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 support for a key prediction of our model using data on the outcomes of actual trade disputes in the General Agreement on Tariffs and Trade (GATT) and World Trade Organization (WTO).

1. INTRODUCTION

On September 24, 2012, the New York Times ran an article covering a World Trade Organization (WTO) dispute between the United States and the EU over launch-aid subsidies that the EU provides to Airbus, and 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 noncooperative U.S.–EU trade war, but it is not: The trade sanctions threatened by Washington were WTO-authorized sanctions by which the United States would achieve compensation for the harmful trade effects of EU subsidies, and the Times report describes one development in an ongoing legal process of dispute resolution within the WTO.

Unlike the sporadic trade wars of past eras (see Coneybeare, 1987), international trade disputes of this kind are now a regular feature of the world trading system. In fact, since the creation of the WTO in 1995, there have been on average 25 trade disputes initiated in the WTO each year. But 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” all the way to a DSB ruling. And in these latter cases, sometimes the DSB ruling is implemented, whereas at other times, governments negotiate a post-ruling settlement. In the WTO and its predecessor, the General Agreement on Tariffs and Trade (GATT), just over 50% of disputes settle early, before a DSB ruling is issued. And in 20% of those GATT/WTO disputes that do go to a ruling, instead of implementing the DSB ruling, the governments negotiate their own post-ruling settlement. This variation in dispute outcomes has been well documented empirically (see, e.g., Busch and Reinhardt, 2000, 2006). And as the $10 billion in trade sanctions hanging in the balance for the Airbus dispute...
illustrates, there can be a great deal riding on how these disputes are resolved. It is therefore important for economists to understand why the various dispute outcomes come about.

In the economics literature on trade agreements, however, there are few models that even predict the occurrence of trade disputes. In this article, we develop a simple model of trade agreements that generates trade disputes and a rich set of possible outcomes of those disputes as an equilibrium 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 contract form. We also offer an initial assessment of one of the model's key predictions in light of data on trade disputes in the GATT/WTO.

Our model focuses on trade policies that are discrete in nature. This focus seems appealing because many trade disputes in the GATT/WTO concern policies such as regulatory regimes or product standards that, once in place, do not accommodate marginal adjustments easily. Even policies that might in principle appear to be continuous, such as domestic taxes and export subsidies, are in practice often implemented with complex programs that, unlike import tariffs, are difficult to alter ex post in a marginal and continuous way. And trade disputes over the level of import tariffs are rare.

In our model, governments contract over trade policy (free trade or protection) in the presence of ex ante uncertainty about the state of the world, as embodied in 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 state of the world 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 key feature of our model is that these ex post negotiations are subject to a transaction cost, namely, that government-to-government compensation entails a deadweight loss; this assumption seems warranted because, as the Airbus example suggests, in the context of trade disputes, governments rarely have access to cash transfers and instead rely on inefficient forms of compensation such as the "self-help remedy" of trade sanctions.

The three above-mentioned features of our model—the inefficiency of government-to-government transfers, the presence of uncertainty about the DSB ruling, and the discreteness of the policy—are key to the model's predictions, because they allow for the possibility that governments may not settle early. As a consequence, our model generates a variety of predictions regarding when governments reach an early settlement or fight it out to a court ruling, and in the latter case, when the court ruling is implemented or governments reach a later settlement.

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 imposing protection and 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. If the level of damages is prohibitively high, the contract is equivalent to a "property rule" (or "specific performance" contract) in the law-and-economics terminology, whereas if the level of damages is nonprohibitive, the contract

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2 For example, of the 509 disputes included in the complete listing of WTO disputes to date on the WTO Web site, only two (DS39 and DS485) involve a simple claim that the level of the respondent's import tariffs has exceeded its bindings.

3 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 footnote 10).
is a “liability rule.” In the case of a property rule, the commitment to free trade is treated like a property right that can only change hands by mutual consent, whereas in the case of a liability rule, the importer can buy out of this commitment by paying the contractually specified damages. Our contract class also includes the possibility of a “property rule with escape” (the commitment to free trade is waived—with no compensation owed—in some contingencies), and that of a “liability rule with escape” (the compensation is waived in some contingencies), as well as mixtures of property and liability rules. Legal scholars (e.g., Jackson, 1997; Pauwelyn, 2008) emphasize the distinction between property rules and liability rules and describe variation across issue areas and over time in the use of these rules in the GATT/WTO.

We first establish that all disputes, regardless of the contract form, settle early when the joint benefits of protection are sufficiently far from zero (either positive or negative). That is, trade disputes always end in early settlement if the “efficiency stakes”—the positive or negative change in the governments’ joint surplus that would occur if the disputed policy were removed—are high enough. One might think that this result reflects a decision by the governments that with so much at stake, it is too costly to proceed to a ruling and risk that the DSB might rule incorrectly. But in our model, the governments can always negotiate a post-ruling settlement and implement whatever policy they want, so this is not the reason for the result.

The key to understanding this first result is to recognize that if the efficiency stakes of the dispute are high, then there is no uncertainty as to the policy choice that a DSB ruling would induce, for the simple reason that, regardless of the ruling, governments will always find it worthwhile to implement the efficient policy and enjoy the associated large gain in joint surplus. It then follows that the only impact of proceeding to a DSB ruling when the efficiency stakes are high is that the ruling will determine the damage payment accompanying the policy choice; but the governments can replicate the associated expected payoff in certainty-equivalent terms by themselves, without triggering a ruling in the first place. Hence, when the efficiency stakes are high, governments have no reason to see their dispute through to a DSB ruling and will instead settle early, and this is true regardless of the contract form.

We next establish that disputes need not settle early in states of the world where the efficiency stakes are small. The reason is that, in these states, the policy choice itself can be impacted by the DSB ruling. Indeed, we show that trade disputes proceed to a ruling if and only if the policy choice hinges on the possible DSB ruling: This is because when it does, governments can utilize the policy uncertainty generated by the ruling as a means of compensation, and the inefficiency associated with this method of compensation is small when the dispute’s efficiency stakes are small, making it attractive relative to the alternative of trade sanctions. Thus, when efficiency stakes are small, it is possible that governments will proceed to a ruling, and they will do so if the policy choice hinges on the possible DSB ruling.

Having characterized the general forces in our model that determine whether governments settle early or fight it out to a court ruling, we then focus on the relationship between dispute outcomes and contract form. We first do this taking the contract form as exogenously given. We show that the distinction between property rules and liability rules is important for predicting the outcomes of trade disputes. Specifically, we find that both early and post-ruling settlements are less likely to occur for disputes over property rules than for disputes over liability rules.

We establish this second set of results by building on our earlier finding that all disputes, regardless of contract form, settle early when the efficiency stakes are high and by observing that any difference in settlement rates between property rules and liability rules must be associated with disputes where the efficiency stakes are small. We show that in small-efficiency-stakes disputes over property rules, the policy choice always hinges on the DSB ruling, and hence these property-rule disputes never settle early. Moreover, leveraging on the observations above,

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4 According to our model, the DSB also plays additional roles beyond generating policy uncertainty and thereby serving as a randomization device for the governments. Provided the DSB signal is informative (better than a coin flip), the DSB’s policy choice is noisy but “right” more often than not. And as we discuss later, the DSB plays an important off-equilibrium role even when the dispute does not proceed to a ruling.
we show that there is never post-ruling settlement for disputes over property rules either. By contrast, in small-efficiency-stakes disputes over liability rules, the policy choice may or may not hinge on the DSB ruling, depending on the details of the liability rule and on other parameters. And so liability-rule disputes can settle early even when the efficiency stakes are small, and when they proceed to a DSB ruling, we show that post-ruling settlement can occur as well.

We also consider how dispute outcomes depend on key ex ante features of the contracting environment, again first taking the contract form as exogenously fixed. We describe how changes in the cost of transfers, the accuracy of DSB rulings, and the degree of ex ante uncertainty impact the likelihood of early and post-ruling settlement. And when comparing the equilibrium outcomes of early and post-ruling settlements, we show that the latter should be more liberalizing than the former.

Finally, we derive the optimal contract form within our class of contracts. We focus on the accuracy of the DSB information and degree of ex ante uncertainty as the key determinants of the optimal contract. We find that if the DSB can gather precise information or if ex ante uncertainty is small, the optimal contract is a property rule, possibly with escape. By contrast, if the DSB information is imprecise and ex ante uncertainty is large, we show that the optimal contract is a liability rule (again possibly with escape). In addition to illuminating the conditions most favorable to the performance of property and liability rules, our findings here confirm that each of these two contract forms can be optimal within our model. We then revisit each of our findings on dispute outcomes derived for exogenous contracts, and we confirm that our results on the relationship between dispute outcomes and contract form are preserved (and in one case strengthened) when the contract is chosen optimally.

In this article, we cannot provide a systematic investigation of our model’s empirical content, but we do offer an initial assessment of one key prediction, namely, that early settlement rates should be lower in disputes over property rules than in disputes over liability rules. We find that data on GATT/WTO disputes support this prediction. Specifically, both when we look across rules within the WTO era and when we adopt a difference-in-difference approach that also exploits variation in rules between the GATT and WTO eras, we find evidence of a significantly lower settlement rate for disputes over property rules than for disputes over liability rules.

For the questions we consider here, the relevant economics literature on trade agreements is somewhat sparse. Maggi and Staiger (2015) develop a related model, but in that model, there are no rulings in equilibrium, because governments have no uncertainty about the ruling, so that model cannot shed light on the conditions under which governments settle early or proceed to a DSB ruling, and in the latter case whether or not they reach a post-ruling settlement.5,6

There are models of trade agreements that generate disputes in equilibrium and have an explicit role for the DSB, including Beshkar (2010), Maggi and Staiger (2011), Park (2011), and Staiger and Sykes (2017), but none of these models generates the rich dispute outcome possibilities that we describe above. A notable exception is the model by Beshkar (2016), where early settlement and DSB rulings can both occur in equilibrium, and in the latter case, governments may reach a post-ruling settlement. Beshkar’s model differs from ours on several dimensions. First, it assumes continuous policies (tariffs) and a binary state of the world (high

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5 The model of Maggi and Staiger (2015) differs from the model we develop here along several other dimensions as well. First, in that model, the DSB cannot observe any information ex post, so the contract is noncontingent; hence, a property-rule contract cannot allow “escapes,” and the level of damages specified by a liability rule must be noncontingent (a contract form sometimes called “liquidated damages”). In contrast, here, the DSB (if invoked) can observe a noisy signal of the state of the world and so the contract can include “escape clauses” that are contingent on the DSB investigation. A second and related difference is that, in the present article, the accuracy of the DSB investigation plays an important role in determining the optimal contract and the outcome of disputes, whereas in Maggi and Staiger (2015), there is no DSB investigation at all. And finally, there is a methodological difference: The feature that the DSB can observe information ex post makes the analysis more complex relative to our earlier paper, and this is reflected in the need to assume a linear cost of transfer for tractability (see Lemma 1 and the surrounding discussion).

6 In a recent working paper (Maggi and Staiger, 2016), we examine the implications of judicial learning for the dynamics of trade disputes. We discuss this paper further in the last section.
or low political pressure in the importing country), whereas our model assumes a binary policy and a continuous state of the world. Second, it assumes that the importing government privately observes a political shock, and the DSB, if invoked, observes a signal of that shock and makes the signal public. And third, it assumes that governments are not able to renegotiate at a key juncture, and this is important for the possibility of equilibrium rulings.\(^7\) A notable difference in results is that in Beshkar’s model, the optimal contract always takes the form of a liability rule, whereas in our model, the optimal contract can be either a liability rule or a property rule.

By contrast, the law-and-economics literature has long had models of settlement (see, e.g., Bebchuck, 1984; Reinganum and Wilde, 1986). And there is a vast 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, 2015), 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.\(^8\)

In the next section, we lay out the basic model. Section 3 focuses on the outcome of disputes. Section 4 characterizes the optimal contract. Section 5 presents evidence from GATT/WTO disputes. Section 6 concludes. Proofs not included in the body of the article are available in the online Appendix.

2. THE MODEL

We introduce our model in two steps. First, we describe the contracting environment, and then we describe specific contract types that will feature prominently in our subsequent analysis.

2.1. The Contracting Environment. We begin by describing the economic structure, which is similar to Maggi and Staiger (2015). 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 trade policy for the industry, which we denote \(T \in \{FT, P\}\) (“Free Trade” or “Protection”), whereas the Foreign government is passive in this industry. As noted in Section 1, many trade disputes in the GATT/WTO focus on nontariff policy choices that are discrete in practice, and our assumption of a binary policy instrument is a simple way to capture this property. In Section 6, we discuss in more detail the role of our binary policy assumption.

A transfer may also be exchanged between the governments, but we assume that such transfers are costly to orchestrate; that is, 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.\(^9\) Yet, in the GATT/WTO, countries do sometimes achieve compensation indirectly through the “self-help” remedy 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

\(^{7}\) In Beshkar’s (2016) arbitration game, the complainant offers low tariff levels, and the defendant rejects if its privately observed political pressure \(\theta\) is high, after which the DSB automatically steps in and issues a ruling; but after such a rejection, the high level of \(\theta\) is revealed, so it is not clear why governments would go to court at that point if they had the choice (Beshkar focuses on contracts that are impervious to “interim” and “ex post” renegotiation, but this does not include the renegotiation possibility we describe here).

\(^{8}\) Also relevant is the 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 parties to renegotiate both before and after the court ruling; 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, and, in particular, we focus on a simple 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.

\(^{9}\) For example, with two exceptions (the U.S.-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.
\(b\) 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 less than one, or \(c \in (0, 1)\), and that the Home country always bears the deadweight loss \(C(b)\). These two assumptions ensure that Home’s total cost of the transfer inclusive of deadweight loss, \(b + C(b)\), is increasing for all \(b\).10

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 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 the 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 gain from protection, which we denote \(\Gamma \equiv \gamma - \gamma^*\), can be positive or negative. The case \(\Gamma > 0\) can be interpreted as arising when there are significant political economy pressures in the Home country, or perhaps when market failures make trade protection preferable to free trade.11 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 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.12 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.13 The ex ante distribution of \(\gamma\) is common knowledge and has density \(h(\gamma)\), defined over \(\gamma \in [0, \infty)\). We let \(\gamma\) and \(\tilde{\gamma}\) denote the bounds of the support of \(\gamma\); that is, \(\gamma = \inf\{\gamma : h(\gamma) > 0\}\) and \(\tilde{\gamma} = \sup\{\gamma : h(\gamma) > 0\}\). To make the problem interesting, we assume \(\gamma < \gamma^* < \tilde{\gamma}\), 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 (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 less than one, or \(c \in (0, 1)\), and that the Home country always bears the deadweight loss \(C(b)\). These two assumptions ensure that Home’s total cost of the transfer inclusive of deadweight loss, \(b + C(b)\), is increasing for all \(b\).10

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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 (positive or negative) transfer from Home to Foreign, denoted by

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

11 In models of the Grossman–Helpman type, the joint-surplus-maximizing trade policy is typically not free trade whenever there are political economy considerations in the governments’ objectives. Alternatively, the joint-surplus maximizing trade policy may diverge from free trade because of market failures such as imperfect competition or environmental externalities (assuming more targeted policy instruments are not available).

12 On the case for modeling trade agreements as incomplete contracts, see, for example, Maggi (2014), and for a model where trade agreements are endogenously incomplete, see Horn et al. (2010).

13 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 assumptions in the literature on contract design with renegotiation (see, e.g., Segal and Whinston, 2002), though our modeling of imperfect verifiability is more novel.
Our model assumes that governments cannot negotiate lotteries over trade policies. If they could, the bargaining set could be convexified, and the court would never be invoked in equilibrium. Like our assumption that costless transfers are unavailable, this is an ad hoc restriction, but one that reflects a fact of life: In reality, governments are never observed negotiating these kinds of lotteries. Why this is the case is an interesting question, but one that is beyond the scope of this article. We also omit consideration of more sophisticated court mechanisms that could potentially elicit the true value of $\gamma$ and implement the first best. In particular, we do not consider mechanisms based on messages sent by the disputants. However, it is an open question whether or not such mechanisms can improve upon the simple menu contracts we consider in our setting. And as we have argued elsewhere (Maggi and Staiger, 2015), 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.

We impose a minimum of structure on the DSB signal technology by requiring that the conditional density of $\gamma^{dsb}$ given $\gamma$ is log-supermodular, or equivalently that the monotone-likelihood-ratio property is satisfied. This condition is relatively standard and is satisfied by several common distributions (see Athey, 2002, especially footnote 15). And we let $\gamma^{dsb}$ and $\gamma^{dsb}_{max}$ denote the bounds of the support of $\gamma^{dsb}$.

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 Nash bargain over the policy $T$ and the transfer $b$. (3) If governments fail to agree, 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, and if governments fail to agree, the DSB ruling $b^C(\gamma^{dsb})$ applies (so the Home government can choose between setting $FT$ and setting $P$ with compensation $b^C(\gamma^{dsb})$). 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.” We assume that the governments have symmetric bargaining power.

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 noncontingent $FT$ contract—generating the outcome $FT$ (and no transfer) for all realizations of $\gamma$—would strictly improve upon no contract provided that $E[\gamma] < \gamma^*$.}

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 $\gamma$ 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, which is itself an option, as the importer can choose between $(T = P, b = b^C(\gamma^{dsb}))$ and $(T = FT, b = 0)$.

\subsection*{Specific Contract Types}

We now describe the main contract types that will feature prominently in what follows. To do so, we consider the family of contracts where $b^C$ is weakly decreasing in $\gamma^{dsb}$—which we will later argue is a feature of the optimal contract in our environment—and describe a number of contract types that emerge as special cases of this family of contracts.\footnote{We note that, while it is natural to focus here on contracts where $b^C$ is weakly decreasing in $\gamma^{dsb}$ since this is a feature of an optimal contract, our results on dispute outcomes in Section 3 do not rely on this feature.}

A first possibility, illustrated in the top left panel of Figure 1, is a contract that specifies a prohibitively high level of damages for all DSB signals. In this and all panels of Figure 1, we use the label “$b^{prohib}$” to denote the minimum level of damages such that Home prefers $(T = P, b = b^C(\gamma^{dsb}))$ to $(T = FT, b = 0)$ for all $\gamma$. This type of contract specifying an
extreme level of damages is outcome-equivalent to a “property rule” (or “specific-performance”) contract in the law-and-economics terminology: Such a contract establishes a strict \( FT \) commitment, which is treated like a property right that can change hands only by mutual consent. On the basis of this observation, below we refer to this type of contract simply as a property rule. A related contract, depicted in the bottom left panel of Figure 1, establishes a strict \( FT \) obligation but waives this obligation under some circumstances. Here, escape is allowed for a range of high DSB signals, where \( b^C(\gamma_{dsb}) = 0 \) and hence no compensation for \( P \) is required, whereas for all lower DSB signals, escape is not allowed and the level of damages \( b^C(\gamma_{dsb}) \) is prohibitively high. We will sometimes refer to this contract type as a property rule “with escape.”

The two contracts we have described thus far represent property rules (with or without escape), because \( b^C(\gamma_{dsb}) \) is set at a prohibitively high level (or else zero). An alternative is a contract that allows breach of the \( FT \) commitment in exchange for nonprohibitive damages—a “liability rule” in the law-and-economics terminology. We define a liability rule as a contract with \( b^C(\gamma_{dsb}) \) below the prohibitive level for all \( \gamma_{dsb} \)—meaning that for any \( \gamma_{dsb} \), there will be some realization of \( \gamma \) in its support (conditional on \( \gamma_{dsb} \)) such that Home prefers \( (T = FT, b = b^C(\gamma_{dsb})) \) to \( (T = FT, b = 0) \). And when the liability rule includes an escape we have \( b^C(\gamma_{dsb}) = 0 \) for high values of \( \gamma_{dsb} \); we depict this contract in the bottom right panel of Figure 1.

A final interesting possibility is the contract depicted in the top right panel of Figure 1, a mixture of a property rule and a liability rule with escape. We will sometimes refer to this contract as a “mixed rule.” It requires strict adherence to the \( FT \) commitment for low values of \( \gamma_{dsb} \), whereas for high values of \( \gamma_{dsb} \) it allows escape without damage payments, 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 the GATT/WTO in later sections, but we note here that aspects reminiscent of this last contract can be seen in the WTO rules on “escape clause” actions, which establish a baseline commitment to \( FT \), but under some conditions permit the importer to compensate the exporter and protect and under more stringent conditions permit the importer to protect without paying compensation.

We have observed that a property rule is outcome-equivalent in our model to an extreme liability rule that sets prohibitively high damages, an observation that is shared by Kaplow and Shavell (1996): but it should be kept in mind that in reality, property rules are typically enforced by means other than extreme levels of compensation. In domestic legal systems, property rules are usually enforced with criminal sanctions (e.g., jail time). In the context of trade agreements, there are no jails into which violators of property rules can be thrown, and the sanctions for violating property rules must take a different form, possibly the undermining of the system of rules itself, in addition to conventional trade sanctions. In any event, for our

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21 In Maggi and Staiger (2015), 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.

22 More specifically, under the WTO escape clause, the importing country can compensate the exporting country and impose protection to address injury to its domestic import-competing industry if the injury is “serious” and results from rising import penetration, but compensation need not be paid at all (for the first three years of an escape clause action) if the injury can be traced to a rise in the absolute level of imports. This is broadly in line with the final contract we describe in the text 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.

23 In practice, property rules rarely if ever achieve perfect deterrence: Auto thefts do occur and jail times are served. Presumably, this is so because there is a distribution of types in the population and in the level of punishment that achieves deterrence, and the possibility of error makes the most extreme punishments unattractive. We abstract from these issues here.

24 This point is discussed at length by Pauwelyn (2008, pp. 148–197), who argues that in the WTO, property rules are enforced by a combination of conventional trade sanctions and a “kicker” in the form of “community costs,” perhaps manifested in an erosion of the WTO member countries’ goodwill in future negotiations toward a country violating a
formal model, the exact nature of the prohibitive penalty associated with violation of a property rule is immaterial, because it remains off the equilibrium path.

3. TRADE DISPUTES

We now examine the implications of our model for the resolution of disputes. 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. Suppose governments agree in stage 2 that the Home 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, whereas compensation is typically a matter for negotiation between the two governments.\(^{25}\) 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 nonzero transfer \( b \neq 0 \), we interpret this as a dispute with early settlement, and if at stage 2, governments reach an agreement that involves no transfer, we interpret this as there being no dispute.\(^{26}\)

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 nonzero 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 \( b^C(\gamma_{\text{dsb}}) \), and the Home government behaves according to the ruling; that is, it chooses one of the two options \((T = FT, b = 0)\) or \((T = P, b = b^C(\gamma_{\text{dsb}}))\). 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 negotiate a different resolution to their dispute in stage 4. We will refer to this outcome as one of post-ruling settlement.

This discussion suggests two key questions that we address in the remainder of this section: (i) When do disputes arise, and when is there early settlement? (ii) When is there post-ruling settlement? We begin by considering the first question and then turn to the second.

3.1. Early Settlement and DSB Rulings. When do disputes arise, and when is there early settlement? To answer these questions, we begin by developing a figure that can be used to characterize the stage-2 outcomes.

\(^{25}\) In fact, the GATT/WTO requires that governments consult whenever a possible retaliation is involved.

\(^{26}\) 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.
For fixed $\gamma^*$, we partition the potential values of $\gamma$ into three intervals or “regions:” Region I, $\gamma \in [0, (1 - c)\gamma^*]$; Region II, $\gamma \in ((1 - c)\gamma^*, (1 + c)\gamma^*)$; and Region III, $\gamma \in [(1 + c)\gamma^*, \infty)$. For realizations of $\gamma$ in Regions I and III, the “efficiency stakes” of the dispute—the positive or negative change in joint surplus generated by a change in the policy—are high; in Region II, the efficiency stakes are low.

In Figure 2, we depict the bargaining frontier for $\gamma$ in each of these regions, with the Home and Foreign government payoffs on the vertical and horizontal axis, respectively. For each region, the bargaining frontier corresponds to the outer envelope of two piecewise-linear subfrontiers, 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 subfrontier reflects the piecewise linearity of $C(b)$, with the slope of each subfrontier given by $- (1 - c)$ for $b < 0$ and by $- (1 + c)$ for $b > 0$ and each subfrontier kinked at $b = 0$. Recalling our assumption that the value $\gamma = \gamma^*$ is in the interior of the marginal support of $\gamma$, it follows that $\gamma$ falls in Region II with positive ex ante probability. By contrast, Regions I and/or III are relevant only if the support of $\gamma$ is sufficiently large.

The top left panel of Figure 2 depicts the bargaining frontier for Region I. Here, $\gamma$ is far below $\gamma^*$, so 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 2 depicts the bargaining frontier for Region III. Here, $\gamma$ is far above $\gamma^*$ and 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, the top right panel of Figure 2 depicts the bargaining frontier for Region II.
frontier for Region II. Here, $\gamma$ is relatively close to $\gamma^*$ and, as a consequence, neither of the policies $FT$ or $P$ Pareto-dominates the other: 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 2. In case of disagreement in stage 2, there will be a DSB ruling followed by post-ruling bargaining (at stage 4). Thus, we need to proceed by backward induction, solve for the equilibrium payoffs of the post-ruling bargaining for each possible ruling $b^C$, and then take the expectation of those payoffs over the possible values of $b^C$ conditional on $\gamma$ (given the contract $b^C(\gamma_{\text{dsb}})$). Formally, 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 $G(\gamma_{\text{dsb}} | \gamma)$ the c.d.f. of $\gamma_{\text{dsb}}$ conditional on $\gamma$, we may express the expected Home and Foreign disagreement payoffs for the stage-2 bargain given $\gamma$ as $\int \tilde{\omega}(b^C, \gamma_{\text{dsb}}, \gamma) dG(\gamma_{\text{dsb}} | \gamma)$, and $\int \tilde{\omega}^*(b^C, \gamma_{\text{dsb}}, \gamma) dG(\gamma_{\text{dsb}} | \gamma)$, respectively.

For the purposes of our next results, we do not need to go through the full backward-induction analysis; we only need to understand whether the disagreement point for the stage-2 bargain lies above the bargaining frontier, in which case governments will trigger a DSB ruling, or rather it lies on or below the frontier, in which case governments will settle early.\(^{27}\)

Our first remark is that the disagreement point for the stage-2 bargain can never lie strictly below the bargaining frontier. If $\gamma$ falls in Region I or III, this point always lies on the bargaining frontier, and if $\gamma$ falls in Region II, it may lie either on the bargaining frontier or above it.

To see this, fix a value of $\gamma$ and consider the possible stage-4 outcomes if governments trigger a DSB ruling. After the ruling governments can bargain again (at stage 4), and since bargaining is efficient, the stage-4 equilibrium payoff point lies on the bargaining frontier regardless of the ruling. Moreover, it is intuitive and can easily be shown that for any $\gamma$, the stage-4 equilibrium payoff point can never lie on the left branch of the $P$ subfrontier or the right branch of the $FT$ subfrontier; that is, it can never be the case that the policy is $P$ and the importer receives a payment ($b < 0$) or the policy is $FT$ and the exporter receives a payment ($b > 0$).

Now let us consider each of the three possible intervals of $\gamma$. If $\gamma$ falls in Region I, given the observations just above, all possible stage-4 equilibrium payoff points lie on the left branch of the $FT$ subfrontier (the red line in the top left panel of Figure 2), and since all these points lie on a single line, the expected payoff point must also lie on this line, and hence the disagreement point for the stage-2 bargain lies on the bargaining frontier. We label such a disagreement point $ED$ in the top left panel of Figure 2. Similarly, if $\gamma$ falls in Region III, all possible stage-4 equilibrium payoff points lie on the right branch of the $P$ subfrontier (the red line in the bottom panel of Figure 2); thus, the expected payoff point must also lie on this line, and hence the disagreement point for the stage-2 bargain in Region III must also lie on the bargaining frontier. We label such a disagreement point $ED$ in the bottom panel of Figure 2.

Finally, suppose $\gamma$ falls in Region II. In this case, the stage-4 equilibrium payoff point must lie either on the left branch of the $FT$ subfrontier or on the right branch of the $P$ subfrontier; thus, the set of possible stage-4 equilibrium payoff points is a weakly convex locus (the red locus in the top right panel of Figure 2).\(^{28}\) It follows immediately that the expected stage-4 payoff point—that is, the disagreement point for the stage-2 bargain—may lie either on the bargaining frontier or above it, but never strictly below it. We depict two possible disagreement points, both labeled $ED$, in the top right panel of Figure 2. And whether the $ED$ point is on the frontier or above it depends on whether the set of possible stage-4 payoff points includes points on both branches of the bargaining frontier or only one of them; we will later examine conditions under which each case arises.

\(^{27}\) If the disagreement point is on the frontier, the governments are indifferent between triggering a DSB ruling and agreeing on the certainty-equivalent terms of the disagreement payoff. We break this indifference in favor of early settlement.

\(^{28}\) It is important to keep in mind that the red locus highlighted in each panel of Figure 2 includes all possible stage-4 payoff points for the corresponding region of $\gamma$, but the set of possible stage-4 payoff points will be a subset of this red locus that depends on the contract and the possible DSB signal realizations.
We are now ready to consider the questions posed at the beginning of this section. First, when do disputes arise? In light of our convention that the no-dispute outcome corresponds to a stage-2 agreement involving no transfers, the answer to this first question is immediate from Figure 2 and our observation just above that governments obtain exactly their expected disagreement payoffs in the stage-2 bargain. The no-dispute outcome arises for $\gamma$ in Region I if and only if the stage-2 disagreement point corresponds to the point $FT$ in the top left panel of Figure 2, for $\gamma$ in Region III if and only if the stage-2 disagreement point corresponds to the point $P$ in the bottom panel of Figure 2, and for $\gamma$ in Region II if and only if the stage-2 disagreement point corresponds to the point $P$ or $FT$ in the top right panel of Figure 2.

We next turn to the question of how disputes are resolved: Does the dispute settle early, or does it proceed to a ruling? A first result is clear, because, as we observed above, in Regions I and III, the disagreement point always lies on the bargaining frontier; in these regions, disputes are always settled early, regardless of the contract. We may therefore state:

**Proposition 1.** If $\gamma$ lies in Region I or III, where the efficiency stakes are high, any dispute will end in early settlement.

Proposition 1 reflects the fact that, as Figure 2 depicts, when the efficiency stakes of the dispute are high (i.e., for $\gamma$ in Regions I or III), there is no uncertainty as to the policy choice that a DSB ruling would induce. For example, if $\gamma$ falls in Region III, policy $P$ will be the result regardless of the ruling: If the DSB-announced damages are not too high, then the importer will choose $P$ and pay the DSB-stipulated damages; otherwise, there will be a post-ruling settlement under which $P$ will again be chosen and governments will settle with a level of damages that is lower than that stipulated by the DSB. A similar logic implies that policy $FT$ will be the result regardless of the ruling when $\gamma$ falls in Region I. Hence, in these circumstances, the only impact of the ruling is to pin down the transfer. But then the expected payoff to the two governments if they trigger a ruling is simply the payoff associated with the chosen policy and the expected transfer, and this is a payoff that the two governments can replicate in certainty-equivalent terms by themselves, without triggering a ruling in the first place. For this reason, the governments settle early in Regions I and III, regardless of the nature of the contract.

Let us now consider disputes that arise in Region II, where the efficiency stakes of the dispute are low. Here, it is possible that the disagreement point for the stage-2 bargain lies above the bargaining frontier and hence that the dispute will proceed to a DSB ruling. To understand when this can happen, the first step is to examine how the equilibrium outcome of the post-ruling (stage-4) bargaining depends on the DSB ruling $b^C$. For this, we turn to Figure 3. The red locus of points in Figure 3 traces out the equilibrium payoffs of the post-ruling bargaining as $b^C$ varies between zero and infinity. Clearly, for $b^C = 0$, the outcome is at point $P$. As $b^C$ increases from zero, initially, the disagreement point travels down along the $P$ subfrontier, and hence the outcome of the post-ruling bargain coincides with the disagreement point. As $b^C$ increases beyond a certain level, the disagreement point dips below the bargaining frontier and travels along the dotted red-and-blue line, and therefore the outcome of the post-ruling bargain will be diagonally above the disagreement point on the $FT$ subfrontier. Finally, as $b^C$ increases beyond the prohibitive level, so that Home prefers to choose free trade instead of protect and pay damages, the disagreement point jumps to point $FT$.

Having traced out how the equilibrium payoff of the post-ruling bargaining varies with $b^C$, the final step is to consider the expected equilibrium payoff of the post-ruling bargain (in light of the contract $b^C(\gamma_{dsb})$ and the distribution of $\gamma_{dsb}$ conditional on $\gamma$), which defines the disagreement point for the stage-2 bargain. And as we have observed above, the dispute proceeds to a ruling if and only if this disagreement point lies above the bargaining frontier.

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29 It may seem surprising that the disagreement point jumps to the $FT$ point as $b^C$ crosses the prohibitive level (say $\gamma_{prohib}$). Note that Home’s disagreement payoff does not jump, but Foreign’s disagreement payoff does: It is clear from Figure 3 that for $\gamma$ in Region II, if Home is indifferent between ($T = FT$, $b = 0$) and ($T = P$, $b = \gamma_{prohib}$), Foreign must strictly prefer the former.
We can now make the following observation: A DSB ruling is triggered in Region II if and only if the policy hinges on the DSB ruling. If this is the case, then the possible payoff outcomes of the post-ruling bargain lie on both of the subfrontiers in Region II, and hence the disagreement point for the stage-2 bargain lies strictly above the bargaining frontier, such as at the point labeled $ED$ in Figure 3, and the dispute will proceed to a ruling. If the policy does not hinge on the DSB ruling, on the other hand, the possible payoff outcomes of the post-ruling bargain lie only on one of the subfrontiers in Region II, and hence the disagreement point for the stage-2 bargain lies on the bargaining frontier and the outcome of the dispute will be an early settlement. We may now summarize with:

**Proposition 2.** If $\gamma$ lies in Region II, where the efficiency stakes are low, a dispute may settle early or it may proceed to a DSB ruling. The dispute will proceed to a DSB ruling if and only if the policy choice hinges on the ruling.

According to Proposition 2, disputes proceed to a ruling when the policy choice hinges on the DSB ruling, and this can occur only when the efficiency stakes of the dispute are low. The reason is that, in these circumstances, a new method of compensation is introduced that would not be available if governments settled early: The governments can utilize the policy uncertainty associated with the DSB ruling as a means of compensation. And the inefficiency associated with this method of compensation is small when the efficiency stakes are small, making it attractive relative to the alternative of trade sanctions. Of course, as long as the DSB signal is informative, the role of the DSB goes beyond that of providing governments with a

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30 Note that this is not a statement about the size of the stakes for either the importer ($\gamma$) or the exporter ($\gamma^*$). It is only a statement about the size of the joint stakes $|\gamma - \gamma^*|$. An interesting question is how the likelihood of a ruling depends on the absolute stakes of the dispute holding the efficiency stakes constant. That is, if we increase $\gamma$ and $\gamma^*$ while keeping $|\gamma - \gamma^*|$ constant, how is the likelihood of a ruling affected? Given our assumptions, the answer is that the absolute stakes have no systematic impact on the likelihood of rulings. In fact, as we establish below, disputes over property rules result in a ruling if and only if $\gamma$ is in Region II, and hence varying the absolute stakes while holding the efficiency stakes constant has no impact whatsoever on the likelihood of rulings for such contracts.
randomization device, because the DSB choice of policy is noisy, but it also selects the more efficient policy with more than a 50% probability. Nevertheless, it is the uncertainty in the DSB ruling that makes a ruling appealing to the governments in these circumstances.

Thus far, we have focused on how the outcome of a dispute depends on the ex post realization of $\gamma$. We next examine how the propensity of governments to settle early depends on some key “ex ante” features of the contracting environment and, in particular, the cost of transfers $(c)$, the degree of ex ante uncertainty in $\gamma$, and the accuracy of DSB rulings. To clarify our terminology, in what follows we use the phrase “likelihood of early settlement” to indicate the ex ante probability of early settlement (as viewed from stage 0) conditional on a dispute occurring.

Here, we analyze the impact of the various parameters on the likelihood of early settlement taking the contract $b_C(\gamma_{dsb})$ as given. In Section 4, we will discuss the case in which the contract can be reoptimized after a parameter change, but we note that the fixed-contract thought experiment we adopt here has an interesting interpretation in its own right. Suppose that the contracting environment evolves over time but the contract is reoptimized only infrequently (in the “long run”), as is arguably the case in the GATT/WTO, where, in practice, the contract can be changed only in the context of a negotiation round. Then our thought experiment amounts to asking how the likelihood of early settlement responds to changes in the contracting environment in the period between two negotiation rounds, that is in the “short run.”

We start by focusing on the impact of the transfer cost $c$. Standard intuition suggests that reducing transaction costs should make settlement more likely. This is not obvious in our setting. For example, we will argue later that a reduction in $c$ may not increase the likelihood of post-ruling settlement. But it turns out that the impact of $c$ on the likelihood of early settlement is unambiguous and conforms with the standard intuition. In the online Appendix, we prove:

**Remark 1.** Reducing the cost of transfers $(c)$ increases the likelihood of early settlement.

Consider next the degree of ex ante uncertainty in $\gamma$. Given the observations we made above, it might be expected that increasing the degree of uncertainty in $\gamma$ would lead to a higher likelihood of settlement, since this would shift probability weight toward more extreme values of $\gamma$. But perhaps surprisingly, a mean preserving spread in $\gamma$ has ambiguous impacts on the settlement rate. An example can illustrate the point. Suppose that $\gamma_{dsb}$ has full support for any $\gamma$, so the support of $b_C(\gamma_{dsb})$ is independent of $\gamma$, and that the support of $b_C(\gamma_{dsb})$ is given by $[\hat{b}, \hat{b}]$, with $\hat{b}$ strictly positive. Suppose the expected value of $\gamma$ is given by $\gamma^*$ and start by focusing on this value, $\gamma = \gamma^*$. With reference to Figure 3, imagine that for $b_C = \hat{b}$, the disagreement point lies on the right branch of the $P$ subfrontier, so the policy outcome is $P$ regardless of the ruling; then—recalling Proposition 2—governments will settle. Next focus on a level of $\gamma$ that moves away from the mean value $\gamma = \gamma^*$ and is instead close to the border between Regions I and II, so that the left branch of the $FT$ subfrontier intersects the $P$ branch just below the point $P$ in Figure 3: In this case, for $b_C = \hat{b}$, the disagreement point will lie on the $FT$ branch of the Pareto frontier, so the policy outcome hinges on the ruling, and hence—recalling Proposition 2—governments will go to a ruling. Thus, in this example, shifting probability weight from the mean $\gamma = \gamma^*$ to values of $\gamma$ away from the mean can decrease the probability of settlement. In our

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31 As we noted in Section 1, the DSB also plays an important off-equilibrium role even when the dispute does not proceed to a ruling, a point we return to in the next section.

32 In principle, the contract could be made fully contingent, obviating the need to reoptimize the contract over time, but such a contract is likely to be too costly or even infeasible.

33 A related but slightly different interpretation is that, at the time governments design the contract, the relevant parameters are only known in an expected sense over a variety of settings to which the contract will apply, and if the contract cannot be fully contingent on these parameters, it must be optimized in expectation across the settings to which the contract will apply. Then, when examining how the likelihood of settlement depends on a given parameter, it seems natural to hold the contract fixed.
Increasing the accuracy of DSB rulings, on the other hand, does have a clear impact on the likelihood of early settlement. To formalize this, we model an increase in the accuracy of the signal $\gamma_{\text{dsb}}$ as a mean-preserving compression of the distribution $G(\gamma_{\text{dsb}} | \gamma)$ for all $\gamma$. As a result of such a mean-preserving compression, the support of $\gamma_{\text{dsb}}$ conditional on $\gamma$ weakly shrinks, and given the contract $b^{C}(\gamma_{\text{dsb}})$, the support of $b^{C}$ conditional on $\gamma$ also weakly shrinks. Thus, referring to Figure 3, if $\gamma$ is in Region II where a DSB ruling can occur, the red locus weakly shrinks, and hence the stage-2 expected disagreement point can only move from a position above the frontier to a position on the frontier. This is true for any $\gamma$, so we can conclude that increasing DSB accuracy can only increase the probability of early settlement. Summarizing:

**Remark 2.** The probability of early settlement is (weakly) increasing in DSB accuracy.

Thus far, we have said nothing about how the contract form affects the propensity of governments to settle early. We now demonstrate that the likelihood of early settlement depends in important ways on whether the contract takes the form of a property rule or a liability rule.

We compare the likelihood of early settlement across different contracts for a given contracting environment (i.e., for given cost of transfers, DSB accuracy, and distribution of $\gamma$). By Propositions 1 and 2, differences in the likelihood of early settlement across different contracts can arise only for $\gamma$ in Region II. We now argue that, if a dispute over a property rule occurs for $\gamma$ in Region II, it will never settle early. To see this, note that in the case of a property rule, there are only two possibilities: (i) If there is no uncertainty as to whether the DSB ruling would grant an escape, then the stage-2 disagreement point is either point $P$ or point $FT$ in the top right panel of Figure 2, and hence there will be no dispute; (ii) if there is uncertainty as to whether the DSB will grant an escape, then the stage-2 disagreement point will lie somewhere on the (interior of the) dashed line that connects $P$ and $FT$ in Figure 3; hence, a dispute occurs, and since the disagreement point is above the bargaining frontier, the dispute proceeds to a ruling.

By contrast, if a dispute over a liability (or mixed) rule occurs for $\gamma$ in Region II, it may proceed to a ruling or it may settle early, depending on whether the possible realizations of $b^{C}(\gamma_{\text{dsb}})$ lead to outcomes along both or only one of the two subfrontiers in Region II, and it is easy to show that both of these cases are possible.

With the likelihood of early settlement the same across contracts for $\gamma$ in Regions I or III, and (weakly) lower for property than for liability (or mixed) rules for $\gamma$ in Region II, we have:

**Proposition 3.** The likelihood of early settlement for disputes over property rules is (weakly) lower than for disputes over liability (or mixed) rules.

Intuitively, disputes proceed to a DSB ruling in our model if and only if the policy choice hinges on the ruling, and this will be the case for (weakly) more states of the world when the dispute concerns a property rule than when it concerns a liability (or mixed) rule.

### 3.2. Post-ruling Settlement

We next turn to post-ruling settlement. Using Propositions 1 and 2, we can focus our discussion of post-ruling settlement on realizations of $\gamma$ in Region II, that
is, for $\gamma \in ((1 - c)\gamma^*, (1 + c)\gamma^*)$, because these are the only realizations of $\gamma$ for which a dispute may proceed to a DSB ruling. Recall that for $\gamma$ in Region II, the shape of the bargaining frontier is as depicted in Figure 3.

A first point is easily established: If the ruling concerns a property rule, there can never be post-ruling settlement. To see this, consider Figure 3. Notice that both points $P$ and $FT$ are on the bargaining frontier; intuitively, even if one policy is more efficient than the other, switching from the less efficient to the more efficient policy cannot make both parties better off in Region II (where the efficiency stakes of the dispute are low), due to the inefficiency of the transfer. But under a property rule, the disagreement point in the post-ruling negotiation is either point $FT$ or (if an escape is granted) point $P$; in either case, there is no possible Pareto improvement over the disagreement point and therefore no possibility of post-ruling settlement.

Next, we argue that, if the ruling concerns a liability or a mixed rule, it is possible that governments will reach a post-ruling settlement. To establish this, we can continue to focus on Figure 3. Suppose that, given the contract and the realization of $\gamma^{dsb}$, the resulting level of damages $b^C(\gamma^{dsb})$ is such that (i) Home prefers setting policy $P$ and paying damages instead of setting policy $FT$, and (ii) the resulting payoff point is strictly below the efficiency frontier. In terms of Figure 3, this means that the disagreement point in the post-ruling negotiation is a point somewhere on the dotted red-and-blue line. In this case, since the disagreement point is below the bargaining frontier, there will be post-ruling settlement.\textsuperscript{36}

We may now state:

**Proposition 4.** Post-ruling settlement can never occur in the case of disputes over property rules, whereas it can occur in the case of disputes over liability (or mixed) rules.

Intuitively, DSB rulings only occur if the efficiency stakes of the dispute are low, and in these circumstances, neither policy ($P$ or $FT$) is Pareto-dominated because any efficiency gains from switching policy would be outweighed by the inefficiency of the transfer needed to redistribute such gains. Under a property rule dispute, the disagreement point in the post-ruling negotiation is given by either policy $FT$ (and no transfer) or policy $P$ (and no transfer), the disagreement point is Pareto-undominated, and there cannot be post-ruling settlement. With a dispute over a liability (or mixed) rule, however, it may well happen that the disagreement point in the post-ruling negotiation is below the efficiency frontier, making post-ruling settlement possible.

We next consider how the likelihood of post-ruling settlement depends on the key ex ante features of the contracting environment, namely, the cost of transfer, the accuracy of DSB rulings, and the degree of uncertainty in $\gamma$. In what follows, by “likelihood of post-ruling settlement,” we mean the probability of post-ruling settlement conditional on a DSB ruling being triggered.

Consider first the transfer cost $c$. Recall from Remark 1 that a decrease in $c$ has the intuitive effect of making early settlement more likely. Interestingly, a decrease in $c$ can make post-ruling settlement less likely. To see why, it is helpful to focus on Region II as depicted in Figure 3. As $c$ decreases, the $P$ and $FT$ points remain fixed, and each branch of the Pareto frontier gets closer to a line with slope $-1$. Note also that, fixing the contract, the support of $b^C$ remains fixed. Suppose, then, that at the initial level of $c$, there is a ruling and focus on a realization of $\gamma^{dsb}$ such that the disagreement point for the stage-4 negotiation is below the central kink in the frontier, somewhere on the dotted red-and-blue line in Figure 3, so there is post-ruling settlement. As $c$ goes down, this disagreement point moves up vertically (because the Home government enjoys all the benefit of the cost savings associated with the fixed $b^C$), whereas the central kink in the frontier moves up diagonally, so it is possible that, after the change, the disagreement point lies above the kink, and hence there is no post-ruling settlement. Hence, reducing the cost of transfers need not increase the propensity of governments to renegotiate DSB rulings.

\textsuperscript{36} One might ask: Can a scenario like the one just described occur under an optimal contract? The answer is yes: This scenario can occur for some realizations of $\gamma^{dsb}$ under an optimal contract if, for example, the contract looks as in the top right panel of Figure 1. And as we discuss in the next section, there exist conditions under which this type of contract is indeed optimal.
Similarly, although according to Remark 2 the likelihood of early settlement rises with DSB accuracy, an increase in DSB accuracy can decrease the likelihood of post-ruling settlement. To see how this is possible, it is again helpful to refer to Figure 3 and recall that post-ruling settlement occurs if the realized \( b^C \) is such that the disagreement point in the post-ruling negotiation lies on the dotted red-and-blue segment. Given the contract \( b^C(\gamma_{\text{dsb}}) \), as the accuracy of the signal \( \gamma_{\text{dsb}} \) increases, the distribution of \( b^C \) concentrates around the value \( b^C(\gamma) \), and if this value yields a disagreement point outside the dotted red-and-blue segment (which is clearly possible, since we are fixing an arbitrary contract), the likelihood of post-ruling settlement will decrease.

Finally, consider the degree of uncertainty in \( \gamma \). It is easy to establish by example that changes in uncertainty about \( \gamma \) have ambiguous impacts on the likelihood of post-ruling settlement, just as in the case of early settlement.\(^{37}\)

Although the likelihood of post-ruling settlement depends in ambiguous ways on the key ex ante features of the contracting environment, our model yields a sharp prediction regarding the direction of post-ruling settlements. In particular, any post-ruling settlement must go in the direction of liberalizing trade, in the sense that governments agree on policy \( FT \) (with Foreign compensating Home) against a disagreement point where Home would have chosen policy \( P \) (and paid the DSB-stipulated damages). This can be seen easily from Figure 3: As explained above, post-ruling settlement occurs when the disagreement point lies on the dotted red-and-blue line (which entails policy \( P \)), and the outcome of the bargain lies on the part of the frontier associated with policy \( FT \).\(^{38}\) We record this in:

**Remark 3.** Whenever the DSB ruling is renegotiated, the post-ruling settlement must be liberalizing, with the exporter compensating the importer and the importer agreeing to \( T = FT \).

Note that, while post-ruling settlements must be liberalizing, early settlements can go in either direction. This is immediate from inspection of Figure 3: A 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). Thus, at a broad level, our model 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 such settlements can only involve agreement to implement \( FT \), not \( P \).\(^{39}\)

4. **THE OPTIMAL CONTRACT**

We now characterize the optimal contract, which we assume maximizes the ex ante joint payoff of the governments \( E[\Omega] \).\(^{40}\) We first provide a general characterization and then consider how the optimal contract form depends on the key features of the contracting environment.

\(^{37}\) And as with early settlement (see footnote 34), it can be established by example that a change in the mean of \( \gamma \) has an ambiguous impact on the likelihood of post-ruling settlement.

\(^{38}\) Maggi and Staiger (2015) derive a similar result concerning the direction of renegotiation, but their result requires the optimality of the contract, whereas here the result follows from the selection of \( \gamma \) into DSB rulings implied by the early settlement decision. Note also that here the result applies to post-ruling settlement but not to early settlement, whereas in Maggi and Staiger (2015), there is only one kind of settlement.

\(^{39}\) 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 empirical section but rather leave its evaluation for future empirical investigation.

\(^{40}\) Our focus 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 efficient 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, e.g., the discussion in Hoekman and Kostecki, 1995, chapter 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.
In principle, we must solve for the subgame-perfect equilibrium of the game for any given contract \( b^C(y^{dsh}) \) 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 optimal \( b^C(y^{dsh}) \) schedule is equivalent to a simpler problem, namely, finding the level of \( b^C \) that maximizes the expected joint payoff as viewed from stage 3, where the signal \( y^{dsh} \) 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.\(^{41}\)

We let \( \bar{\Omega}(b^C, \gamma) \) denote the equilibrium joint payoff in the stage-4 subgame given DSB-determined damages level \( b^C \) and realized \( \gamma \). From the perspective of stage 3, the expected joint payoff is \( E_{y^{dsh}}[\bar{\Omega}(b^C, \gamma)|y^{dsh}] = \int \bar{\Omega}(b^C, \gamma) dH(\gamma|y^{dsh}) \), where \( H(\gamma|y^{dsh}) \) is the c.d.f. of \( \gamma \) conditional on \( y^{dsh} \). The following lemma is proved in the online Appendix:

**Lemma 1.** The optimal contract \( b^C(y^{dsh}) \) solves \( \max_{b^C} E_{y^{dsh}}[\bar{\Omega}(b^C, \gamma)|y^{dsh}] \).

This result is a consequence of the fact that the bargaining frontier is piecewise linear and, as we observed earlier, the only relevant pieces of the frontier are the right branch of the P-subfrontier and the left branch of the FT-subfrontier. As a consequence, the 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 \( b^C(y^{dsh}) \) schedule that maximizes the expected joint disagreement payoff \( E_{y^{dsh}}[\bar{\Omega}(b^C, \gamma)|y^{dsh}] \).\(^{42}\) In what follows we will use \( \Omega^c(b^C, y^{dsh}) \) as shorthand for \( E_{y^{dsh}}[\bar{\Omega}(b^C, \gamma)|y^{dsh}] \).

Lemma 1 allows us to focus on the game as viewed from stage 3, where the DSB signal \( y^{dsh} \) has been observed. In effect, we need to optimize \( b^C \) considering that \( \gamma \) is distributed according to \( h(\gamma|y^{dsh}) \). Using Lemma 1, we next argue that, under some mild conditions, the optimal \( b^C(y^{dsh}) \) schedule is weakly decreasing.

To proceed, we need to impose a minimum amount of regularity on the objective function. The assumptions we have already imposed, and in particular the log-supermodularity of \( h(\gamma|y^{dsh}) \), guarantee that the objective function \( \Omega^c(b^C, y^{dsh}) \) is submodular in \( b^C \) and \( y^{dsh} \) when evaluated at a local maximum (i.e., \( \Omega^c_{b^C|y^{dsh}} \leq 0 \) when \( \Omega^c_{b^C} \leq 0 \)).\(^{43}\) This ensures that, as \( y^{dsh} \) increases, each local maximum decreases. But we also need to rule out the possibility that, as \( y^{dsh} \) increases, the global maximum might “jump” from one local maximum to another, higher local maximum. To rule this out, we impose a further condition: If \( b^C \) and \( b^{C'} \) are such that \( \int b^{C'} \Omega^c_{b^C|y^{dsh}}(b^{C'}, y^{dsh}) db^{C'} = 0 \), then \( \int b^{C'} \Omega^c_{b^C|y^{dsh}}(b^{C'}, y^{dsh}) db^{C'} < 0 \). In words, we require that, given two points \( b^C \) and \( b^{C'} \) such that \( \Omega^c_{b^C} \) is zero “on average” over the interval between the two points, \( \Omega^c_{b^C|y^{dsh}} \) is negative “on average” over this interval as well. As we establish in the online Appendix, this condition is assured if \( c \) is not too large.

Before stating the next result, we introduce a final bit of notation. Recall that \( (y^{dsh}, \hat{y}(y^{dsh})) \) denotes the support of \( y^{dsh} \) and \( (\hat{y}(y^{dsh}), \hat{y}(\hat{y}(y^{dsh}))) \) denotes the support of \( \gamma \) conditional on \( y^{dsh} \). Although we have earlier described in the context of Figure 1 what it means for \( b^C(y^{dsh}) \) to be prohibitive, we now define this more formally: We say that \( b^C \) is **prohibitive** given the signal \( y^{dsh} \n
\(^{41}\) This represents an important methodological difference relative to the analysis in Maggi and Staiger (2015). In that paper, since the contract only specifies a noncontingent level of damages and the court does not observe any information ex post, the optimization problem is much simpler, and we can afford to consider a more general transfer cost function.

\(^{42}\) It can now also be seen that, according to Lemma 1, it can never be optimal in our model for the governments to write a contract that specifies lotteries over \( b^C \) as a function of \( y^{dsh} \), as we observed in footnote 17.

\(^{43}\) Note that this covers the cases of both an interior maximum (where \( \Omega^c_{b^C} = 0 \)) and of a corner maximum at \( b^C = 0 \), and note also that for the result we wish to prove we do not need to worry about the case in which the maximum is a prohibitive level of \( b^C \) because in this case, the optimal \( b^C \) can now go down as \( y^{dsh} \) increases.
if it is such that Home would choose \( T = FT \) for all \( \gamma \) in its conditional support \( (\gamma(\gamma^{\text{dsb}}), \gamma(\gamma^{\text{dsb}})) \), and we let \( \tilde{b}^{\text{prohib}}(\gamma^{\text{dsb}}) \) denote the minimum such level of \( b^C \). In the online Appendix, we prove:

**Proposition 5.** (i) There exist critical levels \( (\gamma^{\text{dsb}}_1, \gamma^{\text{dsb}}_2) \), with \( \gamma^{\text{dsb}}_2 \leq \gamma^{\text{dsb}}_1 \leq \gamma^{\text{dsb}}_2 \), such that the optimal \( b^C \) is prohibitive for \( \gamma^{\text{dsb}} \in (\gamma^{\text{dsb}}_1, \gamma^{\text{dsb}}_2) \), decreasing for \( \gamma^{\text{dsb}} \in (\gamma^{\text{dsb}}_1, \gamma^{\text{dsb}}_2) \) and zero for \( \gamma^{\text{dsb}} \in (\gamma^{\text{dsb}}_1, \gamma^{\text{dsb}}_2) \). (ii) The optimal \( b^C \) is (weakly) increasing in \( \gamma^* \).

Proposition 5 establishes that the optimal level of damages \( b^C \) is (weakly) decreasing in \( \gamma^{\text{dsb}} \) 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 Home government \( (\gamma^{\text{dsb}}) \). Intuitively, since it is not optimal in general to set damages at the level \( \gamma^* \) that fully compensates the Foreign government in our costly-transfer setting, making the damages sensitive to the estimated benefit from breach helps to ensure that breach will occur only when it is likely to be efficient.

With the aid of Figure 1, we earlier interpreted specific contract forms that satisfy the properties stated in Proposition 5. We next highlight conditions under which these 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 \( \gamma^{\text{dsb}} \). We use the support of \( \gamma \) conditional on \( \gamma^{\text{dsb}} \) as a crude but simple measure of the DSB’s uncertainty, so we say that the DSB’s uncertainty about \( \gamma \) is small if the support of \( \gamma|\gamma^{\text{dsb}} \) is small for all \( \gamma^{\text{dsb}} \).

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

We now establish that when the DSB’s uncertainty is small, the optimal \( b^C(\gamma^{\text{dsb}}) \) schedule is a property rule, with or without escape; that is, \( \gamma^{\text{dsb}} = \gamma^{\text{dsb}}_1 \). Here, we provide an intuitive argument, relegating the proof to the online Appendix. The logic of the proof mirrors that of a similar result in Maggi and Staiger (2015). In that model, the DSB does not observe any signal, so the only possible type of uncertainty is ex ante uncertainty about \( \gamma \), and there we show that, if the support of \( \gamma \) is small, the optimal contract is a property rule. The basic argument here is similar, except that we need to consider the support of \( \gamma \) conditional on \( \gamma^{\text{dsb}} \).

Note first that, if the support of \( \gamma|\gamma^{\text{dsb}} \) does not include \( \gamma^* \), clearly the optimal \( b^C \) is prohibitive (zero) if the support lies below (above) \( \gamma^* \). Next, suppose the support of \( \gamma|\gamma^{\text{dsb}} \) includes \( \gamma^* \). If this support is sufficiently small, when \( b^C \) is prohibitive or zero, there is no renegotiation for any \( \gamma \) (as we show in the online Appendix), and hence no transfers in equilibrium. Setting \( b^C \) at a positive but nonprohibitive 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 nonnegligible level of transfer payments in equilibrium. We can thus state:

**Proposition 6.** If the support of \( \gamma|\gamma^{\text{dsb}} \) is sufficiently small for all \( \gamma^{\text{dsb}} \), then a property rule (with or without escape) is optimal: \( \gamma^{\text{dsb}}_1 = \gamma^{\text{dsb}}_2 \). Furthermore, the optimal \( b^C \) is prohibitive (given \( \gamma^{\text{dsb}} \)) if \( E[\Gamma|\gamma^{\text{dsb}}] \leq 0 \) and zero otherwise.

As Proposition 6 indicates, if the DSB information is very accurate and/or ex ante uncertainty is small, the optimal \( b^C(\gamma^{\text{dsb}}) \) 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
subsidiaries—which have been interpreted by legal scholars 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 6 is in fact a noncontingent property rule, which is a prohibitive $b^C$ for all $\gamma^{dsb}$; this will be the case if $E[\gamma^{dsb}] \leq 0$ 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 the DSB’s uncertainty is large and establish that if the support of $\gamma^{dsb}$ is sufficiently large for all $\gamma^{dsb}$, the optimum is a liability rule (with or without escape); that is, $\gamma^{dsb}_2 = \gamma^{dsb}_1 < \gamma^{dsb}_2$. The basic intuition is the following. Consider a given value of $\gamma^{dsb}$ and suppose the support of $\gamma^{dsb}$ is very large. Can a prohibitive level of $b^C(\gamma^{dsb})$—so that Home would rather choose free trade than protect and pay damages—be optimal? If the support of $\gamma^{dsb}$ includes very large values of $\gamma$, for these values of $\gamma$, the $FT$ policy would be very inefficient, so governments will renegotiate toward the policy $P$, but this renegotiation will entail a transfer whose size exceeds $\gamma^*$ (the minimum level needed to convince Foreign to go along with a switch from $FT$ to $P$), which is itself inefficient. Intuitively, then, if $b^C$ is reduced from the prohibitive level to the level $b^C = \gamma^*$, this will not affect the policy outcome ($P$) and will reduce the size of the transfer made in equilibrium, thus improving on the original contract. In the online Appendix, we prove:

**Proposition 7.** If the support of $\gamma^{dsb}$ is sufficiently large for all $\gamma^{dsb}$, then the optimum is a liability rule (with or without escape): $\gamma^{dsb}_2 = \gamma^{dsb}_1 < \gamma^{dsb}_2$.

Proposition 7 indicates that, when ex ante uncertainty is large and there is large noise in the DSB signal, the optimal $b^C(\gamma^{dsb})$ schedule is a liability rule. Accordingly, for every DSB signal realization $\gamma^{dsb}$, there is a range of high $\gamma$ such that the Home government prefers to set $T = P$ and pay $b^C(\gamma^{dsb})$ instead of setting $T = FT$. And if the liability rule includes an escape (i.e., if $\gamma^{dsb}_2 < \gamma^{dsb}_1$), then for sufficiently high values of $\gamma^{dsb}$, the Home government can set $T = P$ without paying any compensation at all.

Together Propositions 6 and 7 extend the results of Maggi and Staiger (2015, Proposition 2) to a setting of imperfect verifiability, confirming the insights of that paper regarding the impact of ex ante uncertainty on the optimal contract and extending these insights to the impact of DSB accuracy. To appreciate the forces at work, consider first the case of a highly inaccurate DSB in the presence of large uncertainty. In this case, Proposition 7 indicates that a liability rule is optimal, not because a liability rule can achieve the “right” policy in the presence of large DSB errors—governments will negotiate a post-ruling settlement to correct large DSB errors regardless of the contract form—but because a liability rule keeps to a minimum the magnitude of trade sanctions that are enacted as part of a settlement. Next, consider the case of high DSB accuracy and/or small uncertainty. In this case, large DSB errors are not possible, and Proposition 6 indicates that a property rule is optimal. Here, the problem with a liability rule is that it involves the use of trade sanctions whenever protection is implemented. By contrast, in this environment, disputes over property rules never result in settlement, because the efficiency consequences of correcting DSB errors with a settlement are never high enough to justify the costly trade sanctions that would accompany the settlement. A property rule is then attractive because it avoids the equilibrium use of trade sanctions while permitting policy mistakes with only minor efficiency consequences.

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 the DSB’s uncertainty is small for all $\gamma^{dsb}$ and one where the DSB’s uncertainty is large for all $\gamma^{dsb}$, and we have described conditions under which property rules and liability rules, possibly with escape, of the
kind highlighted in the top left and bottom panels of Figure 1 are optimal. If the degree of the DSB’s uncertainty is less extreme, it is intuitively clear (and easy to show with examples) that the optimal rule can be a mixture of the rules described in Propositions 6 and 7 along the lines of the mixed rule highlighted in the top right panel of Figure 1.

We conclude this section by observing that in our model, the DSB has an important off-equilibrium role to play, in addition to any on-equilibrium role that it plays through its rulings. This can be seen easily by considering the limiting case where the DSB information is perfect. In that case, the optimal contract is a property rule, and under the optimal contract and with the perfectly informed DSB, there would be no disputes and hence no DSB rulings; yet despite the absence of rulings, governments would achieve the first best, and it is the presence of the DSB in combination with the optimal contract that makes this achievement possible.

4.1. The Outcome of Disputes, Once Again. In Section 3, we interpreted Propositions 3 and 4 as corresponding to a “short-run” analysis. Here, we revisit this analysis from a “long-run” perspective, allowing the contract to be optimized. We now argue that, if the contract is chosen optimally, the result of Proposition 3 is actually strengthened, and Proposition 4 remains unchanged. In the online Appendix, we prove:

**Proposition 8.** If the optimal contract is a property rule (with or without escape), neither early settlement nor post-ruling settlement can occur. If the optimal contract is a liability (or mixed) rule, either kind of settlement can occur.

Thus, the result of Proposition 3 becomes starker if the contract is optimized, in the sense that there can never be early settlement under an optimal property rule, whereas early settlement is possible under an optimal liability rule. And regarding post-ruling settlement, Proposition 8 confirms the result of Proposition 4.

It seems reasonable to suppose that reality lies somewhere between the two benchmark cases we have considered, namely, that of an exogenous contract and that of a fully optimal contract. Hence, as an empirical matter, our model predicts that settlement rates should be lower (though not necessarily zero) for disputes on property rules than for disputes on liability rules.

Finally, one might ask whether the comparative statics results of Section 3—how the rates of early and post-ruling settlement depend on various features of the contracting environment (cost of transfers, ex ante uncertainty, DSB accuracy)—extend to a setting where the contract is fully tailored to such features. Our model does not yield sharp predictions on the impact of these parameter changes when the contract is fully tailored to these parameters, with one exception: If a given parameter change leads to a switch from a liability rule to a property rule, then the likelihood of both early and post-ruling settlement should drop to zero. This is an immediate corollary of Proposition 8. Note that, as a consequence of this, the result of Remark 2 does not hold if the contract is optimized: An increase in DSB accuracy may cause a switch in the optimal contract from a liability rule to a property rule and hence may lead to a drop in the likelihood of early (as well as post-ruling) settlement.

5. EVIDENCE

According to legal scholars, the GATT/WTO evolved 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; Pauwelyn, 2008). In this section, we exploit this variation to offer an initial assessment of one of the key predictions of our model, namely, that early settlement rates

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45 Jackson (1997, pp. 62–63) articulates this view, stating that, whereas 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), the defining feature of a property rule. In support of Jackson’s view, see also Charnovitz (2003), Pauwelyn (2008), and Pelc (2009). For a dissenting view that sees no
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should be lower in disputes over property rules than in disputes over liability rules. We test this prediction with data on the outcomes of trade disputes in the GATT/WTO, looking both across rules and within rules that have evolved over time.46

Pauwelyn (2008) provides a concise listing of the WTO rules that exhibit features of a liability rule, and identifies four such rules that have a counterpart in GATT:

WTO members have the right to unilaterally reintroduce tariffs on imported goods (pursuant to GATT Article XXVIII) ... on condition that they pay compensation or suffer equivalent suspensions of concessions by other WTO affected members. ... A similar liability rule applies where a WTO member is faced with a sudden surge in imports resulting from GATT liberalization commitments and is given the right to impose a so-called safeguard (pursuant to GATT Article XIX). In a first instance, WTO members are asked to work out a deal. ... Yet, if no deal can be reached, the safeguard can, nonetheless, be unilaterally imposed, but affected WTO members have the right to suspend “the application of substantially equivalent concessions.” ... If the safeguard responds to an absolute increase in imports and conforms to the provisions of the Safeguard Agreement, however, such equivalent suspension can only be exercised three years after the safeguard was first imposed. ... Two other instances exist where WTO members can engage in certain conduct that is condemned (yet not unlawful) if only they “pay for it”: first, the provision of so-called “actionable subsidies” which are not prohibited but for which the remedy is either to withdraw the subsidy or “to remove the adverse effects” of the subsidy; second, conduct which does not violate WTO rules but nonetheless nullifies or impairs another member's legitimately expected benefits under a so-called nonviolation complaint (pursuant to GATT Article XXIII:1(b)). (Pauwelyn, 2008, pp. 134–136)

Three of these rules—Article XXVIII modification of tariff schedules, the rule on actionable domestic subsidies, and the nonviolation complaint—correspond closely to the concept of a liability rule in our model, and we classify them as such for the WTO era. The fourth—an Article XIX safeguard or “escape clause” action—is governed under the WTO Safeguard Agreement by rules that correspond more closely to our “mixed” property/liability rule classification, as we have noted in Section 2. We therefore classify the WTO-era escape clause as a mixed rule. We classify all other rules as property rules in the WTO era.

Regarding the evolution in the GATT/WTO 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 1979.47 For the purposes of our empirical investigation, we therefore treat the GATT years 1979–94 as a transitional period and exclude this period from our analysis. And we assume that during the period 1948–78, the GATT operated as a system of liability rules; we will refer to this period as “GATT-I.”

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 et al., 2011) for the WTO disputes. Hudec’s coverage includes every GATT dispute that occurred over the period 1948–89. The WTO Dispute Settlement Database currently includes every WTO dispute that occurred over the period 1995–2011, but we include in our analysis 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 the online Data Appendix. GATT/WTO disputes sometimes involve multiple claimants. We follow

46 We focus here on the model’s predictions about early settlement and leave for future work its predictions about post-ruling settlement (as well as other predictions), because analysis of post-ruling settlement raises a host of familiar econometric issues associated with dynamic discrete choice models that are especially difficult to handle with relatively small samples such as ours.

47 The argument made by Jackson (1997) and others is that, with the strengthening of the dispute settlement procedure in the Tokyo Round negotiations, 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 also Hudec (1993, chapter 4) for a discussion of the significance of the Tokyo Round reform of the DSB.
the standard convention (see, e.g., Reinhardt, 2001; Guzman and Simmons, 2002; and Horn et al., 2011) and treat each claimant–respondent pair as a separate dispute.\textsuperscript{48} As a result, our data set includes 109 GATT-I disputes and 348 WTO disputes.

An important issue is what to count as a settlement. In principle, disputants should 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 classify as “settled early” any claim that was made in a dispute but was not ultimately ruled upon. Our measure of early settlement therefore includes both cases where an official settlement agreement (a “mutually agreed solution”) was reported and cases where the complaint was withdrawn or suspended before a ruling was issued.

An additional issue arises because the typical GATT/WTO dispute covers a variety of claims, not just a single claim as in our model. There are then two approaches to operationalize our definition of early settlement. One approach is to adopt a dispute-level perspective, whereby all the claims included in a dispute are said to be settled early if and only if the dispute does not go to a ruling. A second approach is to adopt a claim-level perspective, whereby each claim in a dispute is said to be settled early if and only if that claim is not ruled upon. This second approach has some obvious advantages, but implementing it requires detailed information on which claims in a dispute were ruled upon and which were not, information that is not available for the GATT-I era disputes.\textsuperscript{49} And even for the WTO-era disputes, where both approaches are in principle feasible, there are pros and cons of each. For example, inferring that an individual claim has been settled simply because it was not ruled upon could be erroneous if the court deemed that it was unnecessary for it to rule upon the claim because its rulings on other claims were already decisive to the outcome of the dispute. Hence, to provide a broad basis for our findings, below, we report evidence from both perspectives.

Table 1 summarizes our classification of claims for the WTO and GATT-I eras. Although all claims were considered liability rules in the GATT-I era, most claims evolved to property rules by the WTO era.\textsuperscript{50} Note that Table 1 classifies the escape clause as a mixed rule, but to keep the discussion sharp in what follows we treat the escape clause as a WTO-era property rule.\textsuperscript{51}

\textsuperscript{48} 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 our regressions.

\textsuperscript{49} To implement this second approach for WTO-era disputes, we use the detailed claim-level data from the WTO Dispute Settlement Database. This database records the claims made at two distinct junctures in a dispute: first, when one government—the claimant—requests formal “consultations” with another government (the initial step in any formal GATT/WTO dispute) and, second, when the claimant requests that a “panel” of judges be formed. The WTO database also records those claims that are ruled upon by the panel in each dispute. 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).

\textsuperscript{50} We exclude claims about WTO commitments that have no counterpart in GATT (e.g., claims related to TRIPS, TRIMS, or GATS); this choice seems natural given our emphasis on both across and within rule variation.

\textsuperscript{51} There is a degree of arbitrariness in choosing whether to treat the escape clause as a WTO-era property rule or a WTO-era liability rule. 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 choice to treat the escape clause as a WTO-era property rule. But our results are robust to other ways of treating escape clause disputes (e.g., omitting them from our sample). Also, we classify the export subsidy provisions in the 1979 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), hence the absence of export subsidy cases in the GATT-I era according to Table 1. But classifying the export subsidy reporting requirements contained in GATT Article XVI as export subsidy commitments does not materially alter the results we report below.
To get an initial feel for the data, we start with some descriptive findings. Figure 4 presents the claim-weighted mean rates of early settlement for claims that in the WTO era are classified as property rules ($ES_{P}^{WTO}$) and for claims that in the WTO era are classified as liability rules ($ES_{L}^{WTO}$). Here, we take a dispute-level perspective, to facilitate easy comparisons across the GATT-I and WTO eras. Specifically, letting $P_{WTO}$ denote the set of claims classified in Table 1 as property or mixed rules in the WTO era and $L_{WTO}$ the set of claims classified in Table 1 as liability rules in the WTO era, we define

$$ES_{P}^{WTO} = \frac{\sum_{k \in P_{WTO}} \sum_{j} C_{kj} D_{j}}{\sum_{k \in P_{WTO}} \sum_{j} C_{kj}}$$

and

$$ES_{L}^{WTO} = \frac{\sum_{k \in L_{WTO}} \sum_{j} C_{kj} D_{j}}{\sum_{k \in L_{WTO}} \sum_{j} C_{kj}}.$$

where $j$ indexes disputes and $k$ indexes claims and where $C_{kj} = 1$ if claim $k$ was raised in dispute $j$ and 0 otherwise and $D_{j} = 1$ if dispute $j$ ended in early settlement and 0 otherwise. The left bars in Figure 4 correspond to WTO-era disputes, the right bars to GATT-era disputes.

A number of interesting features of Figure 4 stand out. First, as the left bars confirm, for WTO-era disputes, we have $ES_{P}^{WTO} < ES_{L}^{WTO}$. Hence, for WTO-era disputes, the average settlement rate is lower in disputes over property rules than in disputes over liability rules, with the mean rate of settlement equal to 0.53 for property rule claims and rising to 0.63 for liability rule claims. Second, as a comparison between the left bars and the right bars confirms, the average settlement rate rose from the GATT era to the WTO era, but it rose by far less for disputes over rules that became property rules in the WTO era (from 0.42 to 0.53) than it did for disputes

### Table 1

**Classification of Claims**

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Nondiscrimination</td>
<td>Property</td>
<td>0.29</td>
<td>0.17</td>
</tr>
<tr>
<td>Schedule of concessions</td>
<td>Property</td>
<td>0.23</td>
<td>0.24</td>
</tr>
<tr>
<td>National treatment</td>
<td>Property</td>
<td>0.34</td>
<td>0.30</td>
</tr>
<tr>
<td>Film provisions</td>
<td>Property</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Transit</td>
<td>Property</td>
<td>0.02</td>
<td>0.00</td>
</tr>
<tr>
<td>Antidumping/countervailing duty</td>
<td>Property</td>
<td>0.49</td>
<td>0.04</td>
</tr>
<tr>
<td>Customs valuation</td>
<td>Property</td>
<td>0.03</td>
<td>0.01</td>
</tr>
<tr>
<td>Fees/formalities</td>
<td>Property</td>
<td>0.03</td>
<td>0.05</td>
</tr>
<tr>
<td>Marks of origin</td>
<td>Property</td>
<td>0.01</td>
<td>0.01</td>
</tr>
<tr>
<td>Administration of trade regulations</td>
<td>Property</td>
<td>0.20</td>
<td>0.02</td>
</tr>
<tr>
<td>Quantitative restrictions</td>
<td>Property</td>
<td>0.26</td>
<td>0.38</td>
</tr>
<tr>
<td>Balance of payments</td>
<td>Property</td>
<td>0.00</td>
<td>0.06</td>
</tr>
<tr>
<td>Nondiscriminatory quotas</td>
<td>Property</td>
<td>0.09</td>
<td>0.21</td>
</tr>
<tr>
<td>Exchange arrangements</td>
<td>Property</td>
<td>0.01</td>
<td>0.03</td>
</tr>
<tr>
<td>Domestic subsidies</td>
<td>Liability</td>
<td>0.06</td>
<td>0.10</td>
</tr>
<tr>
<td>Export subsidies</td>
<td>Property</td>
<td>0.13</td>
<td>0.00</td>
</tr>
<tr>
<td>State trading</td>
<td>Property</td>
<td>0.02</td>
<td>0.00</td>
</tr>
<tr>
<td>Government development assistance</td>
<td>Property</td>
<td>0.02</td>
<td>0.01</td>
</tr>
<tr>
<td>Escape clause</td>
<td>Mixed</td>
<td>0.09</td>
<td>0.08</td>
</tr>
<tr>
<td>General exceptions</td>
<td>Property</td>
<td>0.01</td>
<td>0.01</td>
</tr>
<tr>
<td>Security exceptions</td>
<td>Property</td>
<td>0.01</td>
<td>0.01</td>
</tr>
<tr>
<td>Violation nullification or impairment</td>
<td>Property</td>
<td>0.03</td>
<td>0.07</td>
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<tr>
<td>Nonviolation</td>
<td>Liability</td>
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<td>0.28</td>
</tr>
<tr>
<td>Free trade agreements/customs unions</td>
<td>Property</td>
<td>0.02</td>
<td>0.00</td>
</tr>
<tr>
<td>Modification of schedules</td>
<td>Liability</td>
<td>0.03</td>
<td>0.06</td>
</tr>
</tbody>
</table>

Note: See the online Appendix for specific GATT/WTO Articles associated with each claim.
over rules that remained liability rules in the WTO era (from 0.26 to 0.63). These two features are broadly consistent with our model’s prediction that early settlement rates should be lower for property rules than for liability rules.

A final interesting feature of Figure 4 is reflected in the right bars: For GATT-era disputes, we have $ES_{P^WTO} > ES_{L^WTO}$. As all rules were liability rules under GATT-I, 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 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, and, if this is the case, one would expect early settlement rates to be lower for these rules under GATT-I.

We next run some simple regressions over the two GATT/WTO eras. We consider first the WTO era. For WTO-era disputes, we can use our claim-level definition of early settlement, $ES_{P^WTO}$.
Table 2
CLAIM-LEVEL WTO-ERA REGRESSIONS

<table>
<thead>
<tr>
<th>Independent Variables</th>
<th>Full Sample</th>
<th>Disputes over Discrete Policies</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1) Logit</td>
<td>(2) OLS</td>
</tr>
<tr>
<td>Constant</td>
<td>3.541***</td>
<td>0.952***</td>
</tr>
<tr>
<td></td>
<td>(0.586)</td>
<td>(0.0166)</td>
</tr>
<tr>
<td>DevRes</td>
<td>0.541***</td>
<td>0.0969***</td>
</tr>
<tr>
<td></td>
<td>(0.171)</td>
<td>(0.0291)</td>
</tr>
<tr>
<td>Property</td>
<td>–2.829***</td>
<td>–0.277***</td>
</tr>
<tr>
<td></td>
<td>(0.591)</td>
<td>(0.0221)</td>
</tr>
<tr>
<td>Observations</td>
<td>916</td>
<td>916</td>
</tr>
<tr>
<td>(Pseudo) $R^2$</td>
<td>0.0611</td>
<td>0.053</td>
</tr>
<tr>
<td>Dyad fixed effects</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>CE</td>
<td>No</td>
<td>No</td>
</tr>
</tbody>
</table>

Note: Standard errors in parentheses. Robust standard errors in all OLS specifications. CE denotes standard errors clustered at the dyad level. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

whereby a claim is defined as settled if and only if it is not ruled upon. With early settlement defined in this way, our sample of claims filed in WTO disputes contains 916 observations.54

Defining the indicator variable $ClaimES_{kj} = 1$ if claim $k$ in dispute $j$ settles early and 0 if this claim does not settle early, and defining the indicator variable $Property_k = 1$ if claim $k$ is a WTO-era property rule and 0 otherwise, we regress $ClaimES_{kj}$ on $Property_k$ and a number of controls.55 The first four columns of Table 2 present logit and OLS estimates, with and without country dyad fixed effects, and with a control $DevRes_j$ (included in the specification without dyad fixed effects that indicates whether the respondent in dispute $j$ is a developing country).56 Across all four specifications, the estimated coefficient on $Property_k$ is negative and strongly significant, confirming that property rule claims exhibit a significantly lower likelihood of early settlement in the WTO era than do liability rule claims, as our model predicts. Moreover, the impacts are sizable. Focusing on our logit regressions with dyad fixed effects, the average marginal effect for $Property_k$ is $-0.44$, indicating that, all else equal, the probability of settlement is predicted to be $0.44$ lower for a property rule claim than for a liability rule claim. And focusing on our OLS regressions with dyad fixed effects, the probability of settlement is predicted to be $0.27$ lower for property rule relative to liability rule claims.

As we noted in Section 2, our theory is developed in the context of trade disputes over policies that are discrete. So, it is important to check that our empirical results are not driven by disputes over continuous policies. Of course, distinguishing empirically between discrete and continuous policies requires a sometimes subtle judgment call. Nevertheless, as a robustness check, we

54 Measured at the claim level, the mean rate of early settlement across all property rule ($ES_{P WTO}$) and liability rule ($ES_{L WTO}$) claims in WTO disputes is 76% and 97%, respectively, confirming the model’s prediction that the former should be lower than the latter and in line with the dispute-level calculations behind Figure 4.

55 We treat the selection of disputes, and hence the selection of GATT Articles claimed in a given dispute, as exogenous. Although, 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.

56 Throughout we have experimented with a number of dispute-level controls, including 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 regressions is a dummy variable indicating whether the respondent is a developing country, and so in the specifications we present, only this control variable is included.
reestimate the regressions in the first four columns of Table 2 on a restricted sample that excludes disputes over the following policies: tariffs (but not antidumping duties or countervailing duties), nonprohibitive quotas, tariff-rate quotas, escape clause actions, and simple domestic taxes (but not complicated tax issues related to the impacts of national tax codes).\(^{57}\) The last four columns of Table 2 present these results. Across these specifications, when the sample of disputes is limited to those for which our model should most clearly apply, the estimated coefficient on $Property_k$ is again negative and strongly significant, as the model predicts.

We next explore a difference-in-difference specification in the spirit of our comparisons in Figure 4. To this end, we pool the WTO and GATT-I era samples, define the indicator variable $WTO_j = 1$ if dispute $j$ is a WTO-era dispute and 0 otherwise, and regress $ClaimES_{kj}$ on $Property_k$, $WTO_j$, and the interaction term $Property_k \times WTO_j$, along with a number of controls. The coefficient of interest is that on the interaction term, which captures the “treatment effect” and according to our model should be negative: Claims that became property rules in the WTO era should experience a drop in the rate of settlement between the GATT-I and WTO eras relative to claims that remained liability rules throughout.\(^{58}\) As discussed above, for the GATT-I era, only a dispute-level definition of early settlement is available, whereas for the WTO era, both the dispute-level approach and the claim-level approach are feasible. We present our difference-in-difference estimates with the claim-level approach applied to WTO-era disputes and the dispute-level approach applied to GATT-I era disputes.\(^{59}\) And to address the possibility of correlated errors for claims within the same dispute in the GATT-I era, we present a version of our estimates with standard errors clustered at the dispute level.\(^{60}\)

Table 3 presents logit and OLS estimates of these difference-in-difference regressions, with and without dyad fixed effects, and with the control $DevRes_j$ included in the specification without dyad fixed effects. The results are consistent across all specifications and confirm the message of Figure 4. The coefficient on the WTO dummy is strongly positive, reflecting the rise in overall settlement rates between the GATT-I and WTO eras. But the coefficient on the interaction term is strongly negative: Property-rule “treatment” leads to a drop in the early settlement rate, in line with our model’s prediction. Again, the impacts are sizable. Focusing on our OLS regressions with dyad fixed effects, the probability of early settlement is predicted to drop by 0.47 when the claim switches from a liability to a property rule, all else equal.

Thus far, we have aggregated claims based on the property/liability rule distinction. In a final step, we focus on a more disaggregated comparison across rules, adopting a dispute-level perspective to facilitate comparison across WTO and GATT-I era disputes. With $ClaimES_j = 1$ if dispute $j$ settles early and 0 otherwise, we regress $ClaimES_j$ on a set of variables that indicate whether the specific claims listed in Table 1 were included in dispute $j$. Now the question of interest is whether the inclusion of individual claims in a dispute moves the likelihood of settlement for that dispute in the direction suggested by our model. In Table 4, we report results that exclude those claims that lack statistical significance in any of our specifications, but 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

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\(^{57}\) We treat disputes over antidumping and countervailing duties and over national tax codes as discrete-policy disputes on the grounds that these are not disputes over the levels of simple tax rates but rather concern systemic features of complex regulatory regimes.

\(^{58}\) The treatment effect is only identified by the coefficient on the interaction term in a linear model such as OLS. But even in a nonlinear model such as logit, it is still the case that the sign of the treatment effect is equal to the sign of the coefficient on the interaction term (see Puhani, 2012).

\(^{59}\) As a robustness check on our results, we have also run our difference-in-difference regressions with the dispute-level approach applied to both GATT-I and WTO era disputes and find that the results are consistent with those we present below. We also note that GATT-I era data limitations preclude running our difference-in-difference regressions on a restricted sample of discrete-policy disputes.

\(^{60}\) Clustering at the dyad level yields analogous results.
### Table 3

**DIFFERENCE-IN-DIFFERENCE REGRESSIONS**

<table>
<thead>
<tr>
<th>Independent Variables</th>
<th>(1) Logit</th>
<th>(2) OLS</th>
<th>(3) Logit</th>
<th>(4) OLS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>−0.405***</td>
<td>0.400***</td>
<td>−</td>
<td>0.301**</td>
</tr>
<tr>
<td></td>
<td>(0.527)</td>
<td>(0.127)</td>
<td>(0.123)</td>
<td>(0.123)</td>
</tr>
<tr>
<td>DevRes</td>
<td>0.587***</td>
<td>0.108***</td>
<td>−</td>
<td>−</td>
</tr>
<tr>
<td></td>
<td>(0.160)</td>
<td>(0.0410)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Property</td>
<td>−0.109***</td>
<td>−0.0222</td>
<td>1.139</td>
<td>0.196**</td>
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<tr>
<td></td>
<td>(0.544)</td>
<td>(0.123)</td>
<td>(0.747)</td>
<td>(0.0984)</td>
</tr>
<tr>
<td>WTO</td>
<td>3.939***</td>
<td>0.549***</td>
<td>4.679***</td>
<td>0.652***</td>
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<td></td>
<td>(0.788)</td>
<td>(0.128)</td>
<td>(0.945)</td>
<td>(0.137)</td>
</tr>
<tr>
<td>Property × WTO</td>
<td>−2.726***</td>
<td>−0.256**</td>
<td>−3.939***</td>
<td>−0.467***</td>
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<tr>
<td></td>
<td>(0.803)</td>
<td>(0.126)</td>
<td>(0.955)</td>
<td>(0.105)</td>
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<td>Observations</td>
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<td>844</td>
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<td>(Pseudo) R²</td>
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<td>0.133</td>
<td>0.0795</td>
<td>0.378</td>
</tr>
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</table>

**NOTE:** Standard errors in parentheses Robust standard errors in all OLS specifications. CE denotes standard errors clustered at the dispute level. ***p < 0.01, **p < 0.05, *p < 0.1.

### Table 4

**DISAGGREGATED DISPUTE-LEVEL REGRESSIONS**

<table>
<thead>
<tr>
<th>Independent Variables</th>
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<th>(3) Logit</th>
<th>(4) OLS</th>
<th>(5) Logit</th>
<th>(6) OLS</th>
<th>(7) Logit</th>
<th>(8) OLS</th>
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<tbody>
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<td>−</td>
<td>−</td>
<td>−</td>
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<tr>
<td></td>
<td>(0.221)</td>
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<td>(0.0546)</td>
<td>(0.335)</td>
<td>(0.0794)</td>
<td>(0.149)</td>
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</tr>
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<td>−</td>
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<td>−</td>
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<td>(0.701)</td>
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<td>WTO-era property rules</td>
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</tr>
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<td>National treatment</td>
<td>−0.645***</td>
<td>−0.144*</td>
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<td>−0.142</td>
<td>−0.608</td>
<td>−0.130</td>
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<td>(0.268)</td>
<td>(0.0619)</td>
<td>(0.340)</td>
<td>(0.0722)</td>
<td>(0.519)</td>
<td>(0.114)</td>
<td>(1.052)</td>
<td>(0.463)</td>
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<td>−0.894***</td>
<td>−0.204**</td>
<td>−0.980***</td>
<td>−0.229**</td>
<td>−1.245</td>
<td>−0.263</td>
<td>−0.824</td>
<td>−0.0843</td>
</tr>
<tr>
<td></td>
<td>(0.320)</td>
<td>(0.0693)</td>
<td>(0.414)</td>
<td>(0.0881)</td>
<td>(1.232)</td>
<td>(0.312)</td>
<td>(1.635)</td>
<td>(0.781)</td>
</tr>
<tr>
<td>Admin of trade regs/fees/formalities</td>
<td>−0.558*</td>
<td>−0.125</td>
<td>−0.194</td>
<td>−0.0330</td>
<td>0.448</td>
<td>0.0895</td>
<td>−0.777</td>
<td>−0.189</td>
</tr>
<tr>
<td></td>
<td>(0.286)</td>
<td>(0.0663)</td>
<td>(0.359)</td>
<td>(0.103)</td>
<td>(0.870)</td>
<td>(0.174)</td>
<td>(1.191)</td>
<td>(0.226)</td>
</tr>
<tr>
<td>Escape clause</td>
<td>−0.780</td>
<td>−0.176</td>
<td>−1.147</td>
<td>−0.263</td>
<td>0.764</td>
<td>0.164</td>
<td>16.57</td>
<td>0.316</td>
</tr>
<tr>
<td></td>
<td>(0.415)</td>
<td>(0.0910)</td>
<td>(0.606)</td>
<td>(0.159)</td>
<td>(0.866)</td>
<td>(0.161)</td>
<td>(2.188)</td>
<td>(0.274)</td>
</tr>
<tr>
<td>Export subsidies</td>
<td>−0.844***</td>
<td>−0.192**</td>
<td>−0.236</td>
<td>−0.0541</td>
<td>a</td>
<td>a</td>
<td>a</td>
<td>a</td>
</tr>
<tr>
<td></td>
<td>(0.419)</td>
<td>(0.0920)</td>
<td>(0.508)</td>
<td>(0.119)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>WTO-era liability rules</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nonviolation</td>
<td>0.551*</td>
<td>0.123</td>
<td>0.467</td>
<td>0.104</td>
<td>−1.748***</td>
<td>−0.358***</td>
<td>1.225</td>
<td>0.158</td>
</tr>
<tr>
<td></td>
<td>(0.295)</td>
<td>(0.0632)</td>
<td>(0.393)</td>
<td>(0.0752)</td>
<td>(0.571)</td>
<td>(0.105)</td>
<td>(1.123)</td>
<td>(0.353)</td>
</tr>
<tr>
<td>Domestic subsidies</td>
<td>0.172</td>
<td>0.0417</td>
<td>0.577</td>
<td>0.126</td>
<td>−0.765</td>
<td>−0.174</td>
<td>−1.476</td>
<td>−0.367</td>
</tr>
<tr>
<td></td>
<td>(0.602)</td>
<td>(0.129)</td>
<td>(0.725)</td>
<td>(0.203)</td>
<td>(0.725)</td>
<td>(0.160)</td>
<td>(1.198)</td>
<td>(0.380)</td>
</tr>
<tr>
<td>Observations</td>
<td>348</td>
<td>348</td>
<td>243</td>
<td>348</td>
<td>109</td>
<td>109</td>
<td>42</td>
<td>109</td>
</tr>
<tr>
<td>(Pseudo) R²</td>
<td>0.0790</td>
<td>0.104</td>
<td>0.0557</td>
<td>0.411</td>
<td>0.1464</td>
<td>0.185</td>
<td>0.215</td>
<td>0.691</td>
</tr>
<tr>
<td>Dyad fixed effects</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>CE</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>

**NOTE:** Standard errors in parentheses. Robust standard errors in all OLS specifications. CE denotes standard errors clustered at the dyad level. ***p < 0.01, **p < 0.05, *p < 0.1. “a” denotes claim omitted due to lack of use.
formalities, escape clause, and export subsidies, and two claims that in the WTO era are considered liability rules, namely, nonviolation and domestic subsidies.

The first four columns of Table 4 present logit and OLS estimates for the WTO era, with and without dyad fixed effects, and with the control $DevRes_j$ included in the specification without dyad fixed effects. The logit and OLS estimates in columns 1 and 2 are broadly supportive of our model’s prediction: The inclusion of any of the five property rule claims in a dispute reduces the likelihood of early settlement for that dispute, an impact that is in each case statistically significant at either the 1%, 5%, or 10% level, whereas the inclusion of either of the two liability rule claims in a dispute increases the likelihood of early settlement for that dispute, though this impact is significant at the 10% level only for the nonviolation claim. The inclusion of dyad fixed effects in columns 3 and 4 of Table 4 leaves the point estimates of the coefficients essentially unchanged but raises the standard errors somewhat.

The last four columns of Table 4 present the same specifications but now estimated on the sample of GATT-I era disputes. 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 pattern across estimated coefficients in the GATT-I era similar to the pattern we find 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 reassuring that, in fact, our estimated coefficients over the GATT-I era do not show a pattern similar to our results from the WTO era. Across all the specifications in columns 5–8, none of the coefficients on the WTO-era property rule claims are now significantly different from zero.

Interestingly, a number of the coefficients on the WTO-era liability rule claims turn negative in the GATT-I era regressions, and for nonviolation claims sometimes significantly so. This is the analog of our Figure 4 finding that $ES_{P_{\text{WTO}}} > ES_{L_{\text{WTO}}}$ in the GATT-I era. 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 likelihood 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 footnote 54). This explanation seems especially compelling for the statistically negative coefficient on nonviolation claims in the GATT-I era that are reported in columns 5 and 6 of Table 4, because as noted by Pauwelyn (2008) in the passage we quote above, nonviolation claims concern 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.

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 find support for a central prediction of the model using data on the outcomes of actual trade disputes in the GATT/WTO.

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, this is a simple way to capture situations in which governments dispute over nontariff measures that are discrete in practice, and such disputes are common in the GATT/WTO. But it is nevertheless important to consider a richer set of policy options than our model allows. In the related model of Maggi and Staiger

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61 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 regressions in Table 4, 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.
(2015), we demonstrate that it is indeed the discreteness of the policy instead of its dichotomous nature that is important for the results; we conjecture that the same is true for our results here. If the policy were truly continuous, on the other hand, in the static model presented here, there would typically be no rulings, since the bargaining set would typically be convex. But it is important to note that this may no longer hold in a dynamic setting: for example, in a recent working paper (Maggi and Staiger, 2016) that focuses on the implications of judicial learning, we show that even if policies are truly continuous, there can be DSB rulings in equilibrium. Interestingly, Guzman and Simmons (2002) draw a distinction between policies that have an “all or nothing” character, such as health and safety standards, and policies that are continuous and more “flexible” in nature such as tariffs, and in their empirical study of WTO disputes find that settlement rates are higher for disputes over more continuous policies.

We have also assumed that contracts are automatically enforced, but in reality, international contracts must be self-enforcing. Extending our analysis along these lines is a complex task, but it could have a large 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.

Supporting Information

Additional Supporting Information may be found in the online version of this article at the publisher’s website:

Online Appendix

REFERENCES


As a simplification for characterizing the optimal legal rules, this assumption 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. 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 (2011).