

# ON THE ROLE AND DESIGN OF DISPUTE SETTLEMENT PROCEDURES IN INTERNATIONAL TRADE AGREEMENTS\*

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## Abstract

Formal economic analysis of trade agreements typically treats disputes as synonymous with concerns about enforcement. But in reality, most WTO disputes involve disagreements of interpretation concerning the agreement, or instances where the agreement is simply silent. And some have suggested that the WTO's Dispute Settlement Body (DSB) might serve a useful purpose by granting "exceptions" to rigid contractual obligations in some circumstances. In each of these three cases, the role played by the DSB amounts to "completing" various dimensions of an incomplete contract. Moreover, there is a debate among legal scholars on whether or not precedent-setting in DSB rulings may enhance the performance of the institution. All of this points to the importance of understanding the implications of the different possible degrees of *activism* in the role played by the DSB. In this paper we bring formal analysis to bear on this broad question. We characterize the choice of contractual form and DSB role that is optimal for governments under various contracting conditions. A novel feature of our approach is that it highlights the interaction between the design of the contract and the design of the dispute settlement procedure, and it views these as two components of a single over-arching institutional design problem.

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# 1 Introduction

When countries sign on to an international agreement, what kinds of disputes are anticipated, and what mechanisms are put in place to deal with these disputes? In the context of trade agreements, formal economic analysis typically treats disputes as synonymous with concerns about enforcement, and thereby provides answers to this question from the perspective of optimal enforcement.<sup>1</sup>

Yet even a cursory familiarity with the World Trade Organization (WTO) and its Dispute Settlement Body (DSB) suggests that the answer to this question is likely to be far more complex and subtle than a focus on enforcement alone might suggest. In a typical WTO case, the issue under dispute is rarely the straightforward enforcement of an unambiguous obligation under the agreement. Rather, as a legal matter, most WTO disputes seem to involve plausible disagreements of interpretation concerning what the disputing parties actually signed on to, or instances where the legal text of the agreement is simply silent. Of course, the effective enforcement of an international trade agreement must be a critical determinant of its value to member governments; but at least in the WTO, actual disputes (as opposed to off-equilibrium threats) seem to be more about interpreting “vague” aspects of the contract and filling “gaps” in the contract than about enforcing unambiguous obligations specified by the contract.<sup>2</sup> And it has been suggested by some legal scholars that the WTO DSB might serve a useful purpose by granting “exceptions” to rigid contractual obligations in some circumstances and thereby modifying the contract.<sup>3</sup> In each of these three cases, the *activist* role played by the DSB amounts to “completing” various dimensions of an incomplete contract.

In this paper, we bring formal economic analysis to bear on these broader aspects of the question posed above. In particular, we evaluate the possible role that a DSB might play in helping to complete an incomplete contract, and we characterize the choice of contractual incompleteness and DSB design that would be optimal for governments under various contracting conditions. A distinctive and novel feature of our approach is that it highlights the interaction between the design of the contract and the design of the dispute settlement procedure, and it views these as two components of a single over-arching institutional design problem.

We build from a setting of costly contracting along the lines of Battigalli and Maggi

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<sup>1</sup>See, for example, Bagwell and Staiger (2002, Chapter 6) and the literature cited therein.

<sup>2</sup>Actual WTO disputes may also be about adjusting the bargain in order to maintain enforceability of the contract in the presence of exogenous shocks (see, for example, Bagwell and Staiger, 1990) or to facilitate a form of “efficient breach” (see, for example, Sykes, 2000, Schwartz and Sykes, 2002, Lawrence, 2003, and Howse and Staiger, 2005).

<sup>3</sup>See, for example, the discussion in WTO (2007, pp. 279-282).

(2002) and Horn, Maggi and Staiger (2006) which gives rise to two forms of contractual incompleteness: *rigidity* and *discretion*. From this starting point, we use a simple form of fuzzy logic to introduce a contracting language which is vague in nature, and which gives rise to a third form of contractual incompleteness: *vagueness*. Our analysis then naturally pairs the three possible (non-enforcement) roles of the DSB described above with our three forms of contract incompleteness: the DSB can *interpret* aspects of the contract that are left vague; the DSB can *fill gaps* where the contract is silent and therefore leaves governments with discretion; and the DSB can grant exceptions and thereby *modify* aspects of the contract that are rigid. Or, the DSB can serve none of these functions and simply enforce contractual obligations that are unambiguous.

We consider a simple static (one-period) setting where, in a given industry, the importing country selects a trade policy, and the exporting country can then file a complaint, in which case the DSB steps in and issues a ruling. An important feature of our model is that it is costly for both the complainant (exporter government) and the plaintiff (importer government) to engage in a dispute, and this gives rise to non-trivial strategic interaction between them. Indeed, the relative performance of the various institutional arrangements depends crucially on the impacts of these arrangements on the equilibrium behavior of the governments, which in turn determines the circumstances under which a trade dispute will arise in equilibrium: as we later demonstrate, some of the more subtle insights generated by our framework hinge on how the institutional arrangement affects the equilibrium occurrence of disputes.

A critical feature of our contracting environment is the accuracy of DSB rulings in representing government preferences. We find that, if the DSB plays an activist role, the equilibrium policy tends to be efficient when the DSB is *not* invoked in equilibrium. Also, equilibrium disputes are more frequent when the DSB is *less* accurate. Thus, in effect the motives that trigger a DSB filing are inefficient, and it is the off-equilibrium impacts of the DSB that are efficiency-enhancing.

We characterize the optimal combination of contract and DSB role, as a function of the degree of DSB accuracy. We show that when DSB rulings are sufficiently accurate, it is optimal for governments to build discretion into the contract and provide the DSB with a mandate to fill the gaps when disputes arise. On the other hand, if DSB rulings are sufficiently inaccurate, we show that it is optimal for governments to negotiate a contract which is either vague or rigid and to then bar the DSB from engaging in any attempts to “complete” the contract when disputes arise. Finally, if the accuracy of DSB rulings falls in an intermediate range, we show that it is optimal for governments to negotiate a vague contract and provide the DSB with a mandate to interpret the vague aspects of the contract

when disputes arise.

We next extend the static model to a simple dynamic (two-period) setting to explore a further issue of DSB design: Should DSB rulings set legal *precedent* for future rulings? There is a growing discussion in the legal literature as to whether and to what extent the actual WTO DSB operates on a precedent system. Jackson (2006, page 177) argues that “there is quite a powerful precedent effect in the jurisprudence of the WTO, but ... it is not so powerful as to require panels or the Appellate Body considering new cases to follow prior cases,” and concludes that “the ‘flavor’ of the precedent effect in the WTO is still somewhat fluid.” Given this state of affairs, where the role of precedent in the WTO is very much an open issue of institutional design, it seems particularly important to consider the implications of precedent from a formal perspective. We believe our framework is well-suited for this kind of analysis.<sup>4</sup>

In our dynamic setting, we show that the equilibrium frequency of trade disputes rises with the introduction of legal precedent set by DSB rulings, and that this effect by itself *diminishes* the overall performance of the contract/DSB pair. More broadly, our findings suggest that the introduction of precedent can enhance the performance of a contract/DSB-design pairing only if the expected value of the elimination of duplicative filing costs afforded by precedent outweighs the expected costs associated with the additional filing behavior induced by precedent. When we examine how the resolution of these opposing effects vary with key parameters of the model, we find that the introduction of precedent is more likely to enhance the performance of the institution (i) when the accuracy of DSB rulings is sufficiently low, and (ii) when governments care sufficiently little about the future.

Our model can also shed some light on a more positive question that concerns the outcome of WTO disputes. Empirically, there seems to be a “pro-trade bias” in DSB rulings. Both under the GATT and the WTO, complainants have mostly won their cases. What accounts for this observed bias? One explanation that has been proposed (Goldstein and Steinberg, 2007) hinges on the presence of dispute costs for the *exporter*: if it is costly for the exporter to engage in a dispute, there may be a pro-trade (selection) bias in DSB rulings, because the exporter will file only if there is a high probability of success. Our model suggests a qualification to this insight. In our framework, a pro-trade bias arises if the dispute costs faced by the exporter are high *relative* to those faced by the importer.

We can also address a related question: does the equilibrium *policy outcome* exhibit

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<sup>4</sup>We are not aware of studies that examine the implications of precedent in the context of international agreements. But there are several papers in the literature that examine the effects of precedent in the context of a domestic court system (see for example the classic analysis by Posner, 1973, and the recent paper by Gennaioli and Shleifer, 2007). These papers focus mostly on the question of whether precedent setting makes it more or less likely that the body of law will become more efficient over time.

a pro-trade bias, in the sense that trade protection is under-utilized relative to the first best outcome? A natural conjecture would be that the bias in DSB rulings and in policy outcomes would go hand-in-hand. But, perhaps surprisingly, we find that there is an inverse relationship between the two biases: if there is a pro-trade bias in DSB rulings there tends to be an anti-trade bias in policy outcomes, and vice-versa.

In addition to the work of Battigalli and Maggi (2002) and Horn, Maggi and Staiger (2006) discussed above, we are aware of several other papers that relate to various themes in our paper. In particular, a number of authors have begun to explore the interplay between the form of written contracts and the nature and degree of ex-post activities performed by the court. Shavell (2006), for example, emphasizes how the possible methods of contract interpretation can affect the writing of contracts, and characterizes the optimal method of interpretation. Anderlini, Felli and Postlewaite (2006, 2007) similarly analyze the role of active courts in contracting environments where the ex-ante contracts are incomplete, and characterize optimal court behavior (see also Fon and Parisi, 2007). At a broad level, these papers and our paper have a similar focus, but the particular questions addressed and the formal treatments are quite distinct.<sup>5</sup>

A paper that is related to a different theme of our paper – the notion of vagueness in contracting language – is that of Bustos (2007), who extends Battigalli and Maggi to include a choice between precise and vague clauses in the contract. There are a number of substantial differences between our paper and Bustos', but among these differences are two: first, unlike our paper and those reviewed just above, Bustos is not concerned with the interplay between the form of written contracts and the nature and degree of ex-post activities performed by the court, and indeed the court in Bustos' model plays only a contract-enforcement role; and second, the way in which Bustos defines vagueness – a clause that demands “best effort” in performing the action – is very different from the concept of vagueness that we introduce below and which we believe permeates the contracting language used in trade agreements.<sup>6</sup>

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<sup>5</sup>In the literature on trade agreements, another paper that considers the potential role of the DSB for completing an incomplete contract is Battigalli and Maggi (2003). They consider a setting in which two countries choose product standards, and can only write an agreement that covers existing products, not products that may emerge in the future. To remedy this contractual incompleteness problem, the countries can institute a DSB that fills the gaps of the contract ex post. As in the present paper, the DSB – if invoked – observes a noisy signal of the governments' preferences and maximizes the expected joint payoff of the two countries. But this is where the similarity between the two papers stops: the questions addressed and the formal structure adopted in the two papers are very different.

<sup>6</sup>This is not to say that the notion of vagueness explored by Bustos (2007) is irrelevant for trade agreements. On the contrary, it is possible to find specific examples of the kind of vagueness that Bustos seems to have in mind in the GATT/WTO, where for example GATT Article XVI on subsidies uses the language "seek to avoid" in describing the obligation of contracting parties, or where for example in GATT Article XXXVII it is stated that "the developed contracting parties shall to the fullest extent possible..." . These phrases seem to represent the kind of clause that fits well with Bustos' conception of vagueness. Our point

The rest of the paper proceeds as follows. Section 2 presents our basic static model, and characterizes the optimal choice of contractual incompleteness and DSB design in this static setting. Section 3 extends the model and results to a dynamic setting, and considers the impact of precedent setting in contract/DSB performance. Section 4 concludes.

## 2 The Basic Static Model

We begin this section by first describing the economic structure. We next turn to describe the contracting language, the possible contracts, and our assumptions on contracting costs. With this description in hand, we then present our model of the DSB and turn to an analysis of the equilibrium behavior of governments and optimal contract/DSB design.

### 2.1 The economic structure

We consider a very simple partial-equilibrium setup to develop our points. We focus on a single industry in which an importing government chooses a binary import policy  $T \in \{FT, P\}$  (Free Trade or Protection) to maximize the payoff  $\omega(T; s)$ , where  $s \equiv (s_1, s_2, \dots, s_N)$  is a state vector. We assume for simplicity that each state variable represents a binary event, such as “there is/is not an import surge” or “the domestic industry does/does not shut down.” We will often refer to the random vector  $s$  as the “state of the world,” or simply as the “state.” We let  $p(s)$  denote the probability that state  $s$  occurs. The exporting government is assumed to remain passive in this industry (i.e., there is no exporter policy), and its payoff is given by  $\omega^*(T; s)$ . We denote the joint payoff of the two governments by  $\Omega(T; s) \equiv \omega(T; s) + \omega^*(T; s)$ . Transfers between governments are ruled out by assumption.<sup>7</sup>

Let  $\gamma(s) \equiv \omega(P; s) - \omega(FT; s)$  denote the importing government’s gain from protection. This gain may be thought of as arising from some combination of terms-of-trade and political considerations. We assume that  $\gamma(s) > 0$  for all states  $s$ . Similarly, let  $\gamma^*(s) \equiv \omega^*(P; s) - \omega^*(FT; s)$ . We assume that  $\gamma^*(s) < 0$  for all  $s$ : the exporting government always dislikes

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here is simply that there is a more pervasive kind of vagueness in the GATT/WTO contracting language, and our modeling represents an attempt to formalize it.

<sup>7</sup>While direct transfers are rarely used as part of international trade agreements, it is not uncommon for countries to grant market access through tariff concessions in return for concessions from their trading partners that are unrelated to market access (e.g., tighter intellectual property rights protection, or beefed-up drug control efforts), and these non-market-access concessions can be interpreted as serving the role of international transfers that redistribute the gains from trade liberalization across countries. We can allow for such transfers ex-ante (i.e., transfers that occur at the stage of writing the contract), and need only rule out ex-post transfers (i.e., transfers that occur at the time of a dispute). As discussed in WTO (2007, pp. 283-286), the resolution of WTO disputes almost never involve direct transfers (the one exception to date is the *US-Copyright* case).

import barriers.

Let  $\Gamma(s) \equiv \gamma(s) + \gamma^*(s) = \Omega(P; s) - \Omega(FT; s)$  denote the joint (positive or negative) gain from protection for the two governments. We let  $\sigma^{FT}$  and  $\sigma^P$  denote the sets of states for which the first best (joint-surplus-maximizing) policy is respectively  $FT$  and  $P$ , or equivalently,  $\Gamma(s) < 0$  for  $s \in \sigma^{FT}$  and  $\Gamma(s) > 0$  for  $s \in \sigma^P$ .<sup>8</sup> To make the problem interesting, we assume that the first-best policy is Protection in some states and Free Trade in others; this amounts to assuming that  $\sigma^{FT}$  and  $\sigma^P$  are non-empty. We also assume that each of the  $N$  state variables is relevant for determining the first-best policy (in the particular sense that, for each of the  $N$  state variables, there is at least one state of the world in which the first-best policy hinges on the realized value of that state variable).

The governments observe the realized state  $s$  and the value of  $\Gamma(s)$ . However,  $\Gamma$  is not verifiable, so contracts cannot be made directly contingent on  $\Gamma$ .<sup>9</sup> The underlying state variables  $(s_1, s_2, \dots, s_N)$  on the other hand are verifiable, and they can be specified in a contract at some cost. Therefore, the first-best outcome can be implemented by a contract that makes the policy contingent on the state variables.

## 2.2 Contracting language, contracts and contracting costs

We now describe the language that is available to write a contract, the possible contracts that can be written, and the costs of writing them. We begin by describing the contracts that can be written with the “crisp” (unambiguous) language that is typically assumed to be available in contract theory.

Consider first the benchmark case of a *complete* contract, which specifies  $T$  as a function of the full vector of state variables. As discussed in the previous section, the first best can be achieved with such a contract that takes the form:

$$T^{FB}(s_1, s_2, \dots, s_N) = \begin{cases} P & \text{if } (s_1, s_2, \dots, s_N) \in \sigma^P \\ FT & \text{if } (s_1, s_2, \dots, s_N) \in \sigma^{FT} \end{cases}$$

This contract achieves the first best, but it is likely to be very costly to write, especially if the number of state variables  $N$  is large. Following Battigalli and Maggi (2002) and Horn, Maggi and Staiger (2007), we assume the cost of including a state variable in the contract by  $c_s$ . For now, we assume that specifying the policy ( $FT$  or  $P$ ) is costless (later we will introduce a small cost of specifying the policy as a tie-breaking assumption). Then the complete contract  $T^{FB}(s_1, s_2, \dots, s_N)$  costs  $N \cdot c_s$ .

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<sup>8</sup>As indicated in the text above and further discussed in note 7, we do not allow governments to make transfers to each other, but policies that maximize their joint surplus are first-best from an ex-ante perspective, provided that ex-ante governments are symmetrically positioned. See also note 29.

<sup>9</sup>That payoff levels are not verifiable is a standard assumption in this kind of model (this assumption is made also in Battigalli and Maggi, 2002, and Horn, Maggi and Staiger, 2006).

Given our assumption on contracting costs, it is possible to reduce these costs by writing a contract that makes  $T$  contingent only on a subset of the state variables. The cost of such a contract is given by  $n \cdot c_s$ , where  $n$  is the number of state variables that are specified in the contract. Note that, given our payoff structure, if  $n < N$  the first best cannot be achieved. In the limit, all state variables may be excluded from the contract, in which case we have two possibilities: a completely *rigid* contract, which specifies  $T = FT$  for all states or simply “Free trade always;”<sup>10</sup> and the *discretionary* contract “Trade protection always allowed” (or equivalently, the empty contract). These two contracts represent in a very stylized way the two types of contractual incompleteness that have been highlighted by the contract-theoretic literature: rigidity and discretion. We label these contracts respectively  $R$  and  $D$ . According to our contracting cost assumptions, there is no cost to writing either of these two contracts.

In addition to the crisp-language contracting possibilities described above, we now introduce a language which is *vague* in nature, in the sense that its meaning is only partially defined. To formalize vague language we use a simple type of *fuzzy logic*. To illustrate, consider a sentence  $\mathcal{F}$ , which could sound for example like “there is substantial injury to the domestic industry,” and suppose that the *truth value* of sentence  $\mathcal{F}$  is the following:

$$\text{Sentence } \mathcal{F} \text{ is } \begin{cases} \textit{True} & \textit{if } s_1 = \dots = s_N = 1 \\ \textit{False} & \textit{if } s_1 = \dots = s_N = 0 \\ \textit{Undefined} & \textit{otherwise} \end{cases}$$

If  $T$  is made contingent on the truth value of such a sentence, something novel can be accomplished relative to the crisp-language contracts described above:  $T$  is made responsive to some states of the world where the right policy response is “obvious” ex-ante, but in other states of the world the contract remains vague about the stipulated setting of  $T$ . If for example  $N = 3$ , with  $s_1 = 1$  ( $s_1 = 0$ ) when there is (is not) an import surge,  $s_2 = 1$  ( $s_2 = 0$ ) when the domestic industry does (does not) shut down, and  $s_3 = 1$  ( $s_3 = 0$ ) when the majority of workers in the domestic industry are (are not) unemployed, then sentence  $\mathcal{F}$  could mean the following: there is certainly substantial injury to the domestic industry if there is an import surge, the domestic industry shuts down and the majority of workers in the industry are unemployed; there is certainly not substantial injury to the domestic industry if none of these events has occurred; but in the remaining states of the world it is not defined whether or not there is substantial injury – in other words, in these states it is a matter of interpretation.<sup>11</sup>

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<sup>10</sup>There is no need to consider the rigid contract  $T = P$  for all  $s$ , because this is outcome-equivalent to the discretionary (or empty) contract that we describe next.

<sup>11</sup>A richer model would allow for a multiplicity of vague sentences, some more vague than others; for example there may be sentences that are true in more than one state and false in more than one state. Also, among the sentences with a similar degree of vagueness, some might “match” the first-best policy mapping (in our case,  $FT$  for  $s \in \sigma^{FT}$  and  $P$  for  $s \in \sigma^P$ ) better than others. In our basic model we abstract from

Henceforth we assume that  $s^1 \equiv (1, \dots, 1) \in \sigma^P$  and  $s^0 \equiv (0, \dots, 0) \in \sigma^{FT}$ . In light of the sentence  $\mathcal{F}$ , we will sometimes refer to  $s^1$  and  $s^0$  as “extreme” states, and to all others as the “intermediate” states.<sup>12</sup>

The vague language can be used to write what we label the *vague* ( $V$ ) contract: “Trade protection is allowed only if there is substantial injury to the domestic industry.”<sup>13</sup> We assume that there is no cost to writing the vague ( $V$ ) contract.

Summarizing, we have described three forms of contract incompleteness, each of which can reduce or eliminate the costs of contracting: *rigidity*, *discretion* and *vagueness*. At this point, in principle there are many contracts that we should consider. But in order to bring out the main insights in the simplest possible way, we assume that  $c_s$  is sufficiently high that specifying any state variable in the contract is suboptimal.<sup>14</sup> Under this assumption we can restrict attention to the three benchmark types of incomplete contract: the rigid ( $R$ ) contract, the discretionary ( $D$ ) contract, and the vague ( $V$ ) contract.

Above we assumed that the  $R$ ,  $D$  and  $V$  contracts cost nothing to write. But notice that, unlike the  $D$  contract, both the  $R$  and  $V$  contracts *would* cost something to write if specifying the policy ( $FT$  or  $P$ ) were costly. Later we will introduce a small cost of specifying the policy as a way to break ties between the discretionary contract ( $D$ ) and the rigid/vague contracts ( $R/V$ ).<sup>15</sup>

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these issues by considering only one simple vague sentence. In the context of a richer model, this could be interpreted as the best-performing among the set of possible vague sentences.

<sup>12</sup>Of course, the performance of the  $V$  contract will depend in part on the likelihood of the states  $s_1 = \dots = s_N = 1$  and  $s_1 = \dots = s_N = 0$ ; if  $N$  is large and the elementary events were *iid* these states would have low likelihood, but recall that we allow for elementary events to have different probabilities and to be correlated, so these states need not have low likelihood, and hence the  $V$  contract has a chance to be optimal. An alternative approach – probably more realistic but more cumbersome – would be to assume that  $\mathcal{F}$  is true in more than one state and is false in more than one state. From this perspective, one could interpret each “extreme” state as capturing a *cluster* of states rather than a single state.

<sup>13</sup>We could alternatively consider a contract that says “There must be Free Trade unless there is substantial injury,” or “Protection is allowed if and only if there is substantial injury.” Both of these contracts impose a constraint ultimately only in state  $s^0$  and hence are equivalent to the one considered in the text.

<sup>14</sup>This seems like a reasonable first step, since in this paper we want to focus on the potential role of the DSB for completing an incomplete contract. Reducing  $c_s$  would intuitively diminish the potential role for the DSB, since this would make it optimal to write a more complete contract. But aside from this, it is not clear that reducing  $c_s$  would change the main qualitative insights of the paper. In any event, we leave the exploration of the more general case for future research.

<sup>15</sup>The assumption that specifying a policy is costly would be even more compelling in a richer setting with multiple policy dimensions. Extending the model in this direction would be interesting also because many WTO disputes in reality concern the presence of gaps and vague provisions in the agreement regarding which policies are allowed and which are not. We are currently working on this extension of the model.

## 2.3 The Dispute Settlement Body

Each of the forms of incompleteness described above carries with it a particular set of possible roles that the Dispute Settlement Body (DSB) might play. We begin by describing each of the potential roles that find significant representation in the writings of legal scholars of the WTO. We then identify which possible DSB roles could arise under each type of incompleteness. Finally, we describe in detail our assumptions on DSB behavior and information.

A first, basic role of the DSB is to oversee enforcement of the obligations in the contract.<sup>16</sup> If an obligation is specified unambiguously in the contract and yet is not met, then the DSB can play a role in helping to ensure that compliance is reinstated. To the extent that the DSB is able to ensure enforcement, this role is clearly desirable from an institutional-design point of view, and therefore we feel justified in taking this role for granted and keeping it in the background of the model. Our analysis will thus focus on whether and to what extent it is desirable for the DSB to go beyond a pure enforcement role.

Since the enforcement role of the DSB is not the focus of our model, we make the simplest possible assumption regarding the enforcement of the contract: any obligation that is stated unambiguously in the contract is automatically enforced by the WTO, just as in a standard contracting model where the contract is automatically enforced by a court.<sup>17</sup> A more realistic assumption would be that the DSB intervenes to enforce contractual obligations only if it is invoked by a government (enforcement “on demand”), but this would only complicate the analysis without changing the main insights of the model.<sup>18</sup>

Beyond the enforcement role, the DSB can play three potential roles:

1. Provide interpretations/clarifications of the contract. In effect, under this role the DSB serves as the interpreter of clauses and obligations that are left vague in the original contract. We denote this DSB role by  $i$ .
2. Fill gaps in the contract. In effect, under this role the DSB introduces new obligations that are unambiguously *not* specified in the original contract. We denote this DSB

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<sup>16</sup>There is a deep question about why a DSB is needed for enforcement (see, for example, Maggi, 1999 and Klemenko, Ramey and Watson, forthcoming), but we abstract from this issue here.

<sup>17</sup>To be more precise, we assume that unambiguous obligations are automatically enforced unless the DSB has a mandate to grant exceptions (which is the case under the DSB role  $m$ , to be introduced below) and is invoked under this mandate.

<sup>18</sup>We note that, by keeping enforcement in the background of the model, we are abstracting in this paper from the possibility of permitting “efficient breach,” whereby the importing government would be permitted to adopt Protection if it wished to do so even when the contract stipulated Free Trade unambiguously, provided only that appropriate compensation were paid to the exporting government (see also note 2).

role by  $g$ .<sup>19</sup>

3. Introduce exceptions to rigid aspects of the contract. In effect, under this role the DSB modifies obligations that are unambiguously specified in the original contract. We denote this DSB role by  $m$ .

These roles span the potential (non-enforcement) activities of the DSB that find significant representation in the writings of WTO legal scholars. In effect, the interpretive ( $i$ ), gap-filling ( $g$ ) and modification ( $m$ ) roles entail DSB efforts to “complete” the ex-ante contract. We will sometimes refer to a DSB whose mandate extends beyond the mere enforcement of the contract to include either the interpretation, gap-filling or modification role as an *activist* DSB, and to a DSB whose mandate is confined to contract enforcement as a *non-activist* DSB. Note also that, with enforcement kept in the background of our model, when we make reference henceforth to the DSB being “invoked” or a “dispute” arising, this always refers to one of the three activist DSB roles.

To be clear, the language of the WTO Agreement provides explicitly for an interpretive ( $i$ ) role of the DSB, but this language would seem to rule out the possibility that the WTO DSB could serve the modification role ( $m$ ) or the gap-filling role ( $g$ ). As Article 3, paragraph 2 of the WTO Understanding on Rules and Procedures Governing the Settlement of Disputes indicates:

The dispute settlement system of the WTO is a central element in providing security and predictability to the multilateral trading system. The Members recognize that it serves to preserve the rights and obligations of Members under the covered agreements, and to clarify the existing provisions of those agreements in accordance with customary rules of interpretation of public international law. Recommendations and rulings of the DSB cannot add to or diminish the rights and obligations provided in the covered agreements.

Nevertheless, gap-filling (adding obligations) and modification (diminishing obligations) activities of the WTO DSB are frequently discussed in both positive and normative contexts

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<sup>19</sup>The distinction between gap-filling and interpretation/clarification is described by Goldstein and Steinberg (2007, p. 20) in this way: “Gap-filling refers to judicial law-making on a question for which there is no legal text directly on point, whereas ambiguity clarification refers to judicial law-making on a question for which there is legal text but that text needs clarification.” A similar distinction is adopted by Jackson (2006, p. 184): “In some cases, there are actual gaps in the treaty, in other words, the treaty is totally silent with regard to how it should apply in some circumstances. In other cases, there is treaty language that is applicable, but the treaty language is sufficiently ambiguous that it could reasonably be interpreted in several different ways.”

by legal scholars (see, for example, Goldstein and Steinberg, 2007, and WTO, 2007). As such, we include them as important and relevant potential DSB activities to evaluate.<sup>20</sup>

We may now describe which of the activist roles identified above are relevant for each of the three forms of contractual incompleteness. In the case of discretion ( $D$ ), only the role of gap-filling ( $g$ ) is relevant. In the case of rigidity ( $R$ ), only the role of modification of obligations ( $m$ ) is relevant. And in the case of vagueness ( $V$ ), only the interpretation role ( $i$ ) is relevant.<sup>21</sup>

Whatever the role played by the DSB, we assume that there are costs of a dispute should it occur. In particular, whenever the exporter (complainant) invokes the DSB, the exporter incurs cost  $c^*$  and the importer (defendant) incurs cost  $c$ .<sup>22</sup> We have in mind the costs of litigation, which for each disputant will reflect various administrative costs, the costs of lawyers and the cost of acquiring in-house expertise, the burden of proof, etc., but in the model we treat these costs as parameters.

We next describe our model of DSB behavior. We assume that the DSB always operates in accordance with its mandate. Thus, there are three possible types of dispute that can arise in our model: (1) if the contract is discretionary ( $D$ ) and the DSB has a gap-filling ( $g$ ) role, there may be a dispute in any state for which there is no contractually stipulated obligation (i.e., there may be a dispute in any state  $s$ ); (2) if the contract is vague ( $V$ ) and the DSB has an interpretation ( $i$ ) role, there may be a dispute in any state for which the contractually stipulated obligation is left vague (i.e., there may be a dispute in any intermediate state  $s$ ); and (3) if the contract is rigid ( $R$ ) and the DSB has a modification of obligations ( $m$ ) role, there may be a dispute in any state for which the contractually stipulated obligation is rigid (i.e., there may be a dispute in any state  $s$ ).

As we noted in section 2.1, the two governments are assumed to observe the realized state  $s$  and the associated value of  $\Gamma$ . By contrast, we assume that the DSB observes the realized state  $s$  but not the value of  $\Gamma$ . Thus, the DSB does not know what the “best” (joint-payoff-maximizing) policy is for the realized state  $s$ . If invoked, the DSB observes a noisy

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<sup>20</sup>It is also possible to find examples of courts playing a modification-type role in domestic settings, where the court may void an obligation in the contract (see, for example, Anderlini, Felli and Postlewaite, 2006, 2007).

<sup>21</sup>We feel justified in referring to the utter emptiness of the  $D$  contract as a “gap,” because in a richer model the contract could be empty along some dimensions while including non-empty clauses along other dimensions. Also, for the more general case of our basic model in which  $c_s$  may be low, the optimal contract may have rigidity, discretion and vagueness (or a subset of these) at the same time, and so the DSB may play more than one of the activist roles; our basic model represents an attempt to focus more sharply on the trade-offs between the various roles.

<sup>22</sup>We could also allow for a fixed cost of the DSB, but this would not change our qualitative results regarding the optimal choice among non-empty contracts, because a DSB must be present at least in an enforcement role for any such contract, and so the fixed cost would have to be incurred in any event.

signal of  $\Gamma$  for the current realized state, and it issues a *ruling* – which is simply a policy determination  $T^{DSB}$  for the realized state of the world – with the objective of maximizing the expected joint payoff of the governments given the signal. Note that the DSB ruling  $T^{DSB}$  fills a gap in the  $D$  contract in case (1) above, it interprets a vague obligation in the  $V$  contract in case (2) above, and it simply ignores the obligation stipulated by the  $R$  contract in case (3) above. Finally, we assume that DSB rulings are automatically enforced.<sup>23</sup>

We now describe in more detail our assumptions concerning the information available to the DSB. We assume that: (i) the DSB priors are uninformative, in the sense that  $\Pr(\Gamma(s) > 0) = \Pr(\Gamma(s) < 0) = 1/2$  for each realized state  $s$ ; and (ii) given the realized state  $s$  the DSB observes a noisy but unbiased signal  $\Gamma^{DSB}(s)$ , where the distribution of  $\Gamma^{DSB}(s)$  conditional on  $\Gamma(s)$  is symmetric.

A simple measure of the noise in the DSB signal is  $q(s) \equiv \Pr(\Gamma^{DSB}(s) \stackrel{sgn}{\neq} \Gamma(s))$ ; this is the probability that, given the realized state  $s$ , the DSB signal has the opposite sign from the true  $\Gamma(s)$ . Since the DSB priors are uninformative, it is easy to show that when playing an active role the DSB will issue the ruling  $T^{DSB} = P$  if and only if under the realized state  $s$  it observes a signal  $\Gamma^{DSB}(s) > 0$ .<sup>24</sup> Note that, if the DSB observes no signal at all, it is indifferent (when playing an active role) between choosing  $FT$  and  $P$ , and hence it randomizes in its ruling; this is the benchmark case of maximum DSB noise.<sup>25</sup>

To summarize: the information of the DSB in the realized state  $s$  is given by the signal  $\Gamma^{DSB}(s)$ ; when playing an active role, the DSB ruling is  $T^{DSB} = P$  iff  $\Gamma^{DSB}(s) > 0$ ; and the probability that the DSB recommends the wrong policy when playing an active role is  $q(s)$ .

Note that, since the distribution of  $\Gamma^{DSB}$  conditional on  $\Gamma$  is symmetric,  $q(s)$  is bounded above by  $1/2$ . For the purposes of comparative-static analysis, we will consider equi-proportional changes in the precision of the DSB signal, letting  $q(s) \equiv q \cdot k(s)$ , where  $k(s) \in [0, 1/2]$  for all  $s$  and  $q \in [0, 1]$  is a parameter that captures (inversely) the overall quality of the DSB information. We will vary  $q$  while keeping  $k(s)$  fixed. The case  $q = 0$

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<sup>23</sup>Notice that, conditional on being invoked, our model has the DSB behaving in the same way regardless of the nature of contract incompleteness. In a richer model this feature might be relaxed: for example, the DSB might have a better sense of the ruling that would best serve the member governments when the contract is vague and the DSB's role is to interpret what the governments had in mind than when the contract is discretionary and there is simply a gap for the DSB to fill; a similar observation might apply when comparing the rigid contract to the discretionary contract, and in each case our assumptions abstract from this feature. In effect, our modeling approach accepts this simplification as a reasonable compromise for maintaining tractability.

<sup>24</sup>When playing an active role, the DSB chooses  $T$  to maximize  $E(\Omega(T)|\Gamma^{dsp})$  – where we have omitted the argument  $s$  – so it chooses  $T = P$  iff  $E(\Omega(P)|\Gamma^{dsp}) - E(\Omega(FT)|\Gamma^{dsp}) > 0$ , or  $E(\Omega(P) - \Omega(FT)|\Gamma^{dsp}) > 0$  or finally  $E(\Gamma|\Gamma^{dsp}) > 0$ . But since the signal is unbiased,  $E(\Gamma|\Gamma^{dsp}) = \Gamma^{dsp}$  which proves the claim.

<sup>25</sup>Notice that we are implicitly assuming that when it plays an activist role the DSB is non-strategic, in that it does not attempt to draw inferences about  $\Gamma$  from the governments' behavior.

corresponds to the case in which the DSB has perfect information.<sup>26</sup>

Collecting all the possibilities that we have discussed above for the contract and the potential roles of the DSB, we have the following candidate *institutions*:<sup>27</sup>

<u>Contract DSB Role</u>	<b>Discretion</b>	<b>Rigidity</b>	<b>Vagueness</b>
<b>Non-activist DSB</b>	$D_n$ : no obligations	$R_n$ : rigid obligations	$V_n$ : vague obligations
<b>Activist DSB</b>	$D_g$ : no obligations, DSB fills gaps	$R_m$ : rigid obligations, DSB allows exceptions	$V_i$ : vague obligations, DSB interprets

Observe that the institution  $D_n$  delivers the Nash equilibrium outcome, and so amounts to no institution; the drawback of  $D_n$  of course is that it does nothing to prevent opportunistic behavior by governments. The institution  $R_n$  prevents opportunistic behavior but its rigid insistence on free trade implies that it sometimes gets the policy wrong. The institution  $V_n$  prescribes the correct policy in the extreme states  $s_0$  and  $s_1$ , but in the intermediate states the importer effectively has discretion and so the wrong policy is sometimes chosen under  $V_n$  as well. Finally, the institutions  $D_g$ ,  $R_m$  and  $V_i$  entail high DSB-use costs and subject governments to potential DSB error as the DSB works to “complete” the contract.

We describe now the timing of events. We start with a game that is essentially static. In the dynamic extension that we consider in the next section, this game is repeated and a number of additional issues can be explored. But many of the main points are best illustrated in the simple static setting of this section. We consider the following timing:

stage 0. The institution is created (the contract is written, specifying the substantive obligations and the mandate of the DSB).

stage 1. The state  $(s_1, s_2, \dots, s_N)$  is realized.

stage 2. The importer government chooses the policy  $T \in \{FT, P\}$ .

stage 3. The exporter government decides whether to file a complaint with the DSB.

stage 4. If invoked, the DSB issues a ruling within its mandate  $T^{DSB} \in \{FT, P\}$ .

stage 5. If the DSB rules against the defendant ( $T \neq T^{DSB}$ ), the import policy is modified to comply with the DSB ruling.

stage 6. Trades occur and payoffs are realized.

<sup>26</sup>An alternative way to parameterize the precision of the DSB information would be to assume complete symmetry ( $q(s) = q$ ); the reason we do not do this is that, given the structure we are working with, it is plausible that the DSB has a better idea about the “right” policy in the extreme states  $s^0$  and  $s^1$  than in the intermediate states; therefore we want to allow for the possibility that  $q(s)$  is lower in the extreme states.

<sup>27</sup>In a richer model these forms of contract-incompleteness/DSB-roles could well co-exist in the same institution. But for simplicity we use the term “institution” to refer to the contract/DSB-role pairing.

We can allow governments to renegotiate, both after the state  $(s_1, s_2, \dots, s_N)$  is realized in *stage 1*, and after the DSB issues a ruling in *stage 4* (these are the two relevant renegotiation nodes, because at each of these nodes governments receive some new information). But note that, since transfers between governments are not available, the possibility of renegotiation is irrelevant in this setting. This is because the interests of the two governments are directly in conflict and no Pareto improvement is possible ex-post; hence there is no room for renegotiation.

## 2.4 Analysis

We look for the institution  $\hat{I} \in \{D_n, D_g, R_n, R_m, V_n, V_i\}$  that maximizes the governments' ex-ante joint payoff  $E\Omega(\hat{T}(I); s)$ , where  $\hat{T}(I)$  is the (subgame-perfect) equilibrium policy that emerges under institution  $I$ .<sup>28,29</sup>

Let us first consider the institutions with a non-activist DSB  $(D_n, R_n, V_n)$ . Recall that in each of these cases, the DSB has no mandate to “complete” the contract, and no disputes can arise. The comparison between these three institutions is therefore straightforward.

Under the (Nash) institution  $D_n$ , clearly the equilibrium outcome is the policy  $P$  for all realizations of  $s$ . Under the institution  $R_n$ , the equilibrium outcome is  $FT$  for all  $s$ . And under the institution  $V_n$  – recalling that the  $V$  contract calls for  $FT$  in state  $s^0$  and for  $P$  in state  $s^1$ , while for all other states the obligations are left vague and hence nothing is enforced – the equilibrium outcome is for the importing government to select  $FT$  in state  $s^0$  and  $P$  in all other states.

We can now compare the institutions  $D_n$ ,  $R_n$  and  $V_n$  in terms of the ex-ante joint payoff. First note that  $V_n$  performs strictly better than  $D_n$ : the former imposes  $FT$  in state  $s^0$  and allows  $P$  in the other states, whereas the latter allows  $P$  in all states; thus  $D_n$  implements the wrong policy in one more state than  $V_n$ . So we can ignore the (Nash) institution  $D_n$ .

We turn next to a comparison of  $R_n$  and  $V_n$ . It is convenient to compare these contracts in terms of the expected efficiency losses relative to the first-best outcome. These are given respectively by:

$$L(R_n) = \sum_{s \in \sigma^P} p(s)\Gamma(s), \text{ and } L(V_n) = \sum_{s \in \sigma^{FT} \setminus s^0} p(s)|\Gamma(s)|. \quad (1)$$

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<sup>28</sup>In this setting the equilibrium policy will be unique for each institution.

<sup>29</sup>There are three ways to justify the assumption that the institution is chosen to maximize the governments' joint payoff: one possibility is to allow for ex-ante transfers, i.e., transfers at the time the institution is created (see note 7); a second possibility is to keep the single-sector model and introduce a veil of ignorance, so that ex-ante there is uncertainty over which of the two governments will be the importer and which the exporter; and a third possibility is to introduce a second mirror-image sector.

In general the ranking between these two institutions is ambiguous, and it depends on the intensity of the preference for  $FT$  in states  $s \in \sigma^{FT}$  versus the intensity of the preference for  $P$  in states  $s \in \sigma^P$ . Our main results will hold regardless of this ranking.

We next turn to consider the institutions with an activist DSB:  $D_g$ ,  $R_m$ , and  $V_i$ . It is helpful to distinguish between two cases: (a) those states  $s$  where, for the given institution, the activist role of the DSB is not applicable; and (b) those states  $s$  where the activist role of the DSB is applicable (under its mandate). In case (a), the equilibrium outcome is exactly as characterized above for the case of a non-activist DSB, while in case (b) we have to consider the possibility of disputes and derive the equilibrium outcome by backward induction.

Note that, within the set of activist-DSB institutions –  $D_g$ ,  $R_m$ , and  $V_i$  – case (a) applies only for  $V_i$ , and only then under states  $s^0$  and  $s^1$ ; for all other states and institutions, case (b) applies. Thus, the equilibrium outcome for the institution  $V_i$  in states  $s^0$  and  $s^1$  is the same as for the institution  $V_n$  examined above. It remains to determine equilibrium government behavior for all those states and institutions in which case (b) applies.

Consider first the exporter government’s filing behavior. For a state  $s$  where the activist role of the DSB is applicable under the given institution, the exporter government files a complaint if and only if  $T = P$  and the expected benefit to the exporter government of filing exceeds the exporter government’s cost of filing, that is

$$\Pr(\text{DSB ruling is } FT \mid s) \cdot |\gamma^*(s)| > c^*. \quad (\text{F})$$

Condition (F) is the “filing” condition for the exporter government to invoke the DSB in response to a policy choice by the importer government of  $T = P$ .

Next consider the importer government’s policy choice in a state  $s$  where the activist role of the DSB is applicable under the given institution. The importer government chooses  $T = P$  if either (F) fails – because then the importer government can set  $T = P$  without triggering a dispute – or if (F) holds and the expected benefit to the importer government from trade protection exceeds the cost to the importer government of a DSB dispute:

$$\Pr(\text{DSB ruling is } P \mid s) \cdot \gamma(s) > c. \quad (\text{P})$$

To reduce the number of cases and focus on the more interesting ones, we assume that for each disputant the cost of a dispute is relatively small. More specifically, we assume that in the benchmark case of maximal DSB noise, i.e. where the DSB randomizes when playing an active role, the (F) and (P) conditions are both satisfied for all  $s$ , or:

$$\frac{1}{2}|\gamma^*(s)| > c^* \text{ and } \frac{1}{2}\gamma(s) > c \text{ for all } s. \quad (2)$$

Condition (2) implies that  $c^*$  and  $c$  are sufficiently small so that, for any level of DSB noise, (i) if the first best policy is  $P$ , the importer government chooses  $P$  whether or not this triggers a complaint by the exporter government, and (ii) if the first best policy is  $FT$  but the importer government still chooses  $P$ , the exporter government files a complaint.

We can now examine more closely each of the activist-DSB institutions  $D_g$ ,  $R_m$ , and  $V_i$ .

Consider first the institution  $D_g$ . It is direct to derive the equilibrium actions of the governments for each state:

1. In states  $s \in \sigma^{FT}$ : if  $qk(s) < \frac{c}{\gamma(s)}$  then  $T = FT$  and the DSB is not invoked; if instead  $qk(s) > \frac{c}{\gamma(s)}$  then  $T = P$  and the DSB is invoked.<sup>30</sup>
2. In states  $s \in \sigma^P$ : if  $qk(s) < \frac{c^*}{|\gamma^*(s)|}$  then  $T = P$  and the DSB is not invoked; if instead  $qk(s) > \frac{c^*}{|\gamma^*(s)|}$  then  $T = P$  and the DSB is invoked.

Notice an interesting feature of the  $D_g$  institution: the expected quality of DSB rulings has a perverse effect on the equilibrium utilization of the DSB, in the sense that the DSB is invoked *more* frequently in equilibrium when the accuracy of its rulings is *low* (i.e., when  $q$  is high). Specifically, in states  $s \in \sigma^{FT}$ , the importing government chooses the inefficient policy  $P$  and *induces* a DSB filing by the exporting government if and only if  $qk(s)$  – the probability that the DSB will rule in error and uphold  $P$  when  $FT$  is in fact efficient – is sufficiently high. Similarly, in states  $s \in \sigma^P$ , the exporting government chooses to file with the DSB and *challenge* the importing government’s efficient policy choice  $P$  if and only if  $qk(s)$  – the probability that the DSB will rule in error and mandate  $FT$  when  $FT$  is in fact inefficient – is sufficiently high. In effect, the equilibrium *motives* that trigger a DSB filing under the  $D_g$  institution are inefficient from an ex-ante perspective, and it is the *off-equilibrium* impacts of the activist role of the DSB that are efficiency-enhancing. To confirm this point observe that, in any state for which the DSB is not invoked in equilibrium, the importer chooses the first best policy.<sup>31</sup>

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<sup>30</sup>To see this, note that condition (F) in this state is  $(1 - qk(s)) \cdot |\gamma^*(s)| > c^*$ , or  $qk(s) < 1 - \frac{c^*}{|\gamma^*(s)|}$ ; given (2) this is always satisfied, hence the exporter files iff  $T = P$ . Condition (P) is given by  $qk(s) \cdot \gamma(s) > c$ , or  $qk(s) > \frac{c}{\gamma(s)}$ ; thus the importer chooses  $T = P$  iff  $qk(s) > \frac{c}{\gamma(s)}$ , as claimed. The claim about states  $s \in \sigma^P$  that we make below can be shown analogously.

<sup>31</sup>This particular feature depends on the assumption that  $c$  and  $c^*$  are relatively small. If  $c$  and  $c^*$  were large, inefficient policies would arise also for states where the DSB is not invoked in equilibrium. This is because the threat of invoking the DSB may not be credible if the cost of doing so is high. In this case (which might potentially be relevant for small developing countries, but probably not for large or developed countries), intuitively the role of the DSB would be diminished, but our main qualitative results would still hold, at least to the extent that  $c$  and  $c^*$  are not prohibitive, i.e. so high that they shut down the impact of the DSB altogether.

In any case, we are now in a position to calculate the expected efficiency loss associated with the institution  $D_g$  relative to the first-best outcome. This loss is given by:

$$L(D_g) = \sum_{s \in \hat{\sigma}^{FT} \cup \hat{\sigma}^P} p(s)[qk(s)|\Gamma(s)| + c^{all}], \quad (3)$$

where  $\hat{\sigma}^{FT}$  is the set of states under the  $D_g$  institution for which Free Trade is efficient, the importing government chooses to protect, and the exporting government files a complaint (i.e.,  $s$  such that  $s \in \sigma^{FT}$  and  $qk(s) > \frac{c}{\gamma(s)}$ ),  $\hat{\sigma}^P$  is the set of states under the  $D_g$  institution for which Protection is efficient, the importing government chooses to protect, and the exporting government files a complaint (i.e.,  $s$  such that  $s \in \sigma^P$  and  $qk(s) > \frac{c^*}{|\gamma^*(s)|}$ ), and  $c^{all} \equiv c + c^*$ .

As (3) makes clear, the institution  $D_g$  entails two inefficiencies relative to the first-best: one arising from the probability of DSB error in its activist role, and the other arising from the cost of the dispute. The expected loss  $L(D_g)$  is given by this double inefficiency summed over two sets of states: the set of states  $\hat{\sigma}^{FT}$  for which  $FT$  is the first best policy, there is a gap in the contract and there will be a dispute in equilibrium; and the set of states  $\hat{\sigma}^P$  for which  $P$  is the first best policy, there is a gap in the contract and there will be a dispute in equilibrium.

Note that  $L(D_g)$  is increasing in  $q$  according to (3), for two reasons. First, a higher  $q$  implies more frequent mistakes by the DSB when the DSB is invoked, and this increases the expected cost of DSB error given a dispute in any state  $s$ ,  $qk(s)|\Gamma(s)|$ . And second, as we have observed above, a higher  $q$  also increases the number of states in which the DSB is invoked in equilibrium, and therefore increases the size of the sets  $\hat{\sigma}^{FT}$  and  $\hat{\sigma}^P$ .

Also note from (3) that no loss arises ( $L(D_g) = 0$ ) if  $q$  is lower than a critical level  $\tilde{q} > 0$ . This is the level of  $q$  below which the DSB is not invoked in any state (that is, the level of  $q$  below which the sets  $\hat{\sigma}^{FT}$  and  $\hat{\sigma}^P$  are empty). Intuitively, if the DSB noise is small ( $q < \tilde{q}$ ) then the governments, expecting the DSB (in its active role) to make the right decision with high probability, will act efficiently and avoid the DSB intervention to save on the dispute cost (the importer will always choose the first best policy and the exporter will never file complaints). This reflects the off-equilibrium impacts of the DSB described above. The critical level  $\tilde{q}$  is easy to derive explicitly, but we do not need its explicit expression for the analysis to follow.

Consider next the institution  $V_i$ . Clearly, in all intermediate states (i.e., states other than the extreme states  $s^0$  and  $s^1$ ), the equilibrium government actions are the same as the equilibrium actions we have described above under the institution  $D_g$ . But in states  $s^0$  and  $s^1$  things may be different, because in these states, as we have already observed, the activist role of the DSB is not applicable under the institution  $V_i$ , and hence there is no dispute cost

in these states and the equilibrium outcome is first-best, that is, respectively  $T = FT$  and  $T = P$ .

We are now in a position to calculate the expected efficiency loss associated with the institution  $V_i$  relative to the first-best outcome. This loss is given by:

$$L(V_i) = \sum_{s \in \bar{\sigma}^{FT} \cup \bar{\sigma}^P} p(s)[qk(s)|\Gamma(s)| + c^{all}], \quad (4)$$

where  $\bar{\sigma}^{FT} = \hat{\sigma}^{FT} \setminus s^0$  and  $\bar{\sigma}^P = \hat{\sigma}^P \setminus s^1$ . The interpretation of  $L(V_i)$  is the same as that given for  $L(D_g)$ , except that the sets  $\bar{\sigma}^{FT}$  and  $\bar{\sigma}^P$  now replace  $\hat{\sigma}^{FT}$  and  $\hat{\sigma}^P$ : the set  $\bar{\sigma}^{FT}$  is the set of states for which  $FT$  is the first best policy, the contract is vague and there will be a dispute in equilibrium; and the set  $\bar{\sigma}^P$  is the set of states for which  $P$  is the first best policy, the contract is vague and there will be a dispute in equilibrium.

To compare the performance of the  $D_g$  and  $V_i$  institutions, we define  $\check{q} \equiv \min\left(\frac{c}{k(s^0)\gamma(s^0)}, \frac{c^*}{k(s^1)|\gamma^*(s^1)|}\right)$ . It is direct to verify that, if  $q < \check{q}$ , the DSB will not be invoked in the extreme states  $s^0$  and  $s^1$  under the  $D_g$  institution, and the equilibrium outcome is respectively  $T = FT$  and  $T = P$ . But this corresponds exactly to the outcome under the  $V_i$  institution in the extreme state  $s^0$  and  $s^1$ ; and as we have already observed, the equilibrium outcome under  $D_g$  and  $V_i$  is always the same for intermediate state realizations. Hence, if  $q < \check{q}$ , the equilibrium outcome under  $D_g$  is the same as under  $V_i$  in all (intermediate and extreme) states. By contrast, if  $q > \check{q}$ , the DSB *will* be invoked in at least one of the extreme states  $s^0$  and/or  $s^1$  under the  $D_g$  institution, implying that the double inefficiency described above will be incurred in at least one of these states under the  $D_g$  institution, and implying as a consequence that the expected efficiency loss under  $D_g$  is higher than under  $V_i$ . Thus for  $q > \check{q}$  we find using (3) and (4) that  $V_i$  is strictly preferred to  $D_g$ , while for  $q < \check{q}$  we have a tie. That is:

$$L(D_g) > L(V_i) \text{ if } q > \check{q}, \text{ and } L(D_g) = L(V_i) \text{ if } q < \check{q}.$$

Recalling now our tie-breaking assumption – that specifying the policy ( $FT$  or  $P$ ) entails a small cost, raising the contracting cost of  $V_i$  slightly above  $D_g$  – we conclude that  $V_i$  is better than  $D_g$  if  $q > \check{q}$ , and vice versa if  $q < \check{q}$ . Note that, if  $k(s^0)$  and  $k(s^1)$  are small, so that the DSB would have a very good idea about the “right” policy in the extreme states, then  $\check{q}$  is higher than one, and therefore  $q < \check{q}$  for all  $q \in [0, 1]$ ; in this case  $D_g$  is preferred to  $V_i$  for all  $q \in [0, 1]$ .

Finally, consider the institution  $R_m$ . Under this institution, the contract specifies a rigid free trade rule, but the DSB can allow exceptions if invoked. Notice, though, that the DSB is unconstrained by the (rigid) contract when its mandate includes the modification

of obligations ( $m$ ), and hence if invoked, the DSB makes the same ruling as it would under the discretionary contract. But it should now be clear that the equilibrium outcome under  $R_m$  must then be the same as under  $D_g$ . This is because the DSB will rule in the same way in both cases, hence the governments will make the same decisions in both cases – the fact that under  $R_m$  the contract specifies free trade is irrelevant at the end of the day. Based on this observation, and applying again our tie-breaking assumption – a small cost of specifying the policy ( $FT$  or  $P$ ) that raises the contracting cost of  $R_m$  slightly above  $D_g$  – we conclude that  $R_m$  is dominated by  $D_g$ .

We are now ready to draw our conclusions about the optimal institution. We have narrowed the choice to four institutions:  $V_n$ ,  $R_n$ ,  $V_i$  and  $D_g$ . The best of these institutions is the one that minimizes the expected efficiency loss  $L$ . First note from (1) that  $L(V_n)$  and  $L(R_n)$  are both independent of  $q$ , and hence the ranking between  $V_n$  and  $R_n$  does not depend on  $q$ . Next recall from (3) and (4) that  $V_i$  is preferred to  $D_g$  iff  $q > \check{q}$ . Finally note from (4) and (1) that  $V_n$  is preferred to  $V_i$  iff  $q$  is above a threshold level,<sup>32</sup> and the same can be said for the ranking between  $R_n$  and  $V_i$ . Putting together these results, we have the following:

**Proposition 1** *There exist critical levels  $q_1$  and  $q_2$  (with  $0 < q_1 \leq q_2 \leq 1$ ) such that: for  $q < q_1$  the optimal institution is  $D_g$ ; for  $q_1 < q < q_2$  the optimal institution is  $V_i$ ; and for  $q > q_2$  the optimal institution is either  $V_n$  or  $R_n$ .*

Proposition 1 carries with it a number of implications. We briefly highlight five of these below.

First, Proposition 1 implies that leaving gaps in a contract can be optimal, but only when the DSB is given an activist mandate; by contrast, introducing rigidity into a contract can be optimal, but only when the DSB is given a non-activist mandate; and finally vague clauses can be optimal under either an activist or non-activist DSB mandate (although note that each of the intervals  $(q_1, q_2)$  and  $(q_2, 1)$  may be empty). More broadly, these observations reflect a simple underlying point: it is optimal to leave governments with discretion in more states of the world and endow the DSB with a mandate to rein in the exercise of that discretion the better the quality of the DSB information.

Second, Proposition 1 implies that, if  $q$  is sufficiently small, the first best outcome can be achieved under  $D_g$  or possibly  $V_i$  even though (i) the contract is highly incomplete, (ii) the use of the DSB is costly, and (iii) the DSB rulings are imperfect. The reason is that the threat of invoking the DSB and the expectation of a sufficiently precise DSB ruling is

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<sup>32</sup>To see this, note that (i)  $L(V_n) > L(V_i)$  for  $q = 0$ ; and (ii)  $L(V_i)$  is increasing in  $q$ . It follows that  $V_n$  is preferred to  $V_i$  iff  $q$  is above a threshold level  $q^v$ . Note that  $q^v$  may be higher than one, in which case  $V_i$  is preferred to  $V_n$  for all  $q \in [0, 1]$ .

sufficient to induce governments to act efficiently. But notice that the first-best cannot be achieved if the DSB is not given an activist mandate.

Third, Proposition 1 implies that there is no modification role for the DSB in the optimal institution, contrary to the suggestions of some legal scholars (see WTO, 2007). Intuitively, rather than placing a rigid obligation into the contract and then endowing the DSB with a mandate to modify the obligation ex post, it is always better to simply leave a gap in the contract to begin with and then endow the DSB with a mandate to fill the gap ex post.

Fourth, Proposition 1 suggests an interesting question: Can an activist DSB role be desirable even if the DSB has no information in any state and simply randomizes (i.e. even if  $q = 1$  and  $k(s) = 1/2 \equiv k$  for all  $s$ , so that  $qk = 1/2$ )? Under these conditions, if we let the costs of a dispute ( $c^{all}$ ) go to zero, it is direct to show using (1) and (4) that  $L(V_i) \rightarrow \frac{1}{2}L(R_n) + \frac{1}{2}L(V_n) + \frac{1}{2}p(s_0)|\Gamma(s_0)|$ , which implies  $L(V_i) > \min[L(R_n), L(V_n)]$ . Our model therefore predicts that, at least as long as the costs of a dispute are sufficiently small, the DSB needs to have at least *some* information if an activist DSB role is to improve efficiency: intuitively, this is so because otherwise its frequent mistakes will undermine the value of its activist role.<sup>33</sup>

And finally, we conclude this section by pointing out an interesting implication of our model concerning the frequency of DSB disputes under the optimal institution  $\hat{I}$  as a function of  $q$ . It is a simple corollary of Proposition 1 that, if  $q_2 < 1$ , the probability of a DSB dispute - and hence the expected cost of disputes - under the optimal institution  $\hat{I}$  is non-monotonic in  $q$ , and in particular it is increasing for low levels of  $q$  and decreasing for high levels of  $q$ . The reason is that when  $q$  is sufficiently low the DSB is not invoked at all in equilibrium, and when  $q$  is sufficiently close to 1 it is optimal to have a non-activist DSB. Notice as well that, because there is a monotonic (negative) relationship between  $q$  and the efficiency achieved under the optimal institution, our model implies that there is a nonmonotonic relationship between the equilibrium frequency of DSB use and the performance of the optimal institution in terms of how close it gets to the first-best. Therefore, our model implies that one cannot rely on information about the equilibrium frequency of DSB use to gain information about the performance of the optimal institution in terms of how close it gets to the first-best.

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<sup>33</sup>It might be thought that, if this statement is true for small  $c^{all}$ , then it must be true for larger  $c^{all}$  as well, because the cost of a dispute is part of the inefficiency associated with an activist DSB. But a higher  $c^{all}$  will also reduce the equilibrium frequency of disputes under an activist DSB, and this effect can dominate the direct effect per dispute.

## 2.5 A pro-trade bias in the DSB?

It has been pointed out in the literature on WTO disputes that there is an apparent “pro-trade bias” in DSB rulings. For example, according to the WTO (WTO, 2007, p. 273), “...both under the GATT (82 per cent) and the WTO (88 per cent) complainants have mostly won their cases (counting the ones that went through to an adopted report and ‘decisive’ ruling respectively).” In an effort to offer an interpretation of this bias, Goldstein and Steinberg (2007) argue that, if it is costly for the *exporter* to file a dispute, there may be a pro-trade (selection) bias in DSB rulings, because the exporter will file only when there is a high probability of success.

In this section we show that our model points to a somewhat different interpretation of this pro-trade bias in DSB rulings. Rather than the absolute *level* of dispute costs faced by the exporter, our model suggests that this bias arises when the costs of dispute fall sufficiently on the exporter *relative* to the importer (reflecting, perhaps, the allocation of the burden of proof).

We also raise a related question: Under what conditions do the equilibrium *policy outcomes* skew in favor of free trade relative to the first best outcome, and in this sense exhibit a pro-trade bias? One might conjecture that the two dimensions of bias – the bias in rulings and the bias in policy outcomes – would go in the same direction, but interestingly, we will show that the two biases are inversely related: if there is a pro-trade bias in DSB rulings, then there tends to be an anti-trade bias in policy outcomes, and vice versa.

To simplify the exposition we address these questions in the context of the static model, but it will become clear that the same points can be made also in the two-period model which we develop in the next section, where we allow DSB rulings to set precedent.

We first consider the bias in DSB rulings. In order to focus our analysis on the probability of a pro-trade ruling conditional on filing a dispute, we suppose that in the absence of selection bias, i.e. if disputes were initiated randomly, the outcome of disputes would be unbiased. In other words, we focus on selection as the only source of bias. Formally, we assume

$$\sum_{s \in \sigma^{FT}} p(s) = \sum_{s \in \sigma^P} p(s) \quad (5)$$

(or equivalently,  $\Pr(s \in \sigma^{FT}) = \Pr(s \in \sigma^P)$ ), and

$$\sum_{s \in \sigma^{FT}} q(s)p(s) = \sum_{s \in \sigma^P} q(s)p(s), \quad (6)$$

where to avoid unnecessary notation we now use  $q(s)$  rather than  $qk(s)$  as our (inverse)

measure of the quality of DSB information. Condition (5) says that the first-best policy is  $FT$  or  $P$  with equal probability. Condition (6) says that the DSB error is not correlated with the first-best policy.<sup>34</sup>

For simplicity we consider only the  $D_g$  institution, but similar results apply to the  $V_i$  institution. Recalling that  $\hat{\sigma}^{FT}$  denotes the subset of  $\sigma^{FT}$  in which a dispute is filed under the  $D_g$  institution and similarly  $\hat{\sigma}^P$  denotes the subset of  $\sigma^P$  in which a dispute is filed, we can write:

$$\begin{aligned} & \Pr(T^{DSB} = FT \mid \text{file}) & (7) \\ &= \frac{\Pr(T^{DSB} = FT \mid s \in \hat{\sigma}^{FT}) \cdot \Pr(s \in \hat{\sigma}^{FT}) + \Pr(T^{DSB} = FT \mid s \in \hat{\sigma}^P) \cdot \Pr(s \in \hat{\sigma}^P)}{\Pr(s \in \hat{\sigma}^{FT}) + \Pr(s \in \hat{\sigma}^P)} \\ &= \frac{\sum_{s \in \hat{\sigma}^{FT}} (1 - q(s))p(s) + \sum_{s \in \hat{\sigma}^P} q(s)p(s)}{\sum_{s \in \hat{\sigma}^P} p(s) + \sum_{s \in \hat{\sigma}^{FT}} p(s)}. \end{aligned}$$

It follows from (7) using condition (5) and condition (6) that  $\Pr(T^{DSB} = FT \mid \text{file}) > 1/2$  if and only if

$$\sum_{s \in \hat{\sigma}^{FT}} (1 - 2q(s))p(s) > \sum_{s \in \hat{\sigma}^P} (1 - 2q(s))p(s). \quad (8)$$

Our goal now is to identify the region in  $(c, c^*)$ -space where (8) holds. First note that, if  $c < \min_{s \in \sigma^{FT}} q(s)\gamma(s)$  and  $c^* < \min_{s \in \sigma^P} q(s)|\gamma^*(s)|$ , filing occurs in equilibrium in every state  $s$ . In this case, clearly there is no bias. Next focus on the case in which  $c > \min_{s \in \sigma^{FT}} q(s)\gamma(s)$  or  $c^* > \min_{s \in \sigma^P} q(s)|\gamma^*(s)|$ , so that filing occurs in some but not all states. Recall that, by our small-cost assumption (2), the number of states in  $\hat{\sigma}^{FT}$  depends only on  $c$  (and is weakly decreasing in  $c$ ) and the number of states in  $\hat{\sigma}^P$  depends only on  $c^*$  (and is weakly decreasing in  $c^*$ ). This implies that the left hand side of (8) is a weakly decreasing function of  $c$  and the right hand side of (8) is a weakly decreasing function of  $c^*$ . It follows immediately that (8) is satisfied if and only if  $c^* > h(c)$ , where  $h(\cdot)$  is a weakly increasing function. Thus, at a broad level we find that DSB rulings tend to have a pro-trade bias if the dispute costs incurred by the exporter are high relative to the dispute costs incurred by the importer.

We next characterize the bias in the policy outcomes under the  $D_g$  institution (again, similar results apply to the  $V_i$  institution). Since we are assuming here that the first-best policy is  $FT$  or  $P$  with equal probability, it is natural to say that the policy outcome exhibits a pro-trade bias if  $\Pr(\hat{T}(D_g) = FT) > 1/2$ , where recall that  $\hat{T}(D_g)$  is the equilibrium policy that emerges under institution  $D_g$ .

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<sup>34</sup>To see this, notice that the probability of DSB error conditional on  $s \in \sigma^P$  is  $\sum_{s \in \sigma^P} q(s)p(s) / \sum_{s \in \sigma^P} p(s)$  and the probability of DSB error conditional on  $s \in \sigma^{FT}$  is  $\sum_{s \in \sigma^{FT}} q(s)p(s) / \sum_{s \in \sigma^{FT}} p(s)$ . Given condition (6), these two expressions are equal if and only if  $\sum_{s \in \sigma^P} q(s)p(s) = \sum_{s \in \sigma^{FT}} q(s)p(s)$ .

A key observation is that, in the sets of states where no dispute is filed (i.e.  $\sigma^P \setminus \hat{\sigma}^P$  and  $\sigma^{FT} \setminus \hat{\sigma}^{FT}$ ), the equilibrium policy is the first-best policy. Using this observation, and with some straightforward algebra, we can write:

$$\begin{aligned} \Pr(\hat{T}(D_g) = FT) &= \Pr(s \in \sigma^{FT} \setminus \hat{\sigma}^{FT}) + \Pr(T^{DSB} = FT | s \in \hat{\sigma}^{FT}) \cdot \Pr(s \in \hat{\sigma}^{FT}) + \Pr(T^{DSB} = FT | s \in \hat{\sigma}^P) \cdot \Pr(s \in \hat{\sigma}^P) \\ &= \frac{1}{2} - \sum_{s \in \hat{\sigma}^{FT}} q(s)p(s) + \sum_{s \in \hat{\sigma}^P} q(s)p(s). \end{aligned}$$

This implies that  $\Pr(\hat{T}(D_g) = FT) > 1/2$  if and only if

$$\sum_{s \in \hat{\sigma}^{FT}} q(s)p(s) < \sum_{s \in \hat{\sigma}^P} q(s)p(s) \quad (9)$$

Intuitively, there is no bias in policy outcomes under the  $D_g$  institution if no disputes ever arise, because as we have shown in that case the equilibrium policy is always the first-best policy; and so, as (9) indicates, the extent of anti- or pro- trade bias in policy outcomes depends on the relative size of the sets  $\hat{\sigma}^{FT}$  and  $\hat{\sigma}^P$ .

Using arguments analogous to those above for the analysis of bias in DSB rulings, it is straightforward to show that (9) is satisfied if and only if  $c^* < g(c)$ , where  $g(\cdot)$  is a weakly increasing function. Thus, in sharp contrast with our finding concerning the bias in DSB rulings, we find that the policy outcomes tend to exhibit a pro-trade bias if the dispute costs incurred by the exporter are *low* relative to the dispute costs incurred by the importer. This result becomes even more crisp in the special case where  $q(s)$  and  $p(s)$  are the same for all states. In that case, it is direct to see that the two curves  $h(c)$  and  $g(c)$  coincide, and hence (9) is satisfied if and only if (8) is violated, and vice-versa.

The following proposition summarizes these results:

**Proposition 2** *Under the  $D_g$  and  $V_i$  institutions: (i) There is a pro-trade bias in DSB rulings if and only if  $c^* > h(c)$ , where  $h(\cdot)$  is a (weakly) increasing function. (ii) There is a pro-trade bias in policy outcomes if and only if  $c^* < g(c)$ , where  $g(\cdot)$  is a (weakly) increasing function. (iii) In the symmetric case where  $q(s) = q$  for all  $s$  and  $p(s) = p$  for all  $s$ ,  $h(c) = g(c)$ , and hence there is a pro-trade bias in DSB rulings if and only if there is an anti-trade bias in policy outcomes.*

Figure 1 conveys the main message of Proposition 2 for the symmetric case where  $q(s) = q$  for all  $s$  and  $p(s) = p$  for all  $s$ :<sup>35</sup> the conditions leading to a *pro-trade bias* in the DSB

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<sup>35</sup>In Figure 1, we define  $c_1 \equiv \min_{s \in \sigma^{FT}} q(s)\gamma(s)$ ,  $c_1^* \equiv \min_{s \in \sigma^P} q(s)|\gamma^*(s)|$ ,  $c_2 \equiv \max_{s \in \sigma^{FT}} q(s)\gamma(s)$  and

*rulings* are essentially the same as those leading to an *anti-trade bias* in the *policy outcomes*. Evidently, our model suggests that when  $c^*$  is high relative to  $c$ , the joint behavior that is induced by both the importer government and the exporter government under the  $D_g$  and  $V_i$  institutions ensures that the policy outcomes tend to be biased toward Protection relative to the first best policies even though the DSB, when invoked, will usually find in favor of the complainant and rule for Free Trade.

### 3 Precedent Setting

We turn next to develop a dynamic extension of the static model described in the previous section. With this dynamic extension, we consider a further important issue of DSB design: whether or not DSB rulings should set legal *precedent* for future rulings.

For simplicity, we consider a two-period version of the static model developed above, with a prior period (*Period 0*) in which the institution is created. *Period 1* and *Period 2* then proceed as in the static model of the previous section. We assume that the state of the world  $(s_1, s_2, \dots, s_N)$  is *iid* across the two periods,<sup>36</sup> and we let  $\delta \geq 0$  denote the factor by which governments discount *Period-2* welfare: because “the future” is collapsed into *Period 2*, we allow that  $\delta$  may be arbitrarily large. Finally, we denote by  $T_t$  and  $T_t^{DSB}$  ( $t \in \{1, 2\}$ ) the *Period-t* importer-government policy choice and DSB ruling, respectively.

Given that *Period 2* is the repetition of *Period 1*, and given the *iid* assumption, there is nothing truly dynamic in the contracting environment. The dynamic aspect of the analysis will arise from the presence of the DSB institution, *if* the DSB has precedent-setting authority. But we will later consider an extension of the model that allows for persistence in the state of the world, in order to examine how the optimal institution depends on the degree of persistence.

As in the static model, we can allow the governments to renegotiate the contract at two stages within each period: after the state  $(s_1, s_2, \dots, s_N)$  is realized in *stage 1*, and after the DSB issues a ruling in *stage 4*. From the perspective of *Period 2*, the two possibilities for renegotiation look identical to those in the static model; that is, since transfers between governments are not available, the possibility of renegotiation – both at the end of *stage 1* and at the end of *stage 4* – is irrelevant in *Period 2*. This is because in *Period 2*, as in the static model, the interests of the two governments are directly in conflict and no

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$c_2^* \equiv \max_{s \in \sigma^P} q(s) |\gamma^*(s)|$ . Note that by our assumption (2) we can focus on the region where  $c < c_2$  and  $c^* < c_2^*$ . Also note that the “No-Bias” locus is technically not a function but a correspondence, due to the discrete nature of the state space. If the state space were continuous this locus would be a curve.

<sup>36</sup>The *iid* case is a natural benchmark to consider. At the end of the section we briefly discuss the extension of the model to the case in which shocks are persistent.

Pareto improvement is possible ex-post; hence there is no room for renegotiation. But does this conclusion hold as well from the perspective of *Period 1*? After all, if DSB rulings set a precedent for the future, it seems plausible that governments might want to renegotiate after a “bad” ruling in *stage 4*. Nevertheless, upon further reflection it can be seen that the “winning” country under the DSB ruling in *Period 1* would never agree to a renegotiation without the possibility of transfers.<sup>37</sup> Hence, we may conclude that there is no room for renegotiation in our dynamic model.

We next describe the formal meaning of “precedent” within our model. When DSB rulings set *precedent*, we assume that a *Period-1* ruling  $T_1^{DSB}(s')$  for the realized state of the world  $s'$  implies henceforth that the contract specifies  $T(s') = T_1^{DSB}(s')$ . Therefore, if the DSB operates under precedent and the DSB is invoked in *Period 1* for the realized state of the world  $s'$ , then in *Period 2* the contract is “complete” for the state of the world  $s'$ .<sup>38</sup>

An interesting question is whether and to what extent it is costly for the DSB to describe the realized state  $s'$ , which it must do if its ruling is to set a precedent for future realizations of this state. In reality, this cost is probably non-negligible but significantly lower than the cost of describing a state *ex-ante*, before its realization. What we have in mind is similar to Battigalli and Maggi (2002)’s notion of “unforeseen events” (see their Section II.B6): ex ante there is a set of elementary events  $s_i$  that the contracting parties are aware of, but also a large number of “latent” elementary events that they do not have in mind because they are normally turned “off.” If a latent elementary event is turned “on” ex post, at that point it becomes relatively easy to describe.<sup>39</sup> For simplicity we assume that the cost of describing the

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<sup>37</sup>More broadly, it is tempting to think of the periodic GATT/WTO multilateral negotiating “Rounds” as environments in which government-to-government transfers can more effectively be orchestrated (see note 7) and where the precedent set by “bad” DSB rulings might be addressed through renegotiation. This interpretation, however, is well beyond the scope of our simple model.

<sup>38</sup>What we have described above is not the only conceivable way to introduce precedent in the DSB. In principle, one could consider an institution where the DSB “completes” the contract not just for the realized state  $s'$  but also for other states. However, given our assumptions this is unlikely to be an attractive option, because the DSB observes a signal of  $\Gamma(s)$  only for the realized state  $s'$ , while it has no information at all for any other state. Moreover, describing states that are different from the realized state  $s'$  is likely to be costly, just as it is costly to describe states ex-ante. But it is not hard to imagine a slightly different model where it might be attractive to extend the application of precedent beyond the realized state  $s'$ . Suppose for example that  $\Gamma(s)$  is increasing in each state variable  $s_i$  (so that each  $s_i$  is interpreted as a political shock that increases the payoff from protection), and this is known to the DSB. Then it might be desirable to adopt the following precedent system: if the DSB ruling is *FT* for state  $s'$ , in the future the same ruling applies for any state  $s \preceq s'$ , and if the ruling is *P* for state  $s'$ , in the future the same ruling applies for any state  $s \succeq s'$ . (This means that, for example, if the DSB chooses *FT* in a situation where there is an import surge and the import-competing industry has shrunk, then in the future *FT* will apply also if there is an import surge but the import-competing industry has not shrunk.) We suspect that the same qualitative results of our model would extend to this richer setting.

<sup>39</sup>Thus, for example, if the realized state is  $(0, 1, 0, 1, 0, 0, 0)$  and the DSB rules *FT* for this state, the DSB can describe this ruling in a way that establishes precedent as “if shocks  $s_2$  and  $s_4$  occur and there are no other significant shocks, then *FT* applies,” whereas describing all possible states ex ante may be very

realized state  $s'$  is zero. This makes the difference between ex-ante and ex-post description costs rather extreme in our model (recall the assumption that  $c_s$ , the cost of describing a state variable ex-ante, is sufficiently high that specifying a contingent contract is suboptimal), but it would be easy to allow for a positive cost of ex-post description; intuitively, this would have the straightforward effect of making precedent-setting less attractive, other things equal.

Finally, we assume for simplicity that the DSB has no recall in *Period 2* of its observed *Period-1* signal, so that if the same state occurs in both periods and if the DSB is invoked in both periods (which is possible in the absence of legal precedent), then the DSB uses only the *Period-2* signal when making its *Period-2* ruling.<sup>40</sup> It is now immediately clear that, if invoked in *Period 2*, the DSB behaves exactly as it did in the static model characterized in the previous section, because at this point precedent for the future is irrelevant. We now observe that the DSB behaves exactly as it did in the static model even if it is invoked in *Period 1*: the reason is that the prospect that its ruling will set a precedent for the future does not alter the conclusion that, to maximize the expected joint payoff of the governments given its observed signal, the DSB will issue the ruling  $T_1^{DSB}(s) = P$  if and only if under the state  $s$  it observes a signal  $\Gamma_1^{DSB}(s) > 0$ .<sup>41</sup>

In the absence of legal precedent, it is straightforward to see that our dynamic model behaves exactly as a (twice repeated) version of the static model, and our analysis from the previous section carries over. Moreover, it is immediate that introducing precedent has no impact on the performance of any of the institutions with a non-activist DSB, that is, on the institutions  $(D_n, R_n, V_n)$ . Also,  $R_m$  is again outcome-equivalent to  $D_g$ , and hence dominated. Therefore, to evaluate the role of legal precedent in the optimal institution, we need only derive the impact of precedent on the performance of the vague and the discretionary contracts when the activist DSB mandates are, respectively, to interpret and to gap-fill, that is, on the institutions  $V_i$  and  $D_g$ .

We now derive how the performance of the institutions  $D_g$  and  $V_i$  change when DSB rulings set precedent. To accomplish this, we begin from *Period 2*, and work backwards through time.

Let us begin with  $D_g$ . Denote the *Period-1* realized state of the world by  $s'$ . Observe first

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difficult or even impossible.

<sup>40</sup>We make this assumption to keep the model as simple as possible and to focus on the main interesting results. But it is clear that allowing the DSB to recall its past signals would introduce another cost of precedent, because under precedent the DSB cannot then reduce the noise of its signal with repeated draws over time for the same state. Notice, though, that our assumptions stack the deck in favor of precedent, by assuming no DSB recall and ignoring the DSB cost of describing the realized state  $s'$ , and yet we will show below that precedent still performs less well than one might expect.

<sup>41</sup>As in the static model, this follows from the fact that the DSB signal is unbiased and its priors are uninformative, and so there is no reason for the DSB to deviate from this behavior simply because its ruling may create a precedent for the future.

that, if there is no *Period-1* filing, then *Period 2* behaves exactly like the static model under the  $D_g$  institution for all  $s$ . If instead there is a *Period-1* filing with associated *Period-1* DSB ruling  $T_1^{DSB}(s')$ , then in *Period 2* the contract specifies  $T_2(s') = T_1^{DSB}(s')$  and the DSB has no active role for  $s = s'$ , while for  $s \neq s'$ , *Period 2* behaves exactly like the static model under the  $D_g$  institution.

Now consider *Period 1*. Under the  $D_g$  institution, the exporter government files a complaint when the realized state is  $s'$  if and only if  $T = P$  and the expected benefit to the exporter government of filing exceeds the exporter government's cost of filing. Denote by  $B_P^E(s')$  the expected *Period-2* value to the exporter of the precedent that would be set by a DSB ruling, conditional on the realized *Period-1* state  $s'$  (but before the filing decision is made). Then the exporter government files a complaint in *Period 1* when the realized state is  $s'$  if and only if  $T = P$  and

$$\Pr(\text{DSB ruling is } FT \mid s') \cdot |\gamma^*(s')| + \delta B_P^E(s') > c^*. \quad (\text{F1})$$

Condition (F1) is the *Period-1* “filing” condition to invoke the DSB in our dynamic model, and it differs from the analogous condition (F) in the static model in that there is now a second term  $\delta B_P^E(s')$  on the left-hand-side.

To evaluate the new term  $B_P^E(s')$ , we use the sets  $\hat{\sigma}^{FT}$  and  $\hat{\sigma}^P$  as defined in the previous section to write the term  $B_P^E(s')$  explicitly as

$$B_P^E(s') = \begin{cases} p(s') \cdot c^* & \text{if } s' \in \hat{\sigma}^P \cup \hat{\sigma}^{FT} \\ p(s') \cdot [qk(s')|\gamma^*(s')|] & \text{if } s' \in \sigma^P \setminus \hat{\sigma}^P \\ -p(s') \cdot [qk(s')|\gamma^*(s')|] & \text{if } s' \in \sigma^{FT} \setminus \hat{\sigma}^{FT}. \end{cases} \quad (10)$$

These expressions conform to a simple intuition. Recall that  $B_P^E(s')$  is defined as the expected *Period-2* value to the exporter, given the realized *Period-1* state  $s'$ , of the legal precedent that would be set by a DSB ruling. Observe first that precedent is only relevant in *Period 2* if the *Period-2* state realization is also  $s'$ , which occurs with probability  $p(s')$ . This explains why each term on the right-hand-side is multiplied by  $p(s')$ . For  $s' \in \hat{\sigma}^P \cup \hat{\sigma}^{FT}$ , the exporter would have filed in *Period 2* if not for the precedent created by the *Period-1* DSB ruling, and so the exporter saves the *Period-2* filing cost  $c^*$ . For  $s' \in \sigma^P \setminus \hat{\sigma}^P$ , the exporter would not have filed in *Period 2* and the importer would have chosen  $T = P$ , so the exporter enjoys a *Period-2* benefit of  $|\gamma^*(s')|$  from the precedent created by the *Period-1* DSB ruling provided the ruling is in error, which happens with probability  $qk(s')$ . Finally, for  $s' \in \sigma^{FT} \setminus \hat{\sigma}^{FT}$ , the exporter would not have filed in *Period 2* and the importer would have chosen  $T = FT$ , so the exporter suffers a *Period-2* loss in the amount  $\gamma^*(s')$  from the precedent created by the

*Period-1* DSB ruling if the ruling is in error, which happens with probability  $qk(s')$ .

Next consider the importer government's *Period-1* policy choice under the  $D_g$  institution in state  $s'$ . Denote by  $B_P^M(s')$  the expected *Period-2* value to the importer, given the realized *Period-1* state  $s'$ , of the legal precedent that would be set by a DSB ruling. The importer government chooses  $T = P$  if either (F1) fails or if (F1) holds and the expected benefit to the importer government from trade protection exceeds the cost to the importer government of a DSB dispute:

$$\Pr(\text{DSB ruling is } P \mid s') \cdot \gamma(s') + \delta B_P^M(s') > c. \quad (\text{P1})$$

It can be shown that the term  $B_P^M(s')$  can be written explicitly as

$$B_P^M(s') = \begin{cases} p(s') \cdot c & \text{if } s' \in \hat{\sigma}^{FT} \cup \hat{\sigma}^P \\ p(s') \cdot [qk(s')\gamma(s')] & \text{if } s' \in \sigma^{FT} \setminus \hat{\sigma}^{FT} \\ -p(s') \cdot [qk(s')\gamma(s')] & \text{if } s' \in \sigma^P \setminus \hat{\sigma}^P. \end{cases} \quad (11)$$

These expressions have analogous interpretations to those described above for  $B_P^E(s')$ .

Again to reduce the number of cases and focus on the more interesting ones, we impose for the dynamic model a slight strengthening of the static-model condition (2). Specifically, we now assume that in the case of maximal DSB noise ( $qk = 1/2$ ), the (F1) and (P1) conditions are met for any  $s'$ , which is ensured by

$$\frac{1}{2}(1 - \delta p(s))|\gamma^*(s)| > c^* \quad \text{and} \quad \frac{1}{2}(1 - \delta p(s))\gamma(s) > c \quad \text{for all } s. \quad (12)$$

As in the previous section, condition (12) ensures that  $c^*$  and  $c$  are sufficiently small so that, for any level of DSB noise, (i) if the first best policy is  $P$ , the importer government chooses  $P$  in *Period 1* whether or not this triggers a complaint by the exporter government, and (ii) if the first best policy is  $FT$  but the importer government still chooses  $P$  in *Period 1*, the exporter government files a complaint.

It is now a simple matter to derive the equilibrium *Period-1* actions of the governments for each state under the  $D_g$  institution when DSB rulings set precedent:

1. For  $s \in \sigma^{FT}$ : if  $qk(s) < \frac{c}{(1+\delta p(s))\gamma(s)}$  then  $T_1 = FT$  and the DSB is not invoked in *Period 1*; if instead  $qk(s) > \frac{c}{(1+\delta p(s))\gamma(s)}$  then  $T_1 = P$  and the DSB is invoked in *Period 1*.
2. For  $s \in \sigma^P$ : if  $qk(s) < \frac{c^*}{(1+\delta p(s))|\gamma^*(s)|}$  then  $T_1 = P$  and the DSB is not invoked in *Period 1*; if instead  $qk(s) > \frac{c^*}{(1+\delta p(s))|\gamma^*(s)|}$  then  $T_1 = P$  and the DSB is invoked in *Period 1*.

It is instructive to compare the *Period-1* equilibrium actions of the governments under the  $D_g$  institution when DSB rulings set precedent with the *Period-1* equilibrium actions of

the governments under the  $D_g$  institution when DSB rulings do not set precedent which, as we have observed, are then the same as the equilibrium actions under the  $D_g$  institution in the static model of the previous section. In effect, for  $s \in \sigma^{FT}$ , precedent *magnifies* the gain that the importer can anticipate (from  $\gamma(s)$  to  $(1 + \delta p(s))\gamma(s)$ ) if it provokes a DSB filing by setting  $T = P$  and the DSB rules in error (which the DSB does with probability  $qk(s)$ ). And similarly, for  $s \in \sigma^P$ , precedent magnifies the gain that the exporter can anticipate (from  $|\gamma^*(s)|$  to  $(1 + \delta p(s))|\gamma^*(s)|$ ) if it files against  $T = P$  and the DSB rules in error (which the DSB does with probability  $qk(s)$ ).

Evidently, then, one effect of allowing DSB rulings to set precedent under the  $D_g$  institution is that the number of states in which a complaint is filed must go up, and hence the equilibrium *Period-1 frequency* of filings must rise. But as we noted in the previous section in the context of the static model, the equilibrium motives that trigger a DSB filing are always inefficient from an ex-ante perspective, and it is the off-equilibrium impacts of the activist role of the DSB that are efficiency-enhancing. By itself, therefore, the observation that precedent increases the equilibrium filing frequency suggests that introducing precedent into the  $D_g$  institution could *diminish* the efficiency of the institution. Also note that, even though introducing precedent makes the DSB in some sense “more activist,” this does not increase the beneficial off-equilibrium effect of the DSB. However, weighing against these negative effects of precedent is the benefit of eliminating the duplicative costs of filing each period.

To assess the net impact, let  $D_g^P$  denote the  $D_g$  institution with precedent setting, and  $L(D_g^P)$  denote the loss (relative to the first best) associated with the  $D_g^P$  institution. To express  $L(D_g^P)$  in an explicit form, it is helpful to first define the set  $\hat{\sigma}_{\mathcal{P}}^{FT}$  as the set of states  $s$  such that  $s \in \sigma^{FT}$  and  $qk(s) > \frac{c}{(1+\delta p(s))\gamma(s)}$ , and similarly define the set  $\hat{\sigma}_{\mathcal{P}}^P$  as the set of states  $s$  such that  $s \in \sigma^P$  and  $qk(s) > \frac{c^*}{(1+\delta p(s))|\gamma^*(s)|}$ . In analogy with the set  $\hat{\sigma}^{FT}$  defined in the previous section, the set  $\hat{\sigma}_{\mathcal{P}}^{FT}$  is the set of states for which (i) Free Trade is efficient and (ii) in *Period 1* there is a dispute in equilibrium under the  $D_g^P$  institution. And in analogy with the set  $\hat{\sigma}^P$  defined in the previous section, the set  $\hat{\sigma}_{\mathcal{P}}^P$  is the set of states for which (i) Protection is efficient and (ii) in *Period 1* there is a dispute in equilibrium under the  $D_g^P$  institution.

With these sets defined, we have:

$$\begin{aligned}
L(D_g^P) - L(D_g) &= \sum_{s \in \hat{\Delta}} p(s)[qk(s)|\Gamma(s)| + c^{all}] \\
&\quad + \delta \sum_{s \in \hat{\Delta}} p^2(s)qk(s)|\Gamma(s)| - \delta \sum_{s \in \hat{\sigma}} p^2(s)c^{all}
\end{aligned} \tag{13}$$

where  $\hat{\sigma} \equiv \hat{\sigma}^P \cup \hat{\sigma}^{FT}$  is the set of states where filing occurs in the absence of precedent (i.e. under the  $D_g$  institution) and  $\hat{\Delta} \equiv (\hat{\sigma}_P^P \cup \hat{\sigma}_P^{FT}) \setminus (\hat{\sigma}^P \cup \hat{\sigma}^{FT})$  is the set of states for which filing occurs in the presence of precedent (i.e. under the  $D_g^P$  institution) but not in its absence.

The first term on the right-hand-side of (13) represents the *Period-1* efficiency loss coming from the additional equilibrium filing behavior and associated DSB error and filing cost that is engendered by the introduction of precedent into the  $D_g$  institution. This term contributes positively to the difference between  $L(D_g^P)$  and  $L(D_g)$ . The second term on the right-hand-side of (13) represents the discounted *Period-2* efficiency loss coming from the additional equilibrium filing behavior and associated DSB error and filing cost that is engendered by the introduction of precedent into the  $D_g$  institution: this can be understood from the observation that  $p^2(s)$  represents the probability that state  $s$  will occur in both *Period 1* and *Period 2*, and therefore that the precedent set from a *Period-1* ruling in state  $s$  will be relevant in *Period 2*. This term contributes positively to the difference between  $L(D_g^P)$  and  $L(D_g)$ . Finally, the third term on the right-hand-side of (13) represents the discounted *Period-2* savings in duplicative filing cost over the states of the world in which *Period-2* filing would have occurred in the absence of precedent (i.e.,  $s \in \hat{\sigma}$ ). This term contributes negatively to the difference between  $L(D_g^P)$  and  $L(D_g)$ .

Evidently,  $L(D_g^P) < L(D_g)$  – and hence the introduction of precedent enhances the performance of the  $D_g$  institution – only if the expected value of the elimination of duplicative filing costs afforded by precedent outweighs the expected costs associated with the additional filing behavior induced by precedent.

We turn next to the vague contract and the interpretive role of the DSB. Let  $V_i^P$  denote the  $V_i$  institution with precedent setting. Again denote the *Period-1* realized state of the world by  $s'$ . If  $s' \notin \{s^0, s^1\}$ , then all of the statements made above for  $D_g^P$  and  $D_g$  apply, with  $V_i^P$  and  $V_i$  taking the place respectively of  $D_g^P$  and  $D_g$ . If instead  $s' \in \{s^0, s^1\}$ , then there is no activist role for the DSB in *Period 1* under the  $V_i$  or the  $V_i^P$  institution, the importer government makes the first-best *Period-1* policy choice *FT* (if  $s' = s^0$ ) or *P* (if  $s' = s^1$ ) as appropriate, and *Period 2* behaves exactly like the static model under  $V_i$ .

Hence, defining the set  $\bar{\sigma}_P^{FT}$  as the set of states  $s$  such that  $s \in \sigma^{FT} \setminus s^0$  and  $qk(s) > \frac{c}{(1+\delta p(s))\gamma(s)}$ , and similarly defining the set  $\bar{\sigma}_P^P$  as the set of states  $s$  such that  $s \in \sigma^P \setminus s^1$  and  $qk(s) > \frac{c^*}{(1+\delta p(s))|\gamma^*(s)|}$ , we may now express the impact on the governments' ex-ante joint payoff that is implied by introducing precedent to the  $V_i$  institution as

$$\begin{aligned}
L(V_i^P) - L(V_i) &= \sum_{s \in \hat{\Delta}} p(s)[qk(s)|\Gamma(s)| + c^{all}] \\
&\quad + \delta \sum_{s \in \hat{\Delta}} p^2(s)qk(s)|\Gamma(s)| - \delta \sum_{s \in \bar{\sigma}} p^2(s)c^{all}
\end{aligned} \tag{14}$$

where in analogy with the definitions of  $\hat{\Delta}$  and  $\hat{\sigma}$ , we define  $\bar{\Delta} \equiv (\bar{\sigma}_P^P \cup \bar{\sigma}_P^{FT}) \setminus (\bar{\sigma}^P \cup \bar{\sigma}^{FT})$  and  $\bar{\sigma} \equiv (\bar{\sigma}^P \cup \bar{\sigma}^{FT})$ .

Clearly, introducing precedent into the  $V_i$  institution involves identical trade-offs to those described above for the  $D_g$  institution, except that the two extreme states  $s^0$  and  $s^1$  are excluded from (included in) this tradeoff for the  $V_i$  institution ( $D_g$  institution).

Thus far we have characterized how the introduction of precedent modifies the equilibrium behavior of governments, and we have derived explicitly the efficiency losses associated with the  $D_g^P$  and  $V_i^P$  institutions. The next step of the analysis is to examine the optimal choice of institution. In this setting, we need to consider six candidates for an optimum, namely the same four institutions considered in the static model ( $R_n, V_n, V_i$  and  $D_g$ ) plus the two institutions with precedent ( $D_g^P$  and  $V_i^P$ ). In general, any of these six institutions can be optimal depending on parameter values, but we can say something about how changes in  $q$  and  $\delta$  affect the optimal choice of institution.

Consider first the impact of changes in the DSB noise  $q$ . In analogy with the previous section, an increase in  $q$  clearly favors non-activist-DSB institutions over activist-DSB institutions, so that as  $q$  increases the optimal institution can only switch from one of the latter to one of the former. Also, it continues to be true that an increase in  $q$  favors institutions where the DSB interprets a vague contract ( $V_i$  and  $V_i^P$ ) over institutions where the DSB fills gaps ( $D_g$  and  $D_g^P$ ), so that as  $q$  increases the optimal institution can only switch from one of the latter to one of the former. Thus, the result of Proposition 1 generalizes to this dynamic setting: as  $q$  increases, the optimal institution switches from a discretionary contract with a gap-filling DSB to a vague contract with a contract-interpreting DSB to a vague or rigid contract with a non-activist DSB (possibly “skipping over” one or more of these).

But how does an increase in  $q$  affect the desirability of introducing precedent-setting in the DSB, or in other words the comparison between  $D_g$  and  $D_g^P$  and between  $V_i$  and  $V_i^P$ ? To answer this question we need to understand how  $q$  affects the differences  $L(D_g^P) - L(D_g)$  and  $L(V_i^P) - L(V_i)$ . We focus our discussion on  $L(D_g^P) - L(D_g)$ ; the same conclusions will be true for  $L(V_i^P) - L(V_i)$ .

Let us assume that  $k(s)$  is sufficiently close (or equal) to  $1/2$  for all  $s$ , so that as  $q$  goes from zero to one, the DSB signal goes from perfect to uninformative. This is a natural way to parameterize the degree to which the DSB is *informed*, with  $q = 1$  then indicating that the DSB is perfectly informed and  $q = 0$  indicating that the DSB is completely uninformed. Consider equation (13). Note first that, if  $q = 0$ , the sets  $\hat{\Delta}$  and  $\hat{\sigma}$  are both empty, and hence  $L(D_g^P) - L(D_g) = 0$ . As  $q$  increases from zero, the first of these two sets to become non-empty is  $\hat{\Delta}$ , and hence  $L(D_g^P) - L(D_g) > 0$ .<sup>42</sup> Next note that, if  $q = 1$ , filing occurs for

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<sup>42</sup>To see this, note that  $\hat{\Delta}$  is the set of states  $s$  such that either (i)  $s \in \sigma^{FT}$  and  $\frac{c}{q(1+\delta p(s))\gamma(s)} < k(s) < \frac{c}{q\gamma(s)}$ ,

all states both in the presence and in the absence of precedent, and therefore  $\hat{\sigma}$  includes all states and  $\hat{\Delta}$  is empty, and hence  $L(D_g^P) - L(D_g) < 0$ . It is then a small step to prove the following result:

**Proposition 3** *Conditional on the DSB playing an activist role (gap-filling or interpretation), it is optimal to give the DSB precedent-setting authority when the DSB is sufficiently uninformed, while it is preferable not to do so when the DSB is sufficiently informed.*

Proposition 3 reports a somewhat surprising result, but it can be understood to reflect a simple logic as follows. Consider the  $D_g$  and  $D_g^P$  institutions (analogous arguments hold for the  $V_i$  and  $V_i^P$  institutions). In the case where the DSB is sufficiently uninformed, the DSB will be invoked in every state realization under the  $D_g$  institution, and so when precedent-setting power is introduced into the DSB the equilibrium *Period-1* frequency of filings cannot rise (because it is already 1): the only effect of moving from  $D_g$  to  $D_g^P$  in this case is then to eliminate duplicative filing costs in *Period 2*, which is efficiency enhancing. For this reason, endowing the DSB with precedent-setting powers in the  $D_g$  institution is *desirable* when the DSB operates with sufficiently *little* information. Now consider the case where the DSB is sufficiently informed so that the DSB will be not be invoked in any state realization under the  $D_g$  institution: introducing precedent and moving from  $D_g$  to  $D_g^P$  in this case will either (i) preserve the absence of DSB filings in all state realizations, in which case  $D_g$  and  $D_g^P$  are outcome-equivalent, or (ii) lead to a *Period-1* filing in at least some state realization under  $D_g^P$ , in which case the equilibrium *Period-1* frequency of filings is increased while there is no elimination of duplicative filing costs in *Period 2*, and therefore efficiency must be reduced. For this reason, endowing the DSB with precedent-setting powers in the  $D_g$  institution is *undesirable* when the DSB operates with sufficiently *good* information.

Next we consider the impact of changes in the discount factor  $\delta$ . Again we focus our discussion on  $L(D_g^P) - L(D_g)$ ; the same conclusions will be true for  $L(V_i^P) - L(V_i)$ . We now argue that, for  $q$  in an intermediate range, endowing the DSB with precedent-setting powers in the  $D_g$  institution is (strictly) desirable if governments are sufficiently impatient, while it is preferable not to do so if governments are sufficiently patient.

Here the key observations are that (i) when  $\delta = 0$ , the set  $\hat{\Delta}$  is empty; and (ii) the set  $\hat{\sigma}$  is independent of  $\delta$ , while the set  $\hat{\Delta}$  is weakly increasing in  $\delta$  and as  $\delta \rightarrow \infty$  the set  $\hat{\Delta}$  includes all states  $s$  that are not in  $\hat{\sigma}$ . Consider the case where  $q$  lies in an intermediate range, so

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or (ii)  $s \in \sigma^P$  and  $\frac{c^*}{q(1+\delta p(s))|\gamma^*(s)|} < k(s) < \frac{c^*}{q|\gamma^*(s)|}$ , while the set  $\hat{\sigma}$  is the set of states  $s$  such that either (i)  $s \in \sigma^{FT}$  and  $k(s) > \frac{c}{q\gamma(s)}$ , or (ii)  $s \in \sigma^P$  and  $k(s) > \frac{c^*}{q|\gamma^*(s)|}$ . As  $q$  increases from zero, the thresholds  $\frac{c}{q(1+\delta p(s))\gamma(s)}$  and  $\frac{c}{q\gamma(s)}$  drop down from infinity. It is clear from inspection of the inequalities above that the first set to become nonempty is  $\hat{\Delta}$ .

that the set  $\hat{\sigma}$  is non-empty but not “too large” (i.e., contains a small subset of all states); when  $\delta = 0$ , we have by (i) that  $\hat{\Delta}$  is empty, and so (13) implies  $L(D_g^{\mathcal{P}}) = L(D_g)$ ; for  $\delta > 0$  but sufficiently small, (13) implies  $L(D_g^{\mathcal{P}}) < L(D_g)$ ; and for  $\delta \rightarrow \infty$ , we have by (ii) that  $\hat{\Delta}$  includes all states  $s$  that are not in  $\hat{\sigma}$ , and so (13) implies  $L(D_g^{\mathcal{P}}) > L(D_g)$ ; hence in this case introducing precedent is (strictly) desirable if and only if governments are not too patient (i.e., if and only if  $\delta$  is not too high). The argument for  $L(V_i^{\mathcal{P}}) - L(V_i)$  runs analogously.

It follows from the previous discussion that increasing the degree of patience ( $\delta$ ) makes precedent-setting *less* attractive when the quality of DSB information ( $q$ ) lies in an intermediate range. The following proposition records this result:

**Proposition 4** *There exists an intermediate range of  $q$  such that, conditional on the DSB playing an activist role (gap-filling or interpretation), it is optimal to give the DSB precedent-setting authority if  $\delta$  is sufficiently low, while it is preferable not to do so if  $\delta$  is sufficiently high.*

The intuition for the finding reported in Proposition 4 is simple. If  $q$  is either sufficiently low or sufficiently high, we know from Proposition 3 that introducing precedent is respectively undesirable or desirable regardless of the level of  $\delta$ . What Proposition 4 indicates is that, when  $q$  lies in an intermediate range, the level of  $\delta$  becomes decisive. In particular, when  $\delta$  is small, introducing precedent adds little additional impetus to initiate a dispute with the DSB, and the implied savings of duplicative filing costs then dominate the efficiency effects, making precedent-setting attractive. On the other hand, a large  $\delta$  magnifies the additional impetus to initiate a dispute with the DSB that comes from the introduction of precedent, and this accentuates the efficiency-reducing impacts of a precedent-setting DSB to a sufficient degree that the introduction of precedent-setting powers becomes unattractive.

We conclude by considering a simple extension of the model with persistent shocks. Suppose that the probability of state  $s$  occurring in *Period 2* conditional on state  $s$  having occurred in *Period 1* is  $\tilde{p}(s; \rho)$ , where  $\rho$  is a persistence parameter, so that  $\partial \tilde{p} / \partial \rho > 0$ . Also let  $\hat{p}(s; \rho)$  be the probability that the realized state in both *Period 1* and *Period 2* is  $s$ , with  $\partial \hat{p} / \partial \rho > 0$ . Introducing persistence in the model changes the analysis only at two junctures. First, in the expressions for  $B_p^M(s')$  and  $B_p^E(s')$  above,  $p(s')$  is replaced by  $\tilde{p}(s'; \rho)$ . This implies that, in the (F1) and (P1) conditions, an increase in  $\rho$  has the same qualitative impact as an increase in  $\delta$ , which in turn implies that  $\rho$  and  $\delta$  have the same qualitative impact on the sets  $\hat{\Delta}$  and  $\bar{\Delta}$ . Second, in the expressions for  $L(D_g^{\mathcal{P}}) - L(D_g)$  and  $L(V_i^{\mathcal{P}}) - L(V_i)$ , the term  $p^2(s)$  is replaced by  $\hat{p}(s; \rho)$ , so  $\rho$  and  $\delta$  enter these expressions through  $\delta \hat{p}(s; \rho)$ . It is direct to conclude that an increase in  $\rho$  has the same qualitative impact on these loss differences as an increase in  $\delta$ .

This last observation has an interesting, and perhaps surprising, implication: a high degree of persistence in political shocks – or more generally shocks to government preferences – tends to *disfavor* the use of precedent, even though it magnifies the savings of duplicative filing costs afforded by precedent-setting. The intuition for this result is analogous to the intuition for the impact of  $\delta$ : when persistence is high, precedent-setting magnifies the governments’ incentives to initiate disputes (which reduce efficiency) more than it magnifies the savings in duplicative filing costs.

## 4 Conclusion

We close the paper with two comments. The first one concerns a prominent feature of the WTO dispute settlement process that does not appear in our model. In particular, the WTO’s dispute settlement process emphasizes consultations between the disputing parties prior to the filing of a formal complaint with the DSB, and indeed Busch and Reinhardt (2006) report that roughly half of WTO disputes are resolved in the consultation stage and roughly two-thirds are resolved at some point prior to a DSB ruling. This raises the question of what distinguishes disputes that are resolved early from disputes that proceed to a formal complaint and DSB ruling, and whether our model could account for this distinction. Our model suggests a couple of possible reasons for the fact that some of the disputes are settled early: first, the consultation stage may lead the two governments to exchange information and learn more about the likely direction of the DSB ruling, which (as our model indicates) may remove the governments’ incentives to trigger DSB intervention; and second, from a pure enforcement perspective, the consultation stage may facilitate the exchange of information between the two governments concerning the presence or absence of a suspected deviation. Our model could account for the early resolution of a portion of disputes by adding either or both of these possibilities. But according to Busch and Reinhardt, a key determinant of settlement is whether or not third-parties become involved in the dispute (possibly as a way to prevent discriminatory settlements), suggesting that a proper treatment of this issue would require an extension of our model to a multilateral setting.<sup>43</sup> Such an extension, however, takes us well beyond the scope of a single paper. We therefore again leave this, along with other important extensions, for future work.

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<sup>43</sup>For example, if the absence of third-party involvement permits the disputing parties to reach a discriminatory settlement that takes surplus from the unrepresented third parties, the interests of the two disputing governments would not be directly in conflict *ex post*, and a negotiated (discriminatory) settlement between them would then be possible. These kinds of issues are likely to be very important for developing a more complete understanding of the operation of dispute settlement procedures in a multilateral institution such as the WTO, but formal analysis clearly requires a multi-country setting. Our two-country model can be seen as a first step along the way to providing the foundations for a complete multi-country analysis.

Our final comment concerns the question of whether our model can be interpreted as applying to more than just trade agreements. Do the same insights extend to the optimal design of the role of courts more generally? While a similar model structure could perhaps be applied to other types of international agreements, we do not believe that the insights of the paper can be extended in a straightforward manner to the optimal design of domestic legal institutions, for at least two reasons. First, our assumption that ex-post transfers are not available is not realistic in a domestic setting; the use of monetary compensation as both a settlement tool and a legal remedy is pervasive in domestic settings. Second, at a more methodological level, we have adopted an institutional design approach whereby the structure of the contract and the role of the court are designed jointly ex-ante by the contracting parties (the governments). In a domestic setting, the design of the judicial system and the design of private contracts are decoupled: when two (or more) parties design a contract, they do so taking the court system and its procedures as given; and the court system is designed by legislators (or constitution writers), presumably taking into account that there is a large and heterogenous population of potential users of the court system. It is hard to see how the simple institutional design approach adopted in our paper could be fruitful for the analysis of domestic legal systems.

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# Figure 1

