11} We will refer to this announced level of damages as the DSB’s ruling, and we assume that it will be enforced in the event of an ultimate breakdown in ex-post negotiations. The assumption of enforceable contracts is a strong assumption in the context of international trade agreements, but it seems like the natural starting point for examining the questions we are interested in here.\textsuperscript{12}

Notice that the DSB is committed to ruling according to the schedule $b^C(\gamma^{dsb})$. With this commitment assumption we exclude scenarios where the DSB is itself an active player who can deviate from $b^C(\gamma^{dsb})$ ex post. Modeling the DSB as an active player would be an interesting extension, but note that if governments can commit the DSB to act in the way we have assumed here, then it is optimal for them to do so. Given this commitment assumption, there is no loss assumptions in the literature on mechanism design with renegotiation (see for example Segal and Whinston, 2002), though our modeling of imperfect verifiability is more novel.\textsuperscript{11} We will use the same notation for the random variable $\gamma^{dsb}$ and for its realization, as this should not cause ambiguity.\textsuperscript{12}

As a simplification for characterizing the optimal legal rules, this assumption also finds some support from legal scholars, who readily acknowledge the limitations on enforcement of international agreements but emphasize that issues of enforcement are logically distinct from the choice between property and liability rules (see Jackson, 1997, p. 63, and see also Pauwelyn, 2008, pp. 148-197, for an especially detailed discussion of this point). Such a logical distinction does not of course imply that there is no interaction between enforcement issues and legal rules, a point to which we return in the Conclusion.
of generality in conditioning $b^C$ only on $\gamma^{dsb}$.\footnote{This follows because in our model the only other information that the DSB observes when it is called upon to issue a ruling is that governments have failed to reach a settlement. And while governments could design a schedule which instructed the DSB to make inferences from the governments’ failure to reach settlement, given that the contract is relevant only as a disagreement point there is nothing to be gained from such a schedule relative to the simpler schedule $b^C(\gamma^{dsb})$. To see this, consider the schedule $b^C(\gamma^{dsb}, d)$, where $d = 1$ if governments have disagreed in the prior negotiation. Because the contract is relevant only as a disagreement point, the governments will only consider $b^C(\gamma^{dsb}; 1)$ when they bargain; hence governments can achieve the same outcome with the schedule $b^C(\gamma^{dsb}) = b^C(\gamma^{dsb}; 1)$.} Finally, to rule out uninteresting cases, we assume that the optimal contract is non-empty.\footnote{This is guaranteed, for example, if in expectation free trade is sufficiently jointly preferable relative to protection, as then the empty contract is dominated by a noncontingent $FT$ contract.}

We impose a minimum of structure on the DSB signal technology, by requiring that the joint density of $\gamma$ and $\gamma^{dsb}$ is log-supermodular. This condition is relatively standard and is satisfied by several common distributions (see Athey, 2002, especially footnote 15).

We consider the following timing: (0) Governments write the contract $b^C(\gamma^{dsb})$; (1) $\gamma$ is realized and observed by the governments; (2) Governments bargain a’ la Nash over the policy $T$ and the transfer $b$; (3) If bargaining fails, the DSB observes its signal $\gamma^{dsb}$ and issues its ruling $b^C(\gamma^{dsb})$; (4) If the stage of DSB ruling is reached, governments Nash bargain over the policy and the transfer, with a disagreement point given by the DSB ruling.

We will refer to stage 0 as the “ex ante” stage, to the stage-2 Nash bargain as “pre-ruling negotiation” and to the stage-4 Nash bargain as “post-ruling negotiation.”\footnote{Note that the disagreement point of the post-ruling negotiation, which is given by the DSB ruling $b^C(\gamma^{dsb})$, is itself an option, as the importer can choose between $(T = FT, b = 0)$ and $(T = P, b = b^C(\gamma^{dsb}))$.} We assume that the governments have symmetric bargaining power. We look for the contract $b^C(\gamma^{dsb})$ that maximizes the ex-ante joint payoff of the governments $E[\Omega]$.\footnote{Our emphasis on the maximization of the governments’ ex ante joint surplus seems reasonable, based on two considerations. First, it seems plausible that at the ex ante stage, when the institution is created, governments can orchestrate more effective compensation mechanisms than in the ex post context of a trade dispute, because in an ex-ante setting such as a GATT/WTO negotiating round many issues are on the table at once (see, for example, the discussion in Hoekman and Kostecki, 1995, Ch. 3). And second, if we considered a symmetric two-sector version of our model, then at the ex-ante bargaining stage (given symmetric bargaining powers) governments would select the symmetric point of the Pareto frontier, which maximizes the sum of their payoffs.}

Notice the importance of costly transfers. If efficient transfers were available, governments could achieve the first best by simply waiting to negotiate until after the resolution of uncertainty, and there would be no role for contracting ex ante. But when transfers are costly, the first best cannot be achieved in general, and it may be beneficial to write a contract ex ante.\footnote{For example, this possibility becomes particularly transparent in the extreme case where transfers are prohibitively costly, so that in the absence of an ex ante contract the outcome would be $P$ (and no transfer) for all realizations of $\gamma$. In this case, it is clear that even a non-contingent $FT$ contract – generating the outcome
Finally notice that, after the ex-ante contract has been signed, governments are allowed to negotiate at two stages. A first opportunity occurs in stage 2, where after observing the realization of γ governments can bargain “in the shadow of the law.” At this stage the threat point for negotiations is based on a forecast of the ruling that the DSB would issue in stage 3 should stage-2 negotiations break down. The second opportunity occurs in stage 4, when governments can negotiate “after the court has spoken.” Here the DSB has issued its ruling, and the governments may negotiate their own resolution of the dispute against the threat point given by the implementation of the DSB ruling. After characterizing the optimal contract in the next section, we will return to consider the model’s predictions about the pattern of disputes and settlement when the optimal contract is in place.

3. The Optimal Contract

We now characterize the optimal contract. We first provide a general characterization, and then consider how the optimal contract form depends on features of the contracting environment.

In principle we must solve for the subgame-perfect equilibrium of the game for any given contract $b^C(\gamma_{dsb})$, and then derive the contract that maximizes the ex-ante (subgame-perfect-equilibrium) joint payoff. However a complicating factor in solving this problem is that, in the stage-2 negotiation, governments face uncertainty over the signal that the DSB will observe if negotiations fail, and this makes the analysis quite involved. This is where the linear-cost-of-transfers assumption provides tractability: under this assumption, as we establish below, the problem of finding the $b^C(\gamma_{dsb})$ schedule that maximizes the ex-ante joint payoff $E[\Omega]$ is equivalent to a simpler problem, namely, finding the level of $b^C$ that maximizes the expected joint payoff as viewed from the perspective of the DSB in stage 3, where the signal $\gamma_{dsb}$ has been observed but the true $\gamma$ is unknown. With a nonlinear cost of transfers, this equivalence would not hold, and the problem would then be more complex.

We let $\hat{\Omega}(b^C, \gamma)$ denote the equilibrium joint payoff in the stage-4 subgame given DSB-determined damages level $b^C$ and realized $\gamma$. From the perspective of the DSB at stage 3, the expected joint payoff is $E[\hat{\Omega}(b^C, \gamma)|\gamma_{dsb}] = \int \hat{\Omega}(b^C, \gamma)dH(\gamma|\gamma_{dsb})$, where $H(\gamma|\gamma_{dsb})$ is the c.d.f. of $\gamma$ conditional on $\gamma_{dsb}$. We now state the following:\footnote{\abbrev{(and no transfer) for all realizations of $\gamma$ – would strictly improve upon no contract provided that $E[\gamma] < \gamma^\ast$.}}\footnote{We provide a proof of Lemma 1 in the Appendix, but the proof relies on some elements of the analysis of stage-2 bargaining that are not presented until section 4.3, so the reader may wish to wait until section 4.3 before reading the proof of this Lemma.}
Lemma 1. With \( c(b) = c \cdot |b| \), the optimal contract \( b^C(\gamma^{dsb}) \) solves \( \max_{b^C} E[\hat{\Omega}(b^C, \gamma)|\gamma^{dsb}] \).

This result is a consequence of the fact that, as we later explain, the linear cost of transfers ensures that for each \( \gamma \) the stage-2 bargaining frontier is never strictly concave over the relevant range, and so in the stage-2 bargain governments obtain exactly their expected disagreement payoffs. Therefore, the problem boils down to choosing the \( b^C(\gamma^{dsb}) \) schedule that maximizes the expected joint disagreement payoff \( E[\hat{\Omega}(b^C, \gamma)|\gamma^{dsb}] \).

We now characterize the optimal \( b^C(\gamma^{dsb}) \) schedule. Lemma 1 allows us to focus on the game as viewed from stage 3, where the DSB signal \( \gamma^{dsb} \) has been observed. In effect, we need to optimize \( b^C \) in light of the DSB beliefs on \( \gamma \) conditional on \( \gamma^{dsb} \), which are given by \( h(\gamma|\gamma^{dsb}) \).

The first step is to consider whether or not a given level of damages \( b^C \) will be renegotiated at stage 4 given the realization of \( \gamma \). Recall that the threat point in the stage-4 negotiation is defined by the DSB ruling \( b^C \), so if the negotiation fails, Home may choose between \((T = FT, b = 0)\) and \((T = P, b = b^C)\). Letting \( S(b) \equiv b + c \cdot |b| \) denote the total cost of the transfer \( b \) inclusive of deadweight loss, it is clear that for \( \gamma < S(b^C) \) Home would choose \((T = FT, b = 0)\), while for \( \gamma > S(b^C) \) it would choose \((T = P, b = b^C)\). The line \( \gamma = S(b^C) \), where Home is indifferent between the two options, is depicted in Figure 1.\(^{19}\)

Consider first the case \( \gamma < S(b^C) \). Here the threat point is \((T = FT, b = 0)\), and governments renegotiate to the policy \( P \) if and only if there exists a transfer \( b^e \) such that both governments gain by switching to \((T = P, b = b^e)\), which requires \( \gamma > S(b^e) \) (for the importer) and \( b^e > \gamma^* \) (for the exporter). Clearly, this is the case if and only if \( \gamma > S(\gamma^*) \). Thus governments renegotiate toward policy \( P \) when \( S(\gamma^*) < \gamma < S(b^C) \); the corresponding region is identified in Figure 1 by the label \( P_R \).

Note that \( b^e < b^C \) in this region, because \( S(b^e) < \gamma < S(b^C) \) and \( S(\cdot) \) is increasing.

We now make an important observation: it can never be strictly optimal to have \( b^C > \gamma^* \), because as Figure 1 makes clear, setting \( b^C > \gamma^* \) induces the same policy outcome as setting \( b^C = \gamma^* \) (namely \( FT \) for \( \gamma < S(\gamma^*) \) and \( P \) for \( \gamma > S(\gamma^*) \)), but \( b^C = \gamma^* \) implies a weakly lower expected transfer.\(^{20}\) Hence, in equilibrium governments never renegotiate towards \( P \) (in stage

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\(^{19}\)Figure 1 focuses on non-negative values of \( b^C \). It is easy to show and intuitively clear that \( b^C < 0 \) can never be optimal for any \( \gamma^{dsb} \).

\(^{20}\)This second claim can be seen as follows. Start with any \( b^C = b^C > \gamma^* \). If this is replaced with \( b^C = \gamma^* \), the expected equilibrium transfer falls (weakly), because: (1) if \( \gamma > S(b^C) \), the importer would have chosen \((T = P, b = b^C)\) without renegotiating and now chooses \((T = P, b = \gamma^*)\), so the transfer obviously decreases, and (2) if \( \gamma \in (S(\gamma^*), S(b^C)) \), the contract would have been renegotiated under \( b = b^C \) but will not be renegotiated under \( b = \gamma^* \), and as we established in the text the equilibrium transfer \( b^e \) is higher than \( \gamma^* \). Note also that we only claim that \( b^C > \gamma^* \) is “weakly” dominated by \( b^C = \gamma^* \), because if the support of \( \gamma \) around \( \gamma^* \) is sufficiently
4): the only kind of renegotiation that can occur in equilibrium is from \( P \) to \( FT \).

Consider next the case \( \gamma > S(b^C) \). Here the threat point is \((T = P, b = b^C)\), and governments renegotiate toward policy \( FT \) if and only if there exists a (negative) transfer \( b^e \) such that both governments gain by switching to \((T = FT, b = b^e)\), which requires \( S(b^C) - S(b^e) > \gamma \) (for the importer) and \( \gamma^* > b^C - b^e \) (for the exporter). Clearly, such a transfer exists if and only if \( \gamma < S(b^C) - S(b^C - \gamma^*) \equiv R(b^C) \). Hence, governments renegotiate toward policy \( FT \) when \( S(b^C) < \gamma < R(b^C) \). The corresponding region is identified in Figure 1 by the label \( FT_R \). Note that \( R(b^C) \) is a line with slope \( 2c \) satisfying \( R(0) = (1 - c) \cdot \gamma^* \) and \( R(\gamma^*) = S(\gamma^*) \).

Having characterized the range of \( \gamma \) for which a given level of damages \( b^C \) is renegotiated at stage 4, we are now ready to characterize the optimal contract \( b^C(\gamma^{dsb}) \), which by Lemma 1 maximizes \( E[\tilde{\Omega}(b^C, \gamma)|\gamma^{dsb}] \). To state our first result, we let \((\gamma^{dsb}, \tilde{\gamma}^{dsb})\) denote the support of \( \gamma^{dsb} \) and \((\gamma(\gamma^{dsb}), \tilde{\gamma}(\gamma^{dsb}))\) the support of \( \gamma \) conditional on \( \gamma^{dsb} \). Further, we say that \( b^C \) is prohibitive given the signal \( \gamma^{dsb} \) if it is such that Home would choose \( T = FT \) for all \( \gamma \) in its conditional support \((\gamma(\gamma^{dsb}), \tilde{\gamma}(\gamma^{dsb}))\), and let \( b^{prohib}(\gamma^{dsb}) \) denote the minimum such level of \( b^C \).

One complication in this setting is that the objective \( E[\tilde{\Omega}(b^C, \gamma)|\gamma^{dsb}] \) is not guaranteed to be globally concave in \( b^C \). To make the analysis tractable we assume that the objective admits at most one interior maximum, which (it can be shown) is guaranteed provided that \( h(\gamma|\gamma^{dsb}) \) does not increase too quickly with \( \gamma \). In the Appendix we prove:

**Proposition 1.** (i) There exist critical levels \((\gamma^{dsb}_1, \gamma^{dsb}_2)\), with \( \gamma^{dsb}_1 \leq \gamma^{dsb} \leq \gamma^{dsb}_2 \leq \tilde{\gamma}^{dsb} \), such that the optimal \( b^C \) is prohibitive for \( \gamma^{dsb} \in (\gamma^{dsb}_1, \gamma^{dsb}_2) \), decreasing for \( \gamma^{dsb} \in (\gamma^{dsb}_1, \gamma^{dsb}_2) \) and zero for \( \gamma^{dsb} \in (\gamma^{dsb}_1, \gamma^{dsb}_2) \). (ii) The optimal \( b^C \) is (weakly) increasing in \( \gamma^* \).

Proposition 1 establishes that the optimal level of damages \( b^C \) is (weakly) decreasing in \( \gamma^{dsb} \) and (weakly) increasing in \( \gamma^* \). An interesting aspect of this result is that, contrary to the standard logic of efficient breach whereby damages should reflect only the level of harm caused by breach \( \gamma^* \), here the optimal damages may depend not only on \( \gamma^* \) but also on the (signal of the) benefit that breach provides to the importer \( \gamma^{dsb} \). Intuitively, since it is not optimal in general to set damages at the level \( \gamma^* \) that fully compensates the exporter in our costly-transfer setting, making the damages sensitive to the estimated benefit that the importer gains from breach helps to ensure that breach will occur only when it is likely to be efficient.

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\footnote{small, the expected equilibrium transfer is the same in the two cases, as all states \( \gamma > S(\gamma^*) \) have zero density. But in this case, even if \( b^C > \gamma^* \) it still follows that renegotiation from \( FT \) to \( P \) cannot occur with positive probability, which then permits the sentence that follows in the text.}
As a consequence of the result that the optimal $b^C$ is weakly decreasing in $\gamma^{dsb}$, Proposition 1 provides a taxonomy of the possible optimal contracts, with six distinct kinds of contracts becoming optimal depending on the positions of $\gamma_1^{dsb}$ and $\gamma_2^{dsb}$ within the support of $\gamma^{dsb}$. In the next section we will consider conditions under which various contracts within this taxonomy are optimal. But it is useful here to interpret the set of contracts described by Proposition 1, and to emphasize a number that are of particular interest.

A first possibility is that $\gamma_1^{dsb} < \gamma_2^{dsb} = \gamma_3^{dsb} < \gamma_4^{dsb}$, so that only the first and third intervals described in Proposition 1 are nonempty. This possibility is illustrated in the top left panel of Figure 2, and it can be interpreted as a contract that establishes a strict FT obligation – a property rule in the law-and-economics terminology – but waives this obligation under some contingencies. Here, escape is allowed for the high range of DSB signals $\gamma^{dsb} \in (\gamma_2^{dsb}, \gamma_3^{dsb})$, because then $b^C(\gamma^{dsb}) = 0$ and hence no compensation for $P$ is required. And for all lower DSB signals (i.e., for $\gamma^{dsb} \in (\gamma_3^{dsb}, \gamma_1^{dsb})$), escape is not allowed and the compensation implied by $b^C(\gamma^{dsb})$ is set at a prohibitively high level (which for simplicity we depict in this and all panels of Figure 2 by the level labeled “$b^{prohib}$”).

We will refer to this first contract as a contingent property rule, or a “property rule with escape,” to distinguish it from a noncontingent property rule that is also described in Proposition 1. The noncontingent property rule corresponds to the case where $\gamma_1^{dsb} < \gamma_2^{dsb} = \gamma_3^{dsb}$. It is depicted in the bottom left panel of Figure 2, and describes a contract that requires specific performance (FT) without exception.21

The two contracts we have emphasized thus far represent property rules (with or without escape), but Proposition 1 also describes a contract that allows breach of the FT commitment in exchange for nonprohibitive damages – a liability rule in the law-and-economics terminology. In particular, when $\gamma_1^{dsb} < \gamma_2^{dsb} < \gamma_3^{dsb}$, the contract is a liability rule, and when $\gamma_1^{dsb} = \gamma_2^{dsb} < \gamma_3^{dsb} = \gamma_4^{dsb}$, the contract is a liability rule with escape. Here the compensation implied by $b^C(\gamma^{dsb})$ is below the prohibitive level for all $\gamma^{dsb}$ – meaning that for any $\gamma^{dsb}$ there will be some realization of $\gamma$ in the support $[\gamma_2(\gamma^{dsb}), \gamma(\gamma^{dsb})]$ such that Home prefers

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21 We are ignoring the case in which $\gamma_1^{dsb} = \gamma_2^{dsb} = \gamma_3^{dsb} < \gamma_4^{dsb}$, because this is equivalent to the empty contract, and we assumed at the outset that the empty contract is suboptimal. Also, in Maggi and Staiger (2012) we use the property-rule terminology to refer both to a contract that allocates the right of free trade to the exporter (a “prohibitive property rule”) and a contract that allocates the right of protection to the importer (a “discretionary property rule”), whereas here we refer to the former as simply a “property rule” and we de-emphasize the latter when it is noncontingent (the empty contract) and refer to it as an “escape” when it occurs in a contingent fashion.
\(T = P, b = b^C(\gamma^{dsb})\) to \((T = FT, b = 0)\) – and when the liability rule includes an escape (as depicted in the bottom right panel of Figure 2) we have \(b^C(\gamma^{dsb}) = 0\) for high values of \(\gamma^{dsb}\).

A final interesting possibility is the case where \(\underline{\gamma}^{dsb} < \gamma^{dsb}_1 < \gamma^{dsb}_2 = \bar{\gamma}^{dsb}\). This contract, depicted in the top right panel of Figure 2, is a mixture of a property rule and a liability rule with escape, and we will sometimes refer to it as a mixed rule.\(^{22}\) It requires strict adherence to the \(FT\) commitment for low values of \(\gamma^{dsb}\), while for high values of \(\gamma^{dsb}\) escape without damage payments is allowed; and for intermediate values of \(\gamma^{dsb}\), breach is permitted in exchange for (nonprohibitive) damages. We will have more to say about the presence of these various contract forms in GATT/WTO in the next section, but we note here that aspects reminiscent of this last contract can be seen in the WTO rules on “escape clause” actions, which permit governments to suspend their negotiated tariff commitments under certain conditions. At a broad level, these rules establish a baseline commitment to \(FT\), but under some conditions the importer can compensate the exporter and protect, while under more stringent conditions the importer can protect without paying compensation, much like the contract we have just described.\(^{23}\)

Having interpreted the set of optimal contracts identified by Proposition 1, we next highlight conditions under which specific contract forms are optimal.

It is convenient to begin with the case in which ex-post uncertainty about \(\gamma\) is small, meaning that the DSB has little uncertainty about \(\gamma\) given its observed signal \(\gamma^{dsb}\). We use the support of \(\gamma\) conditional on \(\gamma^{dsb}\) as a crude but simple measure of ex-post uncertainty, so we say that ex-post uncertainty about \(\gamma\) is small if the support of \(\gamma|\gamma^{dsb}\) is small for all \(\gamma^{dsb}\).\(^{24}\)

There are two distinct ways that ex-post uncertainty about \(\gamma\) can be small. First, there can be small noise in the signal \(\gamma^{dsb}\), even if ex-ante uncertainty is large. And second, since the support of \(\gamma|\gamma^{dsb}\) can be no larger than the unconditional support of \(\gamma\), the latter support can be small, meaning that there is small ex-ante uncertainty about \(\gamma\). Our next result applies under

\(^{22}\)The remaining possibility described by Proposition 1 is the case where \(\underline{\gamma}^{dsb} < \gamma^{dsb}_1 < \gamma^{dsb}_2 = \bar{\gamma}^{dsb}\). This is another “mixed” rule that combines a prohibitive property rule with a liability rule without escape.

\(^{23}\)At a more specific level, under the WTO escape clause the compensation owed to the exporter rises with the trade effects implied by the escape clause action, broadly in line with the contract we have just described under the assumption that the harm suffered by the exporter (\(\gamma^{*}\)) is increasing in these trade effects. At the same time, compensation need not be paid at all (for the first three years of an escape clause action) if the injury suffered by the domestic importer can be traced to a rise in the absolute level of imports as opposed to the less-stringent criterion of rising import penetration, broadly in line with this contract under the assumption that the efficient response to domestic injury is more likely to involve trade protection (\(\gamma\) is high) when the more-stringent (absolute rise in imports) injury criterion is met.

\(^{24}\)In the Conclusion we discuss how our results would change if we modeled changes in uncertainty as mean-preserving changes in the density of \(\gamma|\gamma^{dsb}\) along a given support.
either possibility. In what follows we will refer to ex-post uncertainty simply as “uncertainty.”

We find that when uncertainty is small, the optimal $b^C(\gamma^{dsb})$ schedule is a (possibly contingent) property rule, that is $\gamma_1^{dsb} = \gamma_2^{dsb}$. Figure 1 provides intuition. Note first that, if the support of $\gamma|\gamma^{dsb}$ does not include $\gamma^*$, clearly the optimal $b^C$ is prohibitive (zero) if the support lies below (above) $\gamma^*$. Next suppose the support of $\gamma|\gamma^{dsb}$ includes $\gamma^*$. If this support is sufficiently small, then when $b^C$ is prohibitive or zero there is no renegotiation for any $\gamma$, and hence no transfers in equilibrium. Setting $b^C$ at a positive but non-prohibitive level may achieve a state-contingent policy, but the associated benefit is small because the support of $\gamma$ around $\gamma^*$ is small. On the other hand, the cost of achieving this state-contingency is not small, because it requires a non-negligible level of transfer payments in equilibrium.\footnote{Here we make the argument more precise. Recall that, given $b^C$, the policy outcome is $FT$ for $\gamma < R(b^C)$ and $P$ for $\gamma > R(b^C)$. Thus, when the support of $\gamma|\gamma^{dsb}$ is small around $\gamma^*$, if we want to induce a state-contingent policy outcome the transfer $b^C$ needs to be close to $R^{-1}(\gamma^*) = \frac{\gamma^*}{2}$. Clearly, this transfer level does not become negligible as the support shrinks. Note that for $\gamma > R(b^C)$ the equilibrium transfer will be exactly $b^C$, while for $\gamma < R(b^C)$ the contract will be renegotiated, and the equilibrium transfer will be $b^e = \frac{2(b^C - \frac{\gamma^*}{2}) + c(\gamma - \gamma^*)}{2(1-c)} - \frac{\gamma^*}{2}$. This renegotiated transfer $b^e$ may be smaller in magnitude than $\frac{\gamma^*}{2}$, but is unrelated to the size of the support of $\gamma$ and hence does not become small as the support shrinks.}

We can thus state:

**Proposition 2.** If the support of $\gamma|\gamma^{dsb}$ is sufficiently small for all $\gamma^{dsb}$, then a property rule (with or without escape) is optimal: $\gamma_1^{dsb} = \gamma_2^{dsb}$. Furthermore, the optimal $b^C$ is prohibitive (given $\gamma^{dsb}$) if $E[\Gamma|\gamma^{dsb}] \leq 0$ and zero otherwise.

As Proposition 2 indicates, when uncertainty is small, the optimal $b^C(\gamma^{dsb})$ schedule is a property rule, possibly with escape, and its features can be described very simply: a contract that establishes a strict $FT$ obligation, but which may be waived if the DSB estimates the joint benefit from protection to be high. This contract form is reminiscent of the WTO approach to a variety of baseline contractual obligations – such as the national treatment obligation and the prohibitions on quantitative restrictions and export subsidies – which have been interpreted by legal scholars (e.g. Pauwelyn, 2008) as property rules, but which can be waived under the general exceptions for health, welfare and national security reasons contained in GATT Articles XX and XXI. According to our model the role of the DSB in this context would be to rule on whether or not an exception to the baseline obligation can be applied.\footnote{Notice also that it is possible that the optimal contract as described by Proposition 2 is in fact a noncontingent property rule, that is a prohibitive $b^C$ for all $\gamma^{dsb}$; this will be the case if $E[\Gamma|\gamma^{dsb}] \leq 0$ for all $\gamma^{dsb}$. Here the DSB is not given the role of determining when the $FT$ commitment should be upheld and when an exception should be granted. Denying the DSB this role can be optimal if ex-ante uncertainty is small but the DSB signal is sufficiently uninformative.}
We next focus on an environment where uncertainty is large. Specifically, we consider the case in which the distribution of $\gamma^\text{dsb}$ has full support for all $\gamma^\text{dsb}$: that is, we now assume that $h(\gamma|\gamma^\text{dsb}) > 0$ for all $\gamma$ and $\gamma^\text{dsb}$. In this case, it is clear from Figure 1 that $b^\text{prohib}(\gamma^\text{dsb}) > \gamma^*$. But since we already argued that $b^C > \gamma^*$ can never be strictly optimal, it can never be strictly optimal to set $b^C(\gamma^\text{dsb}) > b^\text{prohib}(\gamma^\text{dsb})$ for any $\gamma^\text{dsb}$. This immediately implies:

**Proposition 3.** If $\gamma|\gamma^\text{dsb}$ has full support for all $\gamma^\text{dsb}$, then the optimum is a liability rule (with or without escape): $\gamma^\text{dsb} = \gamma^\text{dsb}_1 < \gamma^\text{dsb}_2$.

Proposition 3 states that, when uncertainty is large, the optimal $b^C(\gamma^\text{dsb})$ schedule is a liability rule. Accordingly, for every DSB signal realization $\gamma^\text{dsb}$ there is a range of high $\gamma$ such that the Home government prefers to set $T = P$ and pay $b^C(\gamma^\text{dsb})$ rather than setting $T = FT$. And if the liability rule includes an escape (i.e., if $\gamma^\text{dsb}_2 < \gamma^\text{dsb}_1$), then for sufficiently high values of $\gamma^\text{dsb}$ the Home government can set $T = P$ without paying any compensation at all.

Together Propositions 2 and 3 extend to a setting of imperfect verifiability the insights of Maggi and Staiger (2012, Proposition 2) concerning the impact of uncertainty on the optimal contract form. To bring into sharp relief the way in which the optimal contract depends on the degree of uncertainty, we have considered two rather extreme cases, one where uncertainty is small for all $\gamma^\text{dsb}$, and one where uncertainty is large for all $\gamma^\text{dsb}$. And as Proposition 1 suggests, with less extreme assumptions on the degree of uncertainty, the optimal rule could be a mixture of the rules described in Propositions 2 and 3. Nevertheless, taken together, these findings suggest two broad implications. The first concerns the evolution of the optimal contract over time. In particular, Propositions 2 and 3 suggest that, if the accuracy of DSB rulings increases, the optimal contract should move away from liability rules and toward property rules. In this light, one may ask whether or not there has been an evolution from GATT to the WTO in the direction away from liability rules and toward property rules. Here there are some differences of opinion, but the majority of legal scholars answer this question in the affirmative.\(^{27}\) Our model suggests plausible circumstances (increasing DSB accuracy) under which such an evolution

\(^{27}\)Jackson (1997, pp. 62-63) expresses the view that, while the early GATT years were ambiguous on this point, “...by the last two decades of the GATT’s history..., the GATT contracting parties were treating the results of an adopted panel report as legally binding...” and that the WTO “...clearly establishes a preference for an obligation to perform the recommendation...” (emphasis in the original). In support of Jackson’s view, see also Charnovitz (2003), Pauwelyn (2008) and Pelc (2009). For a dissenting view, see Hippler Bello (1996) and especially Schwartz and Sykes (2002).
would be optimal.\textsuperscript{28} The second implication concerns the variation of optimal rules across issues: Propositions 2 and 3 suggest that the use of property rules should be more frequent (other things equal) in issue areas where the accuracy of the information that the DSB can gather ex post is higher, while liability rules should be more common in issue areas where the DSB is not likely to be well informed.

4. Disputes

We now examine the implications of our model for the resolution of disputes. For this purpose, we impose some additional structure to keep our results sharp. Specifically, we now assume that the DSB signal is given by $\gamma^{dsb} = \gamma + \varepsilon$, where $\varepsilon$ is distributed independently of $\gamma$ according to the density $f(\varepsilon)$ with $E[\varepsilon] = 0$, and $f(\varepsilon)$ is symmetric around zero.\textsuperscript{29} For future reference, we let $[-\bar{\varepsilon}, +\bar{\varepsilon}]$ denote the support of $\varepsilon$. Moreover, to limit the taxonomy of cases and focus the analysis on the main points, we assume that the DSB signal is not too inaccurate, in the sense that $\bar{\varepsilon}$ is not too large.\textsuperscript{30}

4.1. Interpreting Model Outcomes

A first step is to map model outcomes to the occurrence of disputes and their resolution.

We begin by discussing the notion of “dispute” in our setting. In particular, we need to identify those stage-2 outcomes for which we will say that a dispute has arisen. A first case is easy: whenever the DSB is invoked and issues its ruling in stage 3, we will say that a dispute has arisen. The more difficult case occurs when the governments reach agreement in stage 2. For example, suppose governments agree in stage-2 that the importer government will set $T = FT$ and that no transfer will be exchanged: Should this be called a dispute with early settlement, or is it more appropriate to think of this as no dispute at all? Our formal model provides no guidance on this interpretive issue, and so we must reach for guidance outside the model. Here we appeal to the fact that in reality the import policy is under the unilateral control of the importing government, while compensation generally takes the form of tariff retaliation by the

\textsuperscript{28}Here it is interesting to note that Pelc (2009), who maintains that the GATT/WTO escape clause has shifted away from a liability-rule and towards a property-rule approach, attributes this shift to an improved ability of the DSB to verify that a legitimate circumstance for escape has arisen, broadly in line with our discussion here.

\textsuperscript{29}A small technical point is that, with the support of $\varepsilon$ fixed and independent of $\gamma$, the realization of the signal $\gamma^{dsb}$ can be negative (for $\gamma$ small enough). This in itself does not cause particular problems, except that now the schedule $b^C(\gamma^{dsb})$ must be defined also for negative values of $\gamma^{dsb}$.

\textsuperscript{30}More specifically, it is sufficient for our purposes that $\bar{\varepsilon}$ is not too much larger than $c\gamma^*$.
exporting government and is typically a matter for negotiation between the two governments.\textsuperscript{31} And so an ad-hoc but reasonable approach to this interpretive issue is the following: if at stage 2 governments reach an agreement that involves a non-zero transfer \( b \neq 0 \), we call this a dispute with early settlement, and if at stage 2 governments reach an agreement that involves no transfer, we say that there is no dispute.\textsuperscript{32}

Having defined the no-dispute outcome, we next interpret each of the remaining three possible model outcomes. A first possibility is that governments agree on a policy \( T \) and a non-zero transfer \( b \) before any DSB ruling. We will refer to this outcome as one of early settlement. A second possibility is that the DSB issues a ruling and the ruling is implemented. This occurs when governments fail to reach agreement in stage 2, the DSB issues a ruling \( b^C(\gamma^{dsb}) \) and the Home government behaves according to the ruling, that is it chooses one of the two options \((T = FT, b = 0)\) and \((T = P, b = b^C(\gamma^{dsb}))\). When a dispute is resolved in this way, we will simply say that the DSB ruling is implemented. A final possibility is that the DSB issues a ruling, but the ruling is not implemented and instead the governments reach a post-ruling settlement in stage 4. We will refer to this outcome as one of post-ruling settlement.

These model dispute outcomes suggest two key questions around which we organize our subsequent analysis: (I) When do disputes arise, and when is there early settlement?; and (II) When is there post-ruling settlement? We begin by considering the second question, and then return to the first question.

\textbf{4.2. When is there Post-Ruling Settlement?}

We first condition on cases in which a DSB ruling has been reached, and ask: When is the DSB ruling implemented and when do governments instead resolve the dispute with their own post-ruling (stage 4) settlement agreement?

Here we can use Figure 1 to make a number of points. First, if the ruling entails prohibitive

\textsuperscript{31}In fact, the GATT/WTO requires that governments consult whenever a possible retaliation is involved.

\textsuperscript{32}A more formal way to justify these interpretations is to consider a slightly richer game that captures some of the more realistic features described above, as follows. Consider replacing stage 1 with an augmented stage 1 in which, after \( \gamma \) is realized, Home selects \( T \in \{P, FT\} \) and then Foreign chooses whether or not to “request consultation.” If Foreign does not request consultation in this augmented stage 1, then the game ends after stage 1 with Home’s selected policy and no compensation. If instead Foreign requests consultation, then the game proceeds to stage 2 as before. Also assume that if Foreign is indifferent, it does not request consultation. In this augmented game, it is natural to say that there is a “dispute” if and only if governments proceed to stage 2. It is straightforward to show that this augmented game ends after stage 1 if and only if the outcome of the original game is a stage-2 agreement described by either \((T = FT, b = 0)\) or \((T = P, b = 0)\); hence this augmented game provides a simple way to capture our more informal discussion in the text.
damages \((b^C(\gamma^{dab}) \geq \bar{b}_{\text{prohib}}(\gamma^{dab}))\), the ruling will be implemented. In terms of Figure 1, this is simply the statement that it can never be optimal to induce renegotiations in the region \(P_R\); and this is the only region in which a ruling \(b^C(\gamma^{dab}) \geq \bar{b}_{\text{prohib}}(\gamma^{dab})\) would be renegotiated.

Second, if the ruling entails a positive but non-prohibitive level of damages \((0 < b^C(\gamma^{dab}) < \bar{b}_{\text{prohib}}(\gamma^{dab}))\), a settlement is reached in stage 4 for an intermediate range of \(\gamma\). This follows immediately from the observation that an optimal contract must entail \(b^C(\gamma^{dab}) \leq \gamma^*\) for all \(\gamma^{dab}\), and from inspection of Figure 1. Notice, too, that it is possible for a ruling to be renegotiated even if the DSB “gets it right,” i.e. \(\gamma^{dab} = \gamma\): hence according to our model, it does not follow that a DSB ruling that is not implemented is necessarily a “bad” ruling.

Finally, consider the case \(b^C(\gamma^{dsp}) = 0\). In this case it is clear from Figure 1 that the ruling will be implemented if \(\gamma(\gamma^{dsp}) > R(0)\). On the other hand, if \(\gamma(\gamma^{dsp}) < R(0)\), the ruling would be renegotiated for \(\gamma \in [\gamma(\gamma^{dsp}), R(0)]\); but this is where the extra structure we have imposed comes in: with our assumption that the DSB signal is not too inaccurate \((\bar{\varepsilon} \text{ not too high})\), it can be shown that \(b^C(\gamma^{dsp}) = 0\) cannot be optimal when \(\gamma(\gamma^{dsp}) < R(0)\). \(^{33}\) We may then conclude that if the ruling is \(b^C(\gamma^{dsp}) = 0\), it will be implemented. \(^{34}\) We summarize this discussion with:

**Proposition 4.** In equilibrium, if the DSB ruling is reached, then: (i) if \(b^C(\gamma^{dsp}) = 0\) or \(b^C(\gamma^{dab}) \geq \bar{b}_{\text{prohib}}(\gamma^{dab})\), the ruling will be implemented; (ii) if \(0 < b^C(\gamma^{dab}) < \bar{b}_{\text{prohib}}(\gamma^{dab})\), the ruling will be renegotiated for an intermediate range of \(\gamma\).

Proposition 4 implies that post-ruling settlement should not occur in equilibrium if a property rule (with or without escape) is optimal, whereas post-ruling settlement can occur if a liability (or mixed) rule is optimal. The broad intuition for why post-ruling settlement cannot occur if the optimum is a property rule is the following. Focusing on the case where the DSB rules for a strict FT policy, that is for a prohibitive level of \(b^C\) (a similar intuition applies if the ruling

\(^{33}\) More specifically, it can be shown that the upper bound we imposed on \(\bar{\varepsilon}\) implies that \(b^C(\gamma^{dab}) = 0\) is dominated by \(b^C = \gamma^*\) when \(\gamma(\gamma^{dsp}) < R(0)\). Intuitively, as long as the DSB signal is not too inaccurate, the signal received in any state where \(\gamma < R(0)\) could never be consistent with a high enough Home value of protection to warrant permitting protection for free (i.e., \(b^C = 0\)).

\(^{34}\) Beyond keeping our results sharp, the extra structure we impose here can also be justified for a different reason: that \(b^C(\gamma^{dsp}) = 0\) could be optimal when \(\gamma(\gamma^{dsp}) < R(0)\) is in fact an artifact of our linear transfer cost assumption. In Maggi and Staiger (2012), where we do not allow the DSB to observe a noisy signal of \(\gamma\), we are able to relax the linear-cost assumption and assume instead that \(c(b)\) is U-shaped with \(c'(0) = 0\), as might more naturally capture the deadweight loss associated with inefficient methods of compensation such as tariff retaliation. There we show that \(b^C = 0\) is never optimal when \(\gamma < R(0)\), and instead the optimal contract has \(b^C > 0\). Hence the added structure we impose here can be seen as down-playing an artifact of our linear-cost-of-transfers assumption and allowing us to focus on the main points of our analysis.
is \( b^C = 0 \), notice that governments will renegotiate the ruling and agree on a policy of \( P \) – with the importer paying compensation – only if the ruling is sufficiently “wrong” that it is worth incurring the transfer cost to correct the DSB mistake, which in turn can happen only if the realization of \( \gamma \) is much higher than what the DSB estimated based on its signal. But by Proposition 2, such a large DSB error is not possible if a property rule is to be optimal.

This result suggests a pair of empirical predictions: comparing across GATT/WTO rules, the rate of post-ruling settlement should be lower in disputes over property rules than in disputes over liability (or mixed) rules; and if, as legal scholars argue, there has been an evolution in certain GATT/WTO issue areas toward property rules, then the probability of post-ruling settlement for disputes in these issue areas should drop. And a further implication of Proposition 4 is that, in the case of disputes over liability (or mixed) rules, post-ruling settlement should tend to occur in intermediate states of the world, that is when the efficiency (joint surplus) stakes of the dispute are not large.\(^\text{35}\)

We conclude this section by discussing how the accuracy of DSB rulings affects the probability of post-ruling settlement. Formally we consider a mean-preserving compression of the distribution of \( \varepsilon \) (which may or may not entail a reduction of the support of \( \varepsilon \)).

A first observation follows immediately from the results of Propositions 2 and 4. If increasing the accuracy of DSB rulings leads to a switch in the contract from a liability (or mixed) rule to a property rule, then there will be a drop in the probability of post-ruling settlement. A second observation is more surprising. If the contract is of the liability (or mixed) type and it does not switch to a property contract, then an increase in DSB accuracy may increase the probability of post-ruling settlement, a possibility that is related to our earlier observation that the DSB ruling may be renegotiated even if \( \gamma_{dsb} = \gamma \), so that the DSB ruling “gets it right.”

To confirm that an increase in DSB accuracy may increase the probability of post-ruling settlement if it does not cause a switch to a property rule, we consider a related thought experiment, by examining the impact of increasing DSB accuracy for a fixed contract. This thought experiment is sufficient to make the point, but it is also of independent interest, as it has an interesting interpretation. In particular, suppose that the contracting environment evolves over time but the contract is re-optimized only infrequently (in the “long run”), as is

\(^{35}\)Note, though, that this is not a statement about the size of the stakes for either the importer (\( \gamma \)) or the exporter (\( \gamma^* \)), which according to Proposition 4 could both be large in a liability-rule dispute that ends with a post-ruling settlement. It is only a statement about the size of the joint stakes \( |\gamma - \gamma^*| \), which according to Proposition 4 should lie in an intermediate range when a post-ruling settlement occurs.
arguably the case in the GATT/WTO, where in practice the contract can be changed only in the context of a negotiation round. Then this thought experiment amounts to asking how the probability of post-ruling settlement responds to a change in DSB accuracy in the period between two negotiation rounds, when the contract is fixed. In this sense, we can interpret the answer as illuminating the “short run” implications of rising DSB accuracy.\(^{36}\)

To see intuitively how it is possible that an increase in DSB accuracy can increase the probability of post-ruling settlement, suppose \(b^C(\gamma_{dB})\) is strictly decreasing, and consider again Figure 1.\(^{37}\) To fix ideas, focus on a value of \(\gamma\) inside the interval \((R(0), S(\gamma^*))\), say \(\hat{\gamma}\).\(^{38}\) Suppose that for \(\gamma = \hat{\gamma}\) the possible range of rulings \(b^C\) strictly includes \((R^{-1}(\hat{\gamma}), S^{-1}(\hat{\gamma}))\), that is the interval of \(b^C\) for which the ruling will be renegotiated. Then, with a mean preserving compression of \(\varepsilon\), it is intuitively possible that the probability of post-ruling settlement conditional on \(\gamma = \hat{\gamma}\) — that is the probability that \(b^C\) falls in the interval \((R^{-1}(\hat{\gamma}), S^{-1}(\hat{\gamma}))\) — will increase, and with this it can be shown that the \textit{ex-ante} probability of post-ruling settlement may then go up as well.\(^{39}\) We summarize this discussion with:

**Remark 1.** If the accuracy of DSB rulings increases, then the impact on the probability of post-ruling settlement is as follows: (i) in the “long run,” if the contract switches from a liability (or mixed) rule to a property rule, there will be a drop in the probability of post-ruling settlement; and (ii) in the “short run” with the contract held fixed, the probability of post-ruling settlement may either rise or fall.

As Remark 1 reflects, the only unambiguous relationship between DSB accuracy and the probability of post-ruling settlement occurs when the optimal contract switches from a liability to a property rule as a result of the increase in DSB accuracy. This points to the importance of accounting for the nature of the optimal rules when considering the impact of DSB accuracy on the frequency of post-ruling settlement. And as we establish below, this point is reinforced when the relationship between DSB accuracy and \textit{early} settlement is considered.

\(^{36}\)Of course, if governments are forward-looking, when they optimize the contract they will do so based on their expectations regarding the future path of the exogenous parameters. Our static model cannot capture this aspect of the design of a trade agreement, but one can imagine a dynamic extension of the model where this distinction between short-run and long-run impact of parameter changes could be formalized. While beyond the scope of our paper, such an extension does not seem likely to overturn the result we emphasize here.

\(^{37}\)We focus here on the more surprising possibility that an increase in DSB accuracy can increase the probability of post-ruling settlement, but with similar arguments it is straightforward to show that the opposite impact is possible as well.

\(^{38}\)As will become clear shortly, a DSB ruling can be reached in equilibrium only for \(\gamma \in [R(0), S(\gamma^*)]\).

\(^{39}\)A fully-specified example in which this possibility arises is available from the authors upon request.
4.3. When do Disputes Arise, and When is there Early Settlement?

Having considered the possibility of post-ruling settlement, we now back up to stage 2 and ask: When does a dispute arise, and when it does arise, when does early settlement occur? To answer these questions, it is no longer possible to rely on Figure 1. Hence we begin by developing an additional figure which can be used to characterize the stage-2 outcomes.

For fixed \( \gamma^* \), we partition the marginal support of \( \gamma \) into three “regions:” Region I, \( \gamma \in [0, R(0)] \); Region II, \( \gamma \in (R(0), S(\gamma^*)) \); and Region III, \( \gamma \in [S(\gamma^*), \infty) \). In Figure 3 we depict the stage-2 bargaining frontier for each of the three regions. For each region, the bargaining frontier corresponds to the outer envelope of two piecewise-linear sub-frontiers, one passing through point \( P \) (and associated with \( T = P \) and various levels of the transfer \( b \)), the other passing through point \( FT \) (and associated with \( T = FT \) and various levels of \( b \)): the piecewise-linearity of each sub-frontier reflects the linearity of \( c(b) \) along the relevant portion of that sub-frontier. Recalling our assumption that the value \( \gamma = \gamma^* \) is in the interior of the support of the marginal distribution of \( \gamma \), it follows that Region II is non-empty. By contrast, Regions I and/or III are relevant only if the support of the marginal distribution of \( \gamma \) is sufficiently large.

The top left panel of Figure 3 depicts the stage-2 bargaining frontier for Region I. Here, the efficiency gains from \( FT \) are large, and as a consequence, achieving the frontier always requires \( T = FT \); note that in this case the frontier is globally concave. The bottom panel of Figure 3 depicts the bargaining frontier for Region III. Here the efficiency gains from \( P \) are large, and so achieving the frontier always requires \( T = P \); again, in this case the frontier is globally concave. Finally, consider the top right panel of Figure 3, which depicts the bargaining frontier for Region II. Here, the higher joint payoff may entail either \( FT \) (for \( \gamma \in (R(0), \gamma^*) \)) or \( P \) (for \( \gamma \in (\gamma^*, S(\gamma^*)) \)), but in either case the payoff is higher by a relatively small amount, and as a consequence neither of the policies \( FT \) or \( P \) Pareto-dominates the other; and the frontier is not globally concave, because both the policy \( T \) and the transfer \( b \) change along the frontier.

What remains is to determine the position of the disagreement point for the stage-2 bargain in the various regions of Figure 3. In case of disagreement in stage 2, there will be a DSB ruling followed by post-ruling bargaining (at stage 4). The thick (red) lines in each panel of Figure 3 trace out the outcome of the post-ruling bargaining as \( b^C \) varies between zero (where the outcome is at \( P \) in Regions II and III and diagonally above \( P \) in Region I) and infinity (where the outcome is at \( FT \) in Regions I and II and diagonally above \( FT \) in Region III). Letting \( \tilde{\omega}(b^C, \gamma) \) and \( \tilde{\omega}^*(b^C, \gamma) \) denote the Home and Foreign payoffs in the stage-4 subgame given \( b^C \) and \( \gamma \), and
$G(\gamma^{dsb}\mid \gamma)$ the c.d.f. of $\gamma^{dsb}$ conditional on $\gamma$, we may express the expected Home and Foreign disagreement payoffs for the stage-2 bargain given $\gamma$ as $E[d\mid \gamma] \equiv \int \tilde{\omega}(b^C(\gamma^{dsb}), \gamma)dG(\gamma^{dsb}\mid \gamma)$ and $E[d^*\mid \gamma] \equiv \int \tilde{\omega}(b^C(\gamma^{dsb}), \gamma)dG(\gamma^{dsb}\mid \gamma)$, respectively; and we then represent the corresponding expected disagreement point as $E[D] = (E[d\mid \gamma], E[d^*\mid \gamma])$ in Figure 3. Notice that the $E[D]$ point can never lie strictly below the stage-2 bargaining frontier. This feature confirms our earlier observation (just after the statement of Lemma 1) that in the stage-2 bargain governments obtain exactly their expected disagreement payoffs.

We are now ready to consider the two questions posed at the beginning of this section. We explore first the question of when disputes arise. Recall that we interpret a stage-2 agreement in which $b = 0$ as the absence of a dispute, while if $b \neq 0$ we say that a dispute has arisen. In terms of Figure 3, when the outcome corresponds to either point $FT$ or point $P$, there is no dispute, and otherwise there is a dispute. But it should now be clear that the bargaining outcome can be at point $FT$ ($P$) only if the expected disagreement point is at $FT$ ($P$). Recalling that (i) the optimal $b^C$ is weakly decreasing in $\gamma^{dsb}$ (by Proposition 1) and (ii) the ruling is implemented when $b^C = 0$ and when $b^C \geq S^{-1}(\gamma)$ (by Proposition 4), it is intuitive and easy to show formally that there will be no dispute if either $\gamma$ is small (in which case the expected disagreement point is at $FT$), or $\gamma$ is large (in which case the expected disagreement point is at $P$). Thus, the occurrence of disputes is least likely in the most extreme states.

We next turn to the second question: Conditional on a dispute occurring, when is there early settlement? The answer hinges on whether the disagreement point lies on the bargaining frontier or rather above it: in the former case, the governments are indifferent between triggering a DSB ruling and agreeing on the certainty-equivalent terms of the disagreement payoff, and we assume that this indifference is broken in favor of early settlement; in the latter case the bargain fails and the DSB issues a ruling. But the answer is then clear from Figure 3: in Regions I and III disputes are always settled early, while disputes lead to a DSB ruling for some (possibly empty) subinterval of Region II. Thus, the model suggests that disputes are more likely to go to a DSB ruling in intermediate states, that is, when the efficiency (joint surplus) stakes of the dispute are not large. Intuitively, when the joint surplus at stake in the choice between $P$ and $FT$ is not large (as in Region II), uncertainty over the DSB ruling translates into uncertainty over the implemented policy, and this uncertainty can help governments divide the expected surplus more efficiently than by settling early and relying on costly transfers.

Thus far we have highlighted predictions of our model concerning the states of nature (values
of $\gamma$) under which the various stage-2 outcomes emerge, for a given contract $b^C(\cdot)$. Next we focus on how the equilibrium stage-2 outcome is related to the nature of the optimal contract.

We can make three points. The first is that, if the optimum is a noncontingent property rule, then the outcome is always no dispute. This can easily be seen from Figure 3. If $b^C(\gamma^{dsb})$ is prohibitive for all $\gamma^{dsb}$ in $[\gamma^{dsb}_1, \gamma^{dsb}_2]$, then Region III must be irrelevant (because otherwise for some $\gamma^{dsb}$ we would have $b^C(\gamma^{dsb}) > \gamma^*$, which cannot be optimal as we have noted). And for Regions I and II, $E[D]$ corresponds to the point $FT$, and so there will be no dispute.\(^{40}\)

The second point is that, if a (contingent or noncontingent) property rule is optimal, early settlement is not possible. Intuitively, if the optimum is a property rule, uncertainty over $\gamma|\gamma^{dsb}$ must be small, as Propositions 2 and 3 suggest. This means that either the support of $\gamma$ is small, in which case only Region II – where the Pareto frontier is convex – is relevant, and there cannot be early settlement with a property rule; or the DSB signal is precise, in which case if $\gamma$ is extreme (so that Regions I and/or III are also relevant) the governments are certain about the DSB ruling and so there is no dispute.

The third point is that, if the optimum is instead a liability (or mixed) rule, any of the outcomes, including early settlement, may occur. The possibility of early settlement in this case can be seen directly from examining Regions I and III in Figure 3, where $E[D]$ then corresponds to a point on the stage-2 bargaining frontier whose location depends on the probabilities associated with the various levels of $b^C(\gamma^{dsb})$. In Appendix we prove:

**Proposition 5.** (i) If the optimum is a property rule (with or without escape) the outcome can be “no dispute” or “DSB ruling” (with the latter always implemented), but never “early settlement.” (ii) If the optimum is a liability (or mixed) rule, any of the outcomes may occur.

Proposition 5 indicates that, if a property rule (with or without escape) is optimal, early settlement is not possible, while if a liability rule is optimal early settlement can occur. Hence, the empirical implications of the model with regard to early settlement conform with those regarding post-ruling settlement. In particular, comparing across GATT/WTO rules, the rate of post-ruling settlement and early settlement should be lower in disputes over property rules than in disputes over liability (or mixed) rules; and with the evolution over time in certain

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\(^{40}\)An interesting question is whether noncontingent property rules can be found in the GATT/WTO and, if so, whether disputes are ever observed. As a general matter all property rules in the GATT/WTO have escapes of some kind (and hence are contingent), with one exception: the rules governing permissible retaliation in case of disputes. And we are unaware of a GATT/WTO dispute that involved allegations of unauthorized retaliation.
GATT/WTO rules from liability (or mixed) rules to property rules, we should observe a drop in the probability of post-ruling settlement and early settlement in disputes over those rules.

In spite of its similarity with the post-ruling settlement result, our finding that there cannot be early settlement if the optimum is a property rule has a very different intuition. To see this intuition, note first that when the optimum is a property rule the DSB ruling, if reached, is either a strict $FT$ policy or a policy of $P$ with $b = 0$. There are then two possibilities: either governments are uncertain about the direction of the ruling (which can happen if the contract is a property rule with escape), or they are certain about it. Suppose first that the governments are uncertain about the ruling. The benefit of settling early would be that this can avoid the risk of DSB errors, but given that transfers are costly, settling and sharing the surplus entails a deadweight loss, so this may not achieve a Pareto-improvement over the disagreement point (which is given by the expected DSB ruling) if the cost of DSB errors is not large; and DSB errors indeed cannot be large, otherwise (by Proposition 2) a property rule would not be optimal. On the other hand, if governments are certain about the ruling (e.g. because the contract is a property rule without escape), intuitively they will stay with the existing contract and will not exchange any transfer; hence the outcome will be “no dispute.”

As with our discussion of post-ruling settlement, we can also explore how the accuracy of DSB rulings affects the probability of early settlement by considering a mean-preserving compression in the noise $\epsilon$. As before, if we focus on the “long run” impact of such a change, that is, taking account of the increase in DSB accuracy on the optimal contract, then we have an immediate result which mirrors our finding for post-ruling settlement: if the rise in DSB accuracy leads to a switch from a liability (or mixed) rule to a property rule, then there will be a drop in the probability of early settlement. But turning to the “short-run” impact where the given contract is held fixed, we now have the opposite effect: for a given contract and referring to Figure 3, if $\gamma$ is in Region II where a DSB ruling can occur, the red locus will weakly shrink with an increase in DSB accuracy, and hence $E[D]$ can only move from a position above the stage-2 bargaining frontier to a position on the frontier, implying that in the short run an increase in DSB accuracy can only increase the probability of early settlement. Summarizing:

**Remark 2.** If the accuracy of DSB rulings increases, then the impact on the probability of early settlement is as follows: (i) in the “short run” with the contract held fixed, the probability of early settlement rises (weakly); (ii) in the “long run,” if the contract switches from a liability (or mixed) rule to a property rule, there will be a drop in the probability of early settlement.
Notice that, in the context of the GATT/WTO, if one accepts that DSB accuracy has increased over time and the GATT/WTO contract has been re-optimized only periodically during negotiation rounds, then Remark 2 yields two further empirical predictions: (a) for all issue areas regulated by liability/mixed rules, the rate of early settlement should tend to increase over time for as long as the contract remains unchanged; and (b) for issue areas that switch from a liability/mixed rule to a property rule in a given round, we should observe a nonmonotonicity, with the rate of early settlement rising until the switch occurs and then falling and remaining low thereafter.

Notice also that, as with our post-ruling settlement results, if one were to look at how the rate of early settlement evolves over time without controlling for the nature of the contract, our model would predict no specific pattern. Again, this highlights the importance of considering the interaction between changes in the contracting environment and changes in the contractual rules when studying empirically the outcomes of trade disputes.\textsuperscript{41}

Finally, our model yields interesting predictions about the nature of settlements. In particular, as we have already observed, any post-ruling (stage-4) agreement must be liberalizing: that is, it must imply $T = FT$ with a transfer made from the exporter to the importer, against the disagreement outcome of $T = P$ and compensation $b^C(\gamma_{\text{dsb}})$ paid by the importer to the exporter. On the other hand, it is immediate from Figure 3 that early (stage-2) settlement can involve either $T = FT$ and a payment made from the exporter to the importer (Region I) or $T = P$ and a payment made from the importer to the exporter (Region III).

At a broad level, this last result suggests the interesting empirical prediction that post-ruling settlements should be more liberalizing than early settlements. Intuitively, this is because early settlements, when they occur, will implement the policy choice that would be made under the expected DSB ruling, which can in general be either $FT$ or $P$. Post-ruling settlements, however, occur “after the court has spoken,” and as we have demonstrated when the ex-ante contract is optimized such settlements can only involve agreement to implement $FT$, not $P$.\textsuperscript{42}

\textsuperscript{41}One might wonder whether the model generates predictions about the impact of changes in ex-ante uncertainty on the probabilities of early and post-ruling settlement. The only definite prediction is that, if there is a decrease in ex ante uncertainty that induces switching from a liability/mixed rule to a property rule, there will be a drop in the probabilities of early and post-ruling settlement. Beyond this prediction, the impact of changes in ex-ante uncertainty is ambiguous, even if one holds the contract fixed.

\textsuperscript{42}A practical impediment to taking this prediction to the data is the difficulty in obtaining reliable measures of the details of settlement agreements between countries. For this reason, we do not focus on this prediction in the next section, but rather leave its evaluation for future empirical investigation.
5. Evidence

Providing a systematic empirical investigation of our model’s predictions is beyond the scope of this paper, but here we use data on GATT/WTO trade disputes and their resolution to provide an initial evaluation of two key predictions of our model. First, comparing across rules, the rate of early and post-ruling settlement should be lower in disputes over property rules than in disputes over liability (or mixed) rules; and if there is an evolution over time in certain rules from liability to property rules, then all else equal we should observe a drop in the probability of early and post-ruling settlement in disputes over those rules. Second, assuming the accuracy of the DSB increases through time, then if the contract is of the liability type and holding the contract fixed, the probability of early settlement should rise through time; but if the contract switches to a property rule, then the probability of settlement should fall.

As we have previously discussed, GATT/WTO legal scholars describe an evolution in the legal rules of the GATT/WTO, from a system of liability rules in the earlier GATT decades to a system that, by the time of the creation of the WTO, had become a collection of property rules with a few specific exceptions that remained liability rules (see Jackson, 1997, and Pauwelyn, 2008). With regard to the portion of this evolution that occurred during the GATT era, the major change was arguably related to the reform of the dispute settlement procedure in the Tokyo Round, which was concluded in April 1979.\footnote{The argument made by Jackson (1997) and other scholars is that, with the strengthening of the dispute settlement procedure, the remedies for breach of GATT/WTO obligations were gradually elevated to the status of “specific performance” remedies, corresponding to our notion of a property rule (see note 27). See also Hudec (1993, Chapter 4) for a discussion of the particular significance of the Tokyo Round reform of the DSB.} For the purposes of our empirical investigation, we therefore group the GATT/WTO disputes into three periods: GATT-I (1948-78), GATT-II (1979-89) and WTO (1995-present).\footnote{The reason we drop the years 1990-1994 from our sample is explained in the next subsection.} Our maintained assumption is that GATT-I operated as a system of liability rules, that the WTO operates as a system of property rules with a few specific exceptions that are treated as liability rules, and that GATT-II operated as a transitional system somewhere in between GATT-I and the WTO.

It also seems reasonable to expect, as we mentioned in the Introduction, that DSB accuracy would increase through time, for at least two reasons. First, in the GATT years there was almost surely an important learning process associated with the accumulation of a body of GATT legal decisions that would have contributed to the accuracy of DSB rulings through time (see also note 28). And second, with the creation of the WTO a formal appeals process
and standing panel of appellate judges was introduced into the dispute resolution system, with the purpose of providing a safeguard against incorrect legal interpretations of the GATT/WTO contract. Hence, we will maintain the assumption that DSB accuracy has risen over time.

5.1. Data

We collect data on GATT/WTO disputes and their resolution from two main sources: Hudec (1993) augmented by Reinhardt (1996, 2001) for the GATT era disputes, and the World Bank’s WTO Dispute Settlement Database (see Horn, Johannesson and Mavroidis, 2011 for a description) for the WTO disputes. Hudec’s coverage includes every GATT dispute that occurred over the period 1948-1989. This does not include the GATT disputes that arose during the final 5 years of GATT’s existence prior to the creation of the WTO in 1995, but there are two advantages to restricting coverage of GATT disputes to the 1948-1989 period: first, we then have a single consistent data source for GATT disputes; and second, our resulting measure of GATT-II (1979-89) provides a cleaner break with the creation of the WTO. The WTO Dispute Settlement Database currently includes every WTO dispute that occurred over the period 1995-2011, but we include only the period 1995-2009 to avoid the problem of unknown outcomes for disputes whose resolution may be as yet incomplete.

We provide a detailed description of this data, as well as a description of data for various controls, in our Online Data Appendix. Here we describe four of the most salient data issues.

First, the typical GATT/WTO dispute raises a variety of claims, not just a single claim as in our simple model. Yet all we observe is either that a dispute ends in settlement or that it does not (i.e., we do not observe directly whether their might have been settlement on some claims and a lack of settlement on other claims within a single dispute). Hence for our main results we will adopt the dispute as our unit of observation, and we will consider whether the inclusion of individual claims in a dispute moves the probability of settlement for that dispute in the direction suggested by our model. Later we will describe an approach that allows us to also consider claim-level evidence for a subset of GATT/WTO disputes.

Second, GATT/WTO disputes sometimes involve multiple claimants. We follow the standard convention (see, e.g., Reinhardt, 2001, Guzman and Simmons, 2002, and Horn et al, 2011)

\footnote{A possible counter argument to rising DSB accuracy over time is that the new issues taken on by the WTO have reduced the degree of accuracy. Partly for this reason, below we focus only on those GATT/WTO disputes that concern the issues traditionally addressed by the GATT.}
and treat each claimant-respondent pair as a separate dispute.\textsuperscript{46} As a result our dataset includes 109 GATT-I disputes, 133 GATT-II disputes and 348 WTO disputes.

A third issue is what to count as a settlement. Ideally, disputants report their settlement agreements to the GATT/WTO, but in practice this does not always happen (especially in the GATT era, where there was no official requirement to do so) and so reported settlements are unlikely to be a reliable indicator of actual settlements. For this reason, we include in our measure of settlement both disputes that record an official settlement agreement (a “mutually agreed solution”) and disputes where the complaint is withdrawn or simply suspended.

And a fourth issue is the allocation of claims within the WTO era between property rules and liability rules. We adopt Pauwelyn’s (2008) classification, which is summarized in Table 1. Table 1 also records the frequency with which each claim was brought in a GATT/WTO dispute over the three eras. While all claims were considered liability rules in the GATT-I era, as Table 1 makes clear most claims evolved to property rules by the WTO era. In addition, of the GATT Articles that remained liability rules in the WTO era, the most frequently invoked in GATT/WTO disputes are nonviolation claims (which concern policy measures that are claimed to have eroded negotiated market access commitments but do not violate explicit GATT/WTO commitments) and claims against domestic subsidies.\textsuperscript{47} We have excluded claims about WTO commitments that have no counterpart in the GATT (e.g., claims about violations of TRIPS, TRIMS or GATS commitments); this choice seems natural given our focus.

5.2. Descriptive Findings

To get an initial feel for the data, we first examine the overall rates of settlement across the GATT-I, GATT-II and WTO eras. Table 2 provides the rates of early settlement and post-

\textsuperscript{46}In most cases involving multiple claimants, there are material differences across the claims made by the individual claimants, and so the GATT/WTO typically forms separate panels of judges to assess the claims of each claimant and issue separate panel reports and rulings, consistent with our treatment of multiple claimant cases here. As described below, we also include controls for multiple-claimant disputes in the logits we estimate.

\textsuperscript{47}As discussed in section 3 and note 28, in the context of our model the WTO escape clause can be interpreted as a mixed property/liability rule, and so there is a degree of arbitrariness in our Table 1 classification of the escape clause as a property rule in the WTO era. But if a rule evolves from a pure liability type to a mixed type (as was the case for the escape clause in going from GATT to the WTO), our model is suggestive that settlement rates may be expected to drop, since the rule is moving in the direction of a property rule, hence our classification of the escape clause as a WTO-era property rule in Table 1. In addition, we classify the export subsidy provisions in the Tokyo Round Subsidies Code as the first real export subsidy commitments in the GATT era (see Sykes, 2005, for a detailed discussion of the evolution of subsidy provisions in the GATT/WTO), but other classifications (e.g., classifying the export subsidy reporting requirements contained in GATT Article XVI as export subsidy commitments) do not materially alter the results we report below.
ruling settlement, as well as the difference between the rates of early and post-ruling settlement, across these three periods. Several interesting features of the data are revealed by Table 2.

A first feature relates to the changes in settlement rates over the three eras. The numbers in the first two rows of Table 2 show that these rates have increased from the GATT-I era to the GATT-II era, and have decreased from the GATT-II era to the WTO era. Our model suggests a possible explanation for this non-monotonic pattern: (i) the accuracy of DSB rulings increased between the GATT-I and GATT-II eras while the shift from liability to property rules during this period was comparatively modest and not enough to outweigh this first effect on overall settlement rates, leading to an increase in the (at least early) settlement rate over the period according to Remark 2; and (ii) with the creation of the WTO, the agreement underwent a broad-based conversion to a system of property rules, leading to a drop in early and post-ruling settlement rates at that point according to Propositions 4 and 5.

A second feature is that, while early-settlement rates are consistently higher than post-ruling settlement rates, the difference between the early and post-ruling settlement rate (recorded in the bottom row of Table 2) increases as we move from GATT-I to GATT-II and finally to the WTO era. Our model suggests that a selection effect could help explain this feature, because (i) disputes featuring property rule claims should have both a higher survival rate to the post-ruling stage and a lower post-ruling settlement rate than disputes featuring liability rules according to Propositions 4 and 5, and (ii) this selection effect should be operative only under a system that includes both property and liability rules, and the effect should therefore be absent in the GATT-I era and increasingly present as we move from GATT-II to the WTO.48

We next compare average rates of settlement for property rule claims with average rates of settlement for liability rule claims, to see if there is broad support for our model’s prediction that the former should be lower than the latter. In particular, we focus on early settlement (Proposition 5) and calculate the mean rate of early settlement across all claims that in the WTO era are considered property rules \((ES_{\text{P}}^{\text{WTO}})\), and compare this to the mean rate of early settlement across all claims that in the WTO era are considered liability rules \((ES_{\text{L}}^{\text{WTO}})\).49

48More specifically, for the GATT-I era when GATT operated as a system of liability rules, our model would suggest that lower DSB accuracy with particular claims would lead to lower rates of early settlement over these claims (Remark 2) but not necessarily to lower rates of post-ruling settlement (Remark 1). Hence, our model does not predict that a selection effect on post-ruling settlement rates would be operative in the GATT-I era.

49Specifically, letting \(P_{\text{WTO}}\) denote the set of claims listed in Table 1 which are classified as property rules in the WTO era, and letting \(L_{\text{WTO}}\) denote the set of claims listed in Table 1 which are classified as liability rules in the WTO era, we define \(ES_{\text{P}}^{\text{WTO}} \equiv \frac{\sum_{i \in P_{\text{WTO}}} C_{ij} D_{ij}}{\sum_{i \in P_{\text{WTO}}} C_{ij}}\) and \(ES_{\text{L}}^{\text{WTO}} \equiv \frac{\sum_{i \in L_{\text{WTO}}} C_{ij} D_{ij}}{\sum_{i \in L_{\text{WTO}}} C_{ij}}\), where \(j\) indexes
We plot $ES_{P^{WTO}}$ and $ES_{L^{WTO}}$ for the three periods in Figure 4. For the WTO era Figure 4 shows $ES_{P^{WTO}} < ES_{L^{WTO}}$, with the mean rate of early settlement equal to 0.63 for liability rule claims and dropping to 0.53 for property rule claims. For the GATT-II era we again find that $ES_{P^{WTO}} < ES_{L^{WTO}}$, with an even greater difference between $ES_{P^{WTO}}$ and $ES_{L^{WTO}}$ relative to the WTO era. Finally, for the GATT-I era the inequality is reversed, with $ES_{P^{WTO}} > ES_{L^{WTO}}$.

Is Figure 4 consistent with our model? The fact that $ES_{P^{WTO}} < ES_{L^{WTO}}$ for the WTO era is clearly consistent with our model, and specifically with the result that property rules should be associated with lower settlement rates than liability rules. Next consider the GATT-I era. Recall that all rules were liability rules under GATT-I, and so our model does not yield sharp predictions regarding the comparison between $ES_{P^{WTO}}$ and $ES_{L^{WTO}}$ for the GATT-I era. However, the model is suggestive of a possible explanation for the finding that $ES_{P^{WTO}} > ES_{L^{WTO}}$ under GATT-I. Recall that $ES_{L^{WTO}}$ is the mean rate of early settlement across those rules that are liability rules under GATT-I and will remain liability rules under the WTO. A possibility suggested by the model is that these rules may have remained liability rules because they were characterized by a relatively low degree of DSB accuracy;\(^{50}\) and if this is the case, one would expect early settlement rates to be lower for these rules under GATT-I. Finally consider our finding that $ES_{P^{WTO}} < ES_{L^{WTO}}$ in the GATT-II era. To the extent that (as we have argued) the move toward property rules was already underway in the GATT-II era, the direction of the inequality is in line with the broad message of our model. However a question arises: Why is the difference between $ES_{P^{WTO}}$ and $ES_{L^{WTO}}$ larger in GATT-II than in the WTO era? Our model does not offer any explanation for this particular feature of the data, which we therefore see as an interesting puzzle.

5.3. Logits

We next estimate some simple logits over the three GATT/WTO eras. We begin with an evaluation of our model’s prediction that, other things equal, settlement rates should be lower for property rules than for liability rules. As we now demonstrate, the logit results are broadly supportive of this prediction.

\(^{50}\)Suppose the noise in DSB rulings were composed of two components, one that was common to all issue areas and the other that varied across issue areas. Then, if the common component of the noise decreases over time, one would expect the higher-noise issue areas to be the last ones to be converted into property rules.
We focus on early settlement (Proposition 5), and consider first a comparison across rules in the WTO era.\footnote{We do not consider in our logit analysis the model’s predictions about post-ruling settlements (Proposition 4), because doing so would raise econometric challenges that cannot adequately be addressed with our limited sample size. We leave this evaluation for future work.} With the left-hand-side variable defined as the log odds of early settlement for dispute $j$, we estimate logits that on the right-hand side include variables that indicate whether each of the claims listed in Table 1 was raised in dispute $j$, as well as a number of controls.\footnote{As pointed out in the 2011 WTO World Trade Report (WTO, 2011, p. 179), some claims listed in a GATT/WTO dispute may be subsidiary to other listed claims and hence are not truly at issue in the dispute, and the Report lists a set of simple rules for eliminating these subsidiary claims from those listed in a dispute. In unreported logits we have adopted these rules and find that they have no material impact on our results.} The controls include year and HS1 industry fixed effects, a multiple-claimant dummy, and dummies indicating whether the claimant and/or respondent is a developed or developing country. We find that the only control variable that is consistently statistically significant across specifications is a dummy variable indicating whether the respondent is a developing country, and so in the specifications we present here only this control variable is included, but including the other controls does not change the results we emphasize below. We also exclude those claims that lack statistical significance in any of our specifications, but again their inclusion does not alter the results we emphasize below. The claims that we highlight are the following: five claims that in the WTO era are considered property rules, namely, national treatment, antidumping/countervailing duties, administration of trade regulations and fees and formalities,\footnote{This reflects a combination of the related claims associated with (a) Administration of trade regulations and (b) fees and formalities. For the purposes of our logit estimation, we combine these two sets of claims in order to keep the frequency of such claims reasonably high in the GATT era, but our results are essentially unchanged if we include separate variables for each of these claims.} escape clause, and export subsidies; and two claims that in the WTO era are considered liability rules, namely, nonviolation and domestic subsidies.\footnote{We treat the selection of disputes, and hence the selection of GATT Articles claimed in a given dispute, as exogenous. While in principle one could attempt to estimate an equation predicting when trade disputes arise between GATT/WTO members, from a practical standpoint the data limitations associated with identifying the possible disputes that might arise between each pair of GATT/WTO members make this infeasible (see Bown, 2005, for further discussion of the data constraints in this regard). We see our model as primarily designed to illuminate issues associated with settlement rather than with the initiation of disputes, and so we feel that this focus accurately captures the model’s central empirical content.}

Column 1 of Table 3 presents the logit coefficient estimates for the WTO era. These estimates are broadly supportive of our model’s prediction: the inclusion of any of the five property rule claims in a dispute reduces the odds of early settlement for that dispute, an impact that is in each case statistically significant at either the 1%, 5% or 10% level; while the inclusion of either of the two liability rule claims in a dispute increases the odds of early settlement for that
We turn next to a comparison across rules in the GATT-I era. During this era GATT operated as a system of liability rules, and so for this period our model does not yield strong predictions on the signs of coefficients. Indeed if we were to find a similar pattern across estimated coefficients in the GATT-I era to the pattern we found in the WTO era, there would be reason to doubt the interpretation that our results for the WTO era provide support for our model: and so it is comforting that, in fact, our estimated coefficients over the GATT-I era do not show a pattern similar to our results from the WTO era. But, as in the more descriptive analysis of the previous section, we do find one interesting pattern in the data for the GATT-I era, and the model is suggestive of a possible explanation for it. More specifically, column 2 of Table 3 presents the GATT-I-era logit coefficients, and now the point estimates of the coefficients on the WTO-era property rule claims are evenly split between positive and negative with none statistically significantly different from zero; but notice that the estimated coefficient on both of the WTO-era liability rule claims is now negative (and statistically significant for nonviolation claims). This is the analog of our Figure 4 finding that $ES_{P_{WTO}} > ES_{L_{WTO}}$ under GATT-I. And as we described in the context of Figure 4, a possible explanation suggested by our model is that the accuracy of DSB rulings on nonviolation and domestic subsidy claims was particularly low in the GATT-I era, and this relatively low level of accuracy both reduced the odds of early settlement in the GATT-I era and helped ensure that nonviolation and domestic subsidy claims would remain liability rules in the WTO era (see also note 50).  

Next we focus on the GATT-II era. During this period GATT was in a transitional state somewhere between the system of liability rules that characterized GATT-I and the broad-based system of property rules (with liability rules relegated to a few specific exceptions) that the WTO has become. Column 3 of Table 3 presents the GATT-II era logit coefficient estimates for

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55 A potential concern with these estimates is that early settlement can occur either after the “consultation” phase of a dispute but before the formation of a “panel” of judges has been requested, or after the request for a panel has been made but before the panel has issued its ruling. Because our claims variables are defined based on the claims made at the request for consultation, they are relevant for early settlements that occur before the request for a panel, but may be less relevant for early settlements that occur after the request for a panel has been made, if the claims at that stage are different. To address this possibility, we have also utilized data from the WTO Dispute Settlement Database on the claims made at these two different stages and estimated two separate (sequential) logits with the appropriate claims variables on the right-hand side. Our results, which are available on request, are similar to those we report in column 1 of Table 3.

56 This explanation seems especially compelling for the statistically negative coefficient on nonviolation claims in the GATT-I era logit presented in column 2 of Table 3, because as we noted earlier these are claims about the market access implications of policy measures that did not violate any explicit GATT/WTO commitments, and so it seems natural to expect that the DSB accuracy would be particularly low in evaluating these claims.
early settlement. Now all of the estimated coefficients on WTO-era property rule claims have turned negative (and one in a statistically significant way). And the magnitude and statistical significance of the estimated negative coefficient on the nonviolation claim has now dropped, while the estimated coefficient on the domestic subsidy claim has now turned positive and significant. At a broad level, these findings lie somewhere in between the findings described above for the WTO era and for the GATT-I era, and therefore seem consistent with our model under our maintained assumption that the GATT-II era marked a transition from a system based on liability rules to a system based largely on property rules.

Thus far we have focused on pure cross-sectional comparisons across rules within a given era. The results of these comparisons are consistent with a key prediction of the model—that disputes over property rules should be less likely to settle, other things equal, than disputes over liability rules—but a more convincing probe of this prediction would arguably be to perform a test of the difference-in-differences type.

To see the basic difference-in-differences idea, suppose for a moment that each dispute involved a single rule. Then our model would predict that there should be a larger drop in settlement rates for disputes over rules that evolved from liability to property rules than for disputes over rules that remained of the liability type. This idea must be adapted to take into account that each dispute typically involves multiple rules, but before we proceed, let us start with a cursory comparison of the estimated coefficients in the cross-sectional regressions across eras. For the purposes of this comparison it seems reasonable to focus just on the GATT-I era and the WTO era. Looking across columns 1 and 2 of Table 3, it appears that the impact on settlement rates of WTO-era property rules (i.e. those that evolved from liability to property) has become more strongly negative between the GATT-I era and WTO era than has the impact of WTO-era liability rules (i.e. those that did not evolve), as suggested by our model.

To go beyond the pure cross-sectional regressions and perform a difference-in-difference type analysis, we therefore now pool the WTO-era and GATT-I era data and estimate the logit equation from column 2 of Table 3, augmented to include a WTO-era dummy as well as interaction terms between each claim variable and the WTO-era dummy. The results are reported in column 4 of Table 3. According to our model, we expect that each of the estimated coefficients on the four property-rule interaction terms should be more negative than any of the estimated coefficients on the two liability-rule interaction terms. Our point estimates bear out this prediction for seven of the eight coefficient comparisons, and when we conduct formal hypothesis testing,
we cannot reject the hypothesis that each of the coefficients on the property-rule interaction terms is more negative than any of the coefficients on the liability-rule interaction terms.\footnote{We also test the null hypothesis that, in contradiction to our model, all of the coefficients on the property-rule interaction terms are greater than or equal to each of the coefficients on the liability-rule interaction terms, and find that we can reject this hypothesis at any standard level of significance. To implement these tests we follow Wolak (1991) and Andrews and Soares (2010). The results are available upon request.}

Finally, we turn to our model’s predictions about the impact of DSB accuracy on the probability of early settlement (Remark 2), and extend our baseline logit analysis to shed further light on these predictions. As we mentioned earlier, it is reasonable to suppose that there was an important learning process associated with the DSB adjudication activity, at least over the first few decades of GATT, and that this resulted in a rise of DSB accuracy through time. If we assume that DSB accuracy is increasing in DSB experience, our model predicts that, if the contract is of the liability type and is held fixed, the rate of early settlement should increase with the accumulation of DSB experience. To evaluate this prediction empirically, we focus on the GATT period and create claim-specific experience variables that record the number of times that a particular claim has been raised in previous GATT disputes. We then pool the GATT-I and GATT-II era data and estimate the logit equation from column 2 of Table 3, augmented to include interaction terms between each of the six claim variables and their associated claim-specific experience variable. If a claim is a liability rule and the rule does not change through GATT-I and GATT-II, our model predicts that the coefficient on the interaction term should be positive. On the other hand, if the claim begins as a liability rule and evolves to a property rule, our model is consistent with either sign of this coefficient, since the shift toward a property rule and the increase in DSB accuracy act as counteracting forces.

The results of this augmented logit regression are reported in column 5 of Table 3, and the coefficients on the six interaction terms display an interesting pattern that is broadly consistent with our model. The coefficients on the two liability-rule interaction terms are both positive (one significantly so), as required by our model given that these rules did not evolve over time from liability to property rules. On the other hand, three of the four point estimates for the coefficients on the WTO-era-property-rule interaction terms are negative (one significantly so), a pattern that can also be explained by our model provided that some of the evolution in these claims from liability to property rules occurred between the GATT-I and GATT-II eras. Reinforcing this interpretation is the fact that the one significantly negative coefficient on the WTO-era-property-rule interaction term in column 5 of Table 3 corresponds to the claim which,
according to the GATT-II era logit in column 3 of Table 3, exhibited the clearest evidence of a switch to a property rule between GATT-I and GATT-II.\footnote{If our interpretation of these negative coefficient estimates is correct, then we would expect to find no evidence of negative and significant coefficients on the WTO-era-property-rule interaction terms when the logit in column 5 of Table 3 is estimated separately on the GATT-I and the GATT-II eras (because we have argued that the contracts should have remained largely fixed within each era). And indeed we find no such evidence, although the small number of within-era observations leads to a general lack of significance for any of the interaction terms, so we do not emphasize this finding.}

5.4. Claim-Level Evidence

Above we have adopted the dispute as our unit of observation, and we have used the claims included in a dispute to help predict whether the dispute will settle or not. But an alternative approach is also possible with regard to WTO-era disputes, in light of the detailed claim-level data available from the WTO Dispute Settlement Database. Specifically, this database records the claims made at two distinct junctures in a dispute: first, when one government – the claimant – requests that another government engage with it in formal “consultation” (the initial step in any formal GATT/WTO dispute); and second, when the claimant requests that a “panel” of judges be formed to consider the arguments of both sides in the dispute and issue a ruling. The WTO database also records those claims that are ruled upon in each dispute.

Utilizing this more detailed claim-level WTO data, and under the assumption that any claim made that was not ultimately ruled upon must have been settled prior to the panel ruling, we now take as our unit of observation the individual claim, whether it is made at the request-for-consultation stage or the request-for-panel stage (or both) in a given dispute; and we define that claim as settled prior to the ruling (“early settlement”) if and only if there was no ruling on it. The resulting claim-level definition of early settlement then includes claims that were listed in the request for consultation but not listed in the request for a panel (which we interpret as settled prior to the request-for-panel stage) and it also includes claims that were listed in the request for a panel but were not ruled upon (which we interpret as settled after the panel was formed but prior to the panel ruling).

With early settlement defined at the claim level in this way, our sample of claims filed in WTO disputes contains 916 observations. The mean rate of early settlement across all property rule claims (\(ES_{P_{WTO}}\)) and all liability rule claims (\(ES_{L_{WTO}}\)) in WTO disputes is now 76\% and 97\% respectively, strongly confirming the model’s prediction that the former should be lower than the latter. And analogous to the WTO-era dispute-level logit in column 1 of Table 3, the
coefficient estimates for the claim-level logit presented in column 6 of Table 3 (with the new indicator variable Property taking the value of 1 if the claim is a property rule and 0 otherwise) confirm that property rule claims exhibit significantly lower odds of early settlement in the WTO era than do liability rule claims, as our model predicts.\textsuperscript{59} Hence, the claim-level pattern of settlement in the WTO era provides further support for our model.

6. Conclusion

What explains the wide variation in the observed resolution of trade disputes? We have developed a model of trade agreements with imperfectly verifiable information that can generate a variety of dispute outcomes in equilibrium: governments may reach “early” settlement, they may trigger a DSB ruling and implement it, or they may reach a post-ruling settlement. The model generates predictions on how the dispute outcome depends on the contracting environment and how it correlates with the optimal contract form. We have examined these predictions in light of data on the outcomes of actual trade disputes in the GATT/WTO, and find initial support for our model’s predictions.

To keep our results sharp we have relied on a number of simplifying assumptions. Key among them is our focus on binary policies. As we indicated, trade disputes in the GATT/WTO often focus on non-tariff measures that are discrete in practice, such as regulatory regimes or product standards, and our assumption of a binary policy instrument is a simple way to capture this property. And even policies that might in principle appear to be continuous, such as domestic and export subsidies, are in practice often implemented with complex programs that are difficult to alter ex-post in a marginal and continuous way. But it is nevertheless important to consider a richer set of policy options than our model allows, and if we were to allow for continuous policies in our analysis, it is not hard to see that our model would likely imply a further prediction: all else equal, the frequency of settlement should be higher for policies that are more continuous, and for truly continuous policies there would typically be no rulings.\textsuperscript{60} Guzman and Simmons (2002) draw a similar distinction between issues such as health and safety standards that have

\textsuperscript{59}As with the dispute-level logit in column 1 of Table 3, our claim-level findings are similar when we include year and HS1 digit industry fixed effects. And as with the dispute-level logit (see note 55), we also estimate two sequential claims-level logits corresponding to the request-for-consultation and the request-for-panel stages, and we find results (available on request) which are similar to those we report in column 6 of Table 3.

\textsuperscript{60}This is because, with continuous policies, under some regularity conditions the convexity of the stage-2 bargaining frontier that is necessary for DSB rulings to occur in our model would not arise.
an “all or nothing” character and policies that are continuous and more “flexible” in nature such as tariffs, and in their empirical study of WTO disputes indeed find that settlement rates are higher for disputes over more continuous policies. Hence we view the consideration of more continuous policies as an important direction for extending our theoretical and empirical analysis, but we leave this extension for future research.

In addition to our assumption of binary policies, we have modeled changes in ex-ante uncertainty and DSB accuracy as changes in the support of the relevant distribution. This facilitates a stark delineation between property rules and liability rules and helps simplify our analysis, but in reality the distinction between these rules is more blurred. If we instead modeled changes in ex-ante uncertainty and DSB accuracy as mean-preserving changes in the density along a given support, our results would survive in a “smoother” form, thereby permitting the formalization of statements such as, e.g., “As a rule shifts from a liability rule toward a property rule, the probability of early and post-ruling settlement in disputes over that rule should fall.” And a benefit of this alternative approach would be a tighter link from theory to empirical analysis along this dimension. But to really establish a tight link between our theory and an empirical analysis, there are other modeling features that would have to be addressed as well (e.g., disputes with multiple claims), making such a task well beyond what is feasible in a single paper. Hence, we choose to keep the model simple and interpret its links to our empirical analysis as merely suggestive, and we leave the ambitious task of a more systematic and structured empirical analysis of the predictions of our theory for future research.\footnote{In a similar spirit, we have assumed that there is no cost to initiating disputes, but including such costs in our model could yield interesting predictions about the conditions under which disputes arise in equilibrium. Relatedly, introducing asymmetries in litigation costs between large and small countries and/or developed and developing countries – possibly coupled with asymmetries in bargaining power – could yield insights regarding how the design of legal remedies for breach could best serve a heterogeneous membership.}

And finally, we have assumed that contracts are automatically enforced, but in reality international contracts must be self-enforcing.\footnote{Papers that model the self-enforcing nature of trade agreements include Bagwell and Staiger (1990), Maggi (1999), Ederington (2001), Klimenko et al. (2008) and Park (forthcoming).} Extending our analysis along these lines is a complex task, but it could have a big payoff. In particular, we have emphasized costly transfers as a feature that sets international contracting apart from domestic contracting, but the same might be said about enforcement constraints, suggesting that an analysis of trade disputes and settlement in an environment with both costly transfers and weak enforcement could yield novel insights. We see this as an important direction for future research.
7. Appendix

**Proof of Lemma 1:** Consider an arbitrary schedule \( b^C(\gamma^{dsb}) \). Let the stage-4 equilibrium payoffs of the two governments given \( b^C(\cdot) \), \( \gamma \) and \( \gamma^{dsb} \) be denoted by \((\bar{\omega}(\gamma^{dsb}, \gamma), \bar{\omega}^*(\gamma^{dsb}, \gamma))\) – we omit the schedule \( b^C(\cdot) \) from the payoff functions, as this should not cause confusion. Clearly, since bargaining is efficient, for any \( \gamma^{dsb} \) this payoff pair lies on the ex-post Pareto frontier given \( \gamma \).

Moving back to the stage-2 bargain, consider the expected disagreement payoffs of governments: these are the payoffs that governments expect (having already observed \( \gamma \)) in case a DSB ruling is issued, and they can be written as \((E[\bar{\omega}(\gamma^{dsb}, \gamma)], E[\bar{\omega}^*(\gamma^{dsb}, \gamma)]\))\(^{63}\).

First note that, given our assumption of a linear cost of transfers, the ex-post Pareto frontier for any \( \gamma \) is piece-wise linear, and given by the outer envelope of two sub-frontiers, one associated with the \( P \) policy and one associated with the \( FT \) policy. And because of the linear cost of transfers, each sub-frontier has a kink, which corresponds to the case where there is no transfer in either direction. To fix ideas, suppose the Home payoff is on the vertical axis of the payoff space, so that the \( P \) kink lies North-West of the \( FT \) kink (see for example Figure 3).

The next step of the proof is to argue that in the stage-2 bargain governments obtain exactly their expected disagreement payoffs \((E[\bar{\omega}(\gamma^{dsb}, \gamma)], E[\bar{\omega}^*(\gamma^{dsb}, \gamma)]\)) for all \( \gamma \), because there is no scope for Pareto-improvement over the expected disagreement point. It can easily be shown that the equilibrium payoffs of the stage-4 bargain can never lie on the left branch of the \( P \) sub-frontier or on the right branch of the \( FT \) sub-frontier, that is, it can never be the case that, as a result of stage-4 bargaining, the policy is \( P \) and the importer receives a payment, or the policy is \( FT \) and the exporter receives a payment. This in turn implies that the relevant part of the ex-post Pareto frontier (given by the outer envelope of the right branch of the \( P \) sub-frontier and the left branch of the \( FT \) sub-frontier) is a weakly convex locus for all \( \gamma \). As a consequence, the expected disagreement point at stage 2 – i.e. the expected payoffs anticipated by the governments in case the DSB is invoked – cannot be strictly inside the Pareto frontier for any \( \gamma \), and hence there is no scope for Pareto-improvement over the expected disagreement point. Thus in the stage-2 bargain governments obtain exactly their expected disagreement payoffs \((E[\bar{\omega}(\gamma^{dsb}, \gamma)], E[\bar{\omega}^*(\gamma^{dsb}, \gamma)]\)) for all \( \gamma \).

Now move back to stage 0, where \( b^C(\gamma^{dsb}) \) is chosen to maximize \( E_\gamma(E[\bar{\omega}(\gamma^{dsb}, \gamma)] + \)
\( E[\tilde{\omega}^*(\gamma^{dsb}, \gamma)|\gamma] \), which is given by:

\[
\int \left[ \int (\tilde{\omega}(\gamma^{dsb}, \gamma) + \tilde{\omega}^*(\gamma^{dsb}, \gamma)) h(\gamma^{dsb}|\gamma) d\gamma^{dsb} \right] h(\gamma) d\gamma
\]

\[
= \int \left[ \int (\tilde{\omega}(\gamma^{dsb}, \gamma) + \tilde{\omega}^*(\gamma^{dsb}, \gamma)) h(\gamma|\gamma^{dsb}) d\gamma \right] z(\gamma^{dsb}) d\gamma^{dsb}
\]

where \( h(\gamma) \) is the marginal density of \( \gamma \) and \( z(\gamma^{dsb}) \) is the marginal density of \( \gamma^{dsb} \). Clearly, maximizing the objective boils down to maximizing \( \int (\tilde{\omega}(\gamma^{dsb}, \gamma) + \tilde{\omega}^*(\gamma^{dsb}, \gamma)) h(\gamma|\gamma^{dsb}) d\gamma \) for each given \( \gamma^{dsb} \). QED

Proof of Proposition 1:

We start by deriving the equilibrium policy outcome as a function of \( b^C \) and \( \gamma \): by inspection of Figure 1, the policy outcome is \( T = FT \) for \( \gamma < R(b^C) \) and \( T = P \) for \( \gamma > R(b^C) \).

Next we need to derive the transfer \( b^e \) paid by the exporter when renegotiation occurs, that is in the \( FT_R \) region. Given the Nash bargaining assumption, it is direct to verify that \( b^e = \frac{2b^C - (1-c)\gamma^*-\gamma}{2(1-c)} < 0 \).

Recalling that we can focus on \( b^C \in [0, \gamma^*] \), that for this range of \( b^C \) the equilibrium policy is \( FT \) iff \( \gamma < R(b^C) \), and letting \( V^{FT} \equiv v(FT) + v^*(FT) \), we can write the optimization problem as:

\[
\max_{b^C \in [0, \gamma^*]} E[\hat{\Omega}(b^C, \gamma)|\gamma^{dsb}] = \begin{cases}
V^{FT} + \int_{R(b^C)} (\gamma - \gamma^*) dH(\gamma|\gamma^{dsb})
\end{cases}

- c \cdot \begin{cases}
b^C [1 - H(R(b^C)|\gamma^{dsb})] + \int_{S(b^C)} |b^e(b^C, \gamma)| dH(\gamma|\gamma^{dsb})
\end{cases}.
\]

The expression for \( E[\hat{\Omega}(b^C, \gamma)|\gamma^{dsb}] \) is given by the difference between two terms. The term in the first set of curly brackets is the joint payoff associated with the \( FT \) policy, plus the gain in expected joint payoff associated with allowing the policy \( P \) for \( \gamma \) above \( R(b^C) \). It is simple to see that this term by itself is maximized when \( b^C \) satisfies \( R(b^C) = \gamma^* \). However, weighing against this first term is the deadweight loss associated with the transfers. The expected transfer is given by the second set of curly brackets, and is composed of the transfer \( b^C \) that accompanies the policy \( P \) (when \( \gamma > R(b^C) \)) and the transfer \( b^e \) that accompanies the renegotiated policy \( FT \) (when \( \gamma \in (S(b^C), R(b^C)) \)).
We now prove part (i) of the proposition. Here we will ignore the possibility that the optimal schedule $b^C(\gamma_{dsb})$ may have jumps. The extension of the argument to allow for the possibility of jumps is available upon request.

We first establish that, at any value of $\gamma_{dsb}$ such that the optimal $b^C$ is non-prohibitive, the schedule $b^C(\gamma_{dsb})$ must be locally non-increasing; and moreover, if the optimal $b^C$ is strictly between 0 and $b^{prohib}$, then $b^C(\gamma_{dsb})$ is strictly decreasing. To establish this claim, recall that we have assumed that there is at most one interior local optimum for $b^C$ given $\gamma_{dsb}$. Also, recalling that we can focus on values of $b^C$ that are lower than $\gamma^*$, we can write:

$$
\frac{dE[\hat{\Omega}(b^C, \gamma)|\gamma_{dsb}]}{db^C} = c(1 + c) \cdot |b^C(b^C, S(b^C))| \cdot h(S(b^C)|\gamma_{dsb}) + \frac{c}{1 - c}[H(R(b^C)|\gamma_{dsb}) - H(S(b^C)|\gamma_{dsb})] - c[1 - H(R(b^C)|\gamma_{dsb})].
$$

We now argue that $\frac{dE[\hat{\Omega}(b^C, \gamma)|\gamma_{dsb}]}{db^C}$ is decreasing in $\gamma_{dsb}$ when evaluated at a value of $b^C$ satisfying $\frac{dE[\hat{\Omega}(b^C, \gamma)|\gamma_{dsb}]}{db^C} \leq 0$, which encompasses both the case where the optimal $b^C(\gamma_{dsb}) \in (0, b^{prohib})$ and that where the optimum is $b^C(\gamma_{dsb}) = 0$.

To see this, note that the first and second terms in $\frac{dE[\hat{\Omega}(b^C, \gamma)|\gamma_{dsb}]}{db^C}$. We now turn to part (ii). To prove that the optimal $b^C$ is increasing in $\gamma^*$, note: (a) $R(b^C)$ is increasing in $\gamma^*$; (b) $|b^C(b^C, \gamma)|$ is increasing in $\gamma^*$; (c) $S(b^C)$ is independent of $\gamma^*$; and (d) $H(-|\gamma_{dsb})$ is increasing. Thus $\frac{dE[\hat{\Omega}(b^C, \gamma)|\gamma_{dsb}]}{db^C}$ is increasing in $\gamma^*$, and the claim follows. QED
Proof of Proposition 5:

Claim (ii) can be easily shown by examples, so here we focus on proving claim (i).

In the text we have argued that, the optimum is a property rule without escape, the outcome must be “no dispute”. Consider next the case in which the optimum is a property rule with escape: \(b^C(\gamma^{dsb})\) is prohibitive for \(\gamma^{dsb} \in (\underline{\gamma}^{dsb}, \gamma_1^{dsb})\) and zero for \(\gamma^{dsb} \in [\gamma_1^{dsb}, \gamma^{dsb}]\), with \(\underline{\gamma}^{dsb} < \gamma_1^{dsb} < \gamma^{dsb}\). First observe that the no-dispute outcome is possible in this case, and it occurs for any \(\gamma\) such that \(b^C(\gamma^{dsb})\) defines a noncontingent property rule over the support \([\underline{\gamma}^{dsb}(\gamma), \gamma^{dsb}(\gamma)]\). Next observe that a DSB ruling (which by Proposition 4(i) is always implemented) can also occur in this case: this outcome occurs for any \(\gamma\) in Region II such that \(b^C(\gamma^{dsb})\) defines a contingent property rule over the support \([\underline{\gamma}^{dsb}(\gamma), \gamma^{dsb}(\gamma)]\), because \(E[D]\) then corresponds to a point in the top right panel of Figure 3 that lies somewhere on the dotted line connecting the points \(P\) and \(FT\) – and strictly between these points – at a location that depends on the probability associated with escape but clearly lies above the stage-2 bargaining frontier.

Next we argue that when the optimum is a property rule with escape is that early settlement cannot occur in this case. To see why, notice first that it is immediate from the top right panel of Figure 3 that when the optimum is a property rule with escape early settlement can never occur for \(\gamma\) in Region II, where \(R(0) < \gamma < S(\gamma^*)\): this is because either \(b^C(\gamma^{dsb})\) defines a contingent property rule over the support \([\underline{\gamma}^{dsb}(\gamma), \gamma^{dsb}(\gamma)]\), in which case as we have observed above a ruling will occur; or \(b^C(\gamma^{dsb})\) defines a noncontingent property rule or noncontingent \(b^C = 0\) over the support \([\underline{\gamma}^{dsb}(\gamma), \gamma^{dsb}(\gamma)]\), in which case as we have observed above there will be no dispute. Consider next a realization of \(\gamma\) in Region III (i.e. when \(\gamma > S(\gamma^*)\)). Here it is not possible for the DSB to receive a signal \(\gamma^{dsb}\) such that \(b^C(\gamma^{dsb})\) is prohibitive, because otherwise for that signal we would have \(\tilde{\gamma}(\gamma^{dsb}) > S(\gamma^*)\) and hence \(b^C(\gamma^{dsb})\) prohibitive would require \(b^C(\gamma^{dsb}) > \gamma^*\) which cannot be optimal; and so when the optimum is a property rule with escape as we have supposed, it must then be that for realizations of \(\gamma\) in Region III we can only have DSB signals such that \(b^C(\gamma^{dsb}) = 0\), and hence again no dispute. Finally, consider a realization of \(\gamma\) in Region I, where \(\gamma < R(0)\). We have argued earlier that \(b^C(\gamma^{dep}) = 0\) is inconsistent with \(\tilde{\gamma}(\gamma^{dep}) < R(0)\), and so if the optimum is a property rule with escape it must then be that for realizations of \(\gamma\) in Region I we can only have DSB signals such that \(b^C(\gamma^{dsb})\) is prohibitive, hence a noncontingent property rule and once again no dispute. We conclude that early settlement cannot occur when the optimum is a property rule with escape. QED
References

Andrews, Donald W.K and Gustavo Soares (2010), “Inference for parameters defined by mo-


nomics Letters*, vol. 24, pp. 287-90.


Calabresi, Guido and A. Douglas Melamed (1972), “Property Rules, Liability Rules and In-


Staiger, Robert W. and Alan O. Sykes (2013), “How Important can the Non-Violation Clause be for the GATT/WTO?,” unpublished manuscript, The University of Wisconsin, August.


Figure 2: possible types of contract
Figure 3

Stage - 2 bargaining outcome, $\gamma < R(0)$

Stage - 2 bargaining outcome, $R(0) < \gamma < S(\gamma^*)$

Stage - 2 bargaining outcome, $\gamma > S(\gamma^*)$
Figure 4

Note: Bars represent the claim-weighted average rates of early settlement in a given era for claims that are classified as property ($ES_{WPWTO}$) and liability ($ES_{WLWTO}$) rules in the WTO era; see text for precise definitions.
<table>
<thead>
<tr>
<th>CLAIM</th>
<th>WTO-ERA CLASSIFICATION</th>
<th>PROPORTION OF CASES WHERE CLAIM INVOKED</th>
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<tr>
<td>Nondiscrimination</td>
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<tr>
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<td>National treatment</td>
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<td>Film provisions</td>
<td>property</td>
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</tr>
<tr>
<td>Transit</td>
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<tr>
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<tr>
<td>Violation nullification or impairment</td>
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<tr>
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<tr>
<td>Modification of schedules</td>
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Note: See Data Appendix for specific GATT/WTO Articles associated with each claim.
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<td>0.26 (0.06)</td>
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<td>Decline from Early to Post-Ruling</td>
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Note: Standard errors in parentheses
### Table 3: Logit Coefficients

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<th>Early Settlement</th>
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<td>GATT-II</td>
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Note:
- Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1
- ‘a’ denotes claim omitted due to lack of use.

1: Interaction terms represent the product of the associated base group variable and an indicator variable that takes value 1 if the dispute was a WTO-era dispute and zero otherwise.
2: Interaction terms represent the product of the associated claim variable and its claim-specific experience variable.