Optimal Design of Trade Agreements in the Presence of Renegotiation*

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Abstract

We study the optimal design of trade agreements in a setting where governments can renegotiate the agreement after the resolution of uncertainty but subject to a key transaction cost, namely that compensation between governments is inefficient. The model delivers predictions on the pattern of equilibrium renegotiation and on the structure of the optimal contract. In equilibrium, renegotiation can occur only for an intermediate range of states of the world. And when renegotiation occurs, it always results in trade liberalization, not protection. The optimal contract may be a non-contingent "property-right" contract or an option-type "liability" contract. High uncertainty favors liability rules over property rules, while asymmetries in bargaining power favor property rules over liability rules. Moreover, if a property rule is optimal, it is never renegotiated; only liability rules get renegotiated in equilibrium. And when we introduce a cost of renegotiation, we find that property rules are more likely to be optimal when this cost is higher, a result that reverses a central conclusion of the law-and-economics literature.

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1. Introduction

Trade agreements are contracts between governments that are signed in the presence of considerable uncertainty over future political and economic conditions. Naturally, once the uncertainty is resolved, governments will want to renegotiate a trade agreement if it turns out to be inefficient to implement the commitments contained in the original agreement. It is therefore not surprising that renegotiations are quite frequent in real-world trade agreements, and in particular in the General Agreement on Tariffs and Trade (GATT) and its successor, the World Trade Organization (WTO).[1]

But despite the prominence of renegotiations in real-world trade agreements, virtually all existing models of trade agreements abstract from renegotiation (with the few partial exceptions discussed below). We advance this literature by studying the optimal design of trade agreements in the presence of renegotiation. We show that the possibility of renegotiation can help explain important features of real-world trade agreements, and we derive new predictions concerning the pattern and direction of renegotiation in equilibrium.

With renegotiation possible once uncertainty is resolved, a trade agreement cannot determine the policy outcome directly; rather, it simply defines the disagreement point for the renegotiation. From a theoretical perspective, it is therefore clear that the possibility of renegotiation can fundamentally alter the formal analysis of trade agreements. In fact, if there were no transaction costs, the Coase theorem would apply and the ex-ante agreement would be completely irrelevant for the policy outcome. Of course, in the presence of transaction costs, the disagreement point *can* impact the policy outcome, and a trade agreement can then have important efficiency consequences even when there are ample possibilities for renegotiation. A transaction cost that stands out when governments attempt to renegotiate their trade agreements is the inefficiency of government-to-government compensation. In this context it is a fact of life that international lump-sum transfers are generally not available; rather, compensation between governments typically takes the form of "self-help" through tariff retaliation.[2] This form of government-to-government compensation is clearly inefficient, and the empirical

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[1] Hoda (2001) describes the procedures of tariff renegotiation in the GATT/WTO, which are spelled out in GATT Article XXVIII, and discusses the rich history of tariff renegotiations that occurred between 1948 and 1999. Busch and Reinhardt (2000) focus on renegotiations that occur in the context of GATT/WTO disputes, and document that the majority of disputes end in settlement agreements between the parties.

[2] The question *why* international lump-sum transfers are not available has long been a puzzle in the literature on international agreements, and we do not attempt to resolve that puzzle here. Rather, we take this feature as given and explore its implications for the design of trade agreements in the presence of renegotiation.

magnitude of the deadweight loss is arguably of first-order importance.[3] While more standard transaction costs are no doubt also present, these "transfer costs" are a distinctive feature of contracting between governments in an international environment.

In recent years there has been considerable research more generally on the optimal design of contracts in the presence of renegotiation, leading examples of which are the papers by Maskin and Moore (1999), Segal and Whinston (2002) and Watson (2007). Our approach broadly follows this literature, by considering an environment with nonverifiable information where the contract is designed ex-ante but can be renegotiated through Nash bargaining. However, we depart from this literature by introducing some new features that are motivated by the international trade context, and we also impose some restrictions to make the model tractable. The main feature we add is that government-to-government transfers involve a deadweight loss, hence utility is nontransferable, whereas the typical models of contracting with renegotiation focus on the case of transferable utility.[4] The main restriction we introduce, on the other hand, is that we focus on a binary policy choice (protection or free trade). This buys us tractability, and as we later describe this focus captures many trade-related policies that are discrete in practice. A further restriction is that we focus on a simple class of mechanisms, namely option contracts. As a consequence of the structure we impose, our model delivers sharp results on the pattern of equilibrium renegotiation and on the optimal contract form.

More specifically, we consider a two-country setting where governments contract over trade policy in the presence of uncertainty about the joint benefits of free trade, which could be positive or negative, due for example to political economy factors. Contracts are perfectly enforceable, but the joint benefits of free trade are not verifiable. Governments can renegotiate the contract through Nash bargaining once the state of the world is realized. We assume that transfers between governments involve deadweight loss, and that this transfer cost is increasing and convex in the size of the transfer.

We start by observing that in our setting it may be optimal to induce renegotiation *in equilibrium*, and indeed the model generates predictions concerning the pattern and direction of renegotiation.[5] Regarding direction, if the contract is designed optimally, renegotiation (when

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[3] The inefficiencies of tariffs have been quantified by many studies. For example, in one well-cited attempt (Hufbauer and Elliott, 1994), the authors conclude that U.S. consumers pay over six times the average annual compensation of manufacturing workers to preserve each job "saved" by special U.S. import protection.

[4] This literature has been able to extend some results to the case of nontransferable utility, but the sharpest findings of this literature are all derived with transferable utility.

[5] We note that, within the class of contracts we consider, the "Renegotiation Proofness Principle" does not

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it occurs) will result in trade liberalization, not protection. More specifically, according to our model, equilibrium renegotiations must take a particular form, in which the exporter agrees to compensate the importer in exchange for trade liberalization, against the importer's (credible) threat to protect. This asymmetry in the predicted direction of equilibrium renegotiations reflects two features: first, in the context of trade agreements, the contractual policy obligation is to maintain a liberal trade policy; and second, as we demonstrate, it is never optimal for the contract to induce renegotiation in states of the world where the threat point is the contractual policy obligation itself. Regarding the pattern of renegotiation, while it might be expected that renegotiation would be triggered in extreme states of the world, where the joint benefits of free trade are either very large and positive or very large and negative, we find that in equilibrium renegotiation can only occur for intermediate states of the world.

We next derive results about the optimal contract form. Borrowing terminology from the law-and-economics literature, in our setting the contract can take the form of a *property rule* or a *liability rule*. A property rule assigns ownership of rights concerning trade policy to the contracting parties: it either assigns the right to protect to the importing country or it assigns the right of free trade to the exporting country. A liability rule, on the other hand, gives the importer the option to practice free trade, or to engage in protection and compensate the exporter with a certain amount of *damages*.[6] The appeal of a liability rule is that it may help mitigate the incompleteness of the contract, as it can facilitate the efficient adjustment of trade policies without the need to specify contingencies in the contract. Intuitively, the damage payment set by a liability rule can help induce the importer to internalize the externalities that it imposes on its trading partner through its trade policy choices. However, in our setting, where compensation between governments is inefficient, a key shortcoming of a liability rule is that the damage payments entail deadweight loss, and this gives rise to a non-trivial tradeoff between property and liability rules.

The choice between property rules and liability rules is considered by many scholars and

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hold, that is, it is not possible to achieve the same expected joint payoff with a contract that does not induce renegotiation. As we later discuss (see note 23), whether more elaborate mechanisms could improve upon option contracts in a setting such as ours is an open question.

[6] As we explain further below, a property rule is outcome-equivalent to an extreme liability rule where damages are either zero or prohibitive, thus formally we can focus on the class of liability rules and optimize the level of damages. Also, use of the property- and liability-rule terminology is more common in law-and-economics than in the economics literature on optimal contract design, but the choice between these two types of contract is an important topic also in the latter literature, where a liability-rule contract would be called an option contract, and a property-rule contract is sometimes referred to as a simple "property-right" contract.

practitioners to be a central issue for the design of a trade agreement (see for instance Jackson, 1997, Schwartz and Sykes, 2002, Lawrence, 2003 and Pauwelyn, 2008). And in real-world trade agreements there appears to be considerable variation between liability rules and property rules, both across issues and over time. For example, Pauwelyn (2008) argues that property rules provide the "default" approach in both the WTO (applying for example to quantitative restrictions and export subsidies) and NAFTA, but for certain specific issues, such as tariff bindings and production subsidies, a liability-rule approach has instead been taken.[7] In terms of evolution of these rules over time, there is broad agreement that the early GATT operated as a system of liability rules, but many legal scholars argue that in more recent times the GATT/WTO has evolved toward a property-rule system.[8] Our model sheds light on this variation in contract form across issues and over time.[9]

We find that a property rule is optimal if uncertainty about the joint benefits of protection is sufficiently small, whereas a liability rule is optimal when this uncertainty is large. Under the interpretation that this uncertainty is caused primarily by political-economy shocks, our finding suggests that the use of liability (property) rules should be more (less) prevalent for issue areas that are more "politicized" and hence prone to political-economy shocks. As we argue

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[7]More specifically, clear examples of liability rules in the GATT/WTO are the provisions for temporary and permanent escapes from negotiated tariff bindings (GATT Articles XIX and XXVIII, respectively) and the rules on "actionable" production subsidies (WTO Agreement on Subsidies and Countervailing Measures). Other examples of liability rules in the WTO can be found in the General Agreement on Trade in Services (Article XXI, which provides for the renegotiation of specific commitments in services trade), and in the Agreement on Trade-Related Aspects of Intellectual Property Rights (Article 31, which sets conditions under which compulsory licenses may be issued). The non-violation nullification-or-impairment clause of the GATT can also be interpreted along the lines of a liability rule, as it permits countries to in effect escape their market access commitments with changes in domestic policies and pay damages to injured parties as a remedy. See Pauwelyn (2008, pp. 134-136) for further discussion. And in NAFTA (as well as in many bilateral investment treaties), investor protection against expropriation is set up as a liability rule.

[8]For a discussion of the early GATT system, see Jackson (1969, p. 147), Schwartz and Sykes (2002) and Lawrence (2003, p. 29). For the argument that the WTO has moved closer to a system of property rules, see for example Jackson (1997), Charnovitz (2003), Pauwelyn (2008) and Pelc (2009).

[9]As mentioned above, our model assumes perfect contract enforcement. But unlike a domestic legal setting, in the context of an international agreement enforcement power is potentially quite limited, and a fair question is therefore whether the distinction between a property rule and a liability rule retains its meaning in this context. Certainly legal scholars believe that this distinction remains meaningful in the international setting, as our discussion just above indicates. In fact, these scholars acknowledge the limitations on enforcement of international agreements, but emphasize that issues of enforcement are logically distinct from the choice between property and liability rules (see Jackson, 1997, p. 63, and see also Pauwelyn, 2008, pp. 148-197, for an especially detailed discussion of this point). Of course, this logical distinction does not mean that the two issues do not interact, only that it is meaningful to abstract from one issue while investigating the other. In this light, we see our focus on a model with enforceable contracts as a reasonable first step in the formal analysis of the choice between liability and property rules in trade agreements.

further below, this finding is suggestive of the pattern of liability and property rules observed in the GATT/WTO, and is broadly in line with the emphasis that GATT negotiators placed on uncertainty as they considered the potential benefits of liability rules. Moreover we show that, if a liability rule is optimal, the optimal level of damages falls short of fully compensating the exporter, contrary to the "efficient breach" argument in the law-and-economics literature and in line with features of GATT/WTO remedies based on the principle of reciprocity.

Our model also yields a prediction about the relationship between the optimal contract form and the propensity to renegotiate the contract. We find that if a property rule is optimal, it is not renegotiated in equilibrium: only if the optimal contract takes the form of a liability rule can it be renegotiated in equilibrium. While intuition might have suggested that renegotiation can improve the performance of property rules, since it can offset the intrinsic rigidity of such rules, our finding implies that this intuition is incorrect, as renegotiation can improve the performance of a property rule only if such a rule is suboptimally adopted; if it is optimal to have a property rule, then the possibility of renegotiation is immaterial to its performance. The basic logic underlying our result, as we explain further below, is that a property rule would be renegotiated only in extreme states of the world, but if such extreme states are possible then a property rule cannot be optimal in the first place. We discuss this finding in light of evidence that the use of compensation/tariff-retaliation in the GATT/WTO has diminished through time, and we suggest that this diminished role for equilibrium compensation may be a consequence of the shift from liability to property rules that, in the view of GATT/WTO legal scholars as described above, has occurred over time.

We then examine how the tradeoff between property and liability rules is affected by the presence of bargaining power asymmetries across countries. We find that the introduction of such asymmetries tends to favor property rules over liability rules. This follows from the combination of two results we mentioned above. First, power asymmetries across governments create variation in the size of the equilibrium transfer under renegotiation, depending on whether the stronger country is the exporter (and hence making the transfer) or the importer (and hence receiving the transfer); and given the convexity of the deadweight loss associated with transfers, this variation raises the expected cost of the transfer under renegotiation. Second, while an optimal liability rule can be renegotiated in equilibrium, an optimal property rule is never renegotiated in equilibrium and therefore entails no equilibrium transfers. Hence the introduction of power asymmetries can only favor a property rule relative to a liability rule, and never the

reverse. As we argue below, power asymmetries in the GATT/WTO have increased significantly over time with the expansion of its membership, and this finding therefore suggests one possible reason for the observation noted above that the GATT/WTO began as a liability-rule system but has developed over time into a system of property rules.

Finally, we consider the impact of renegotiation frictions on the optimal form of contract. We capture renegotiation frictions in a very simple way, by introducing a fixed cost of renegotiation. We find that increasing this cost favors property rules over liability rules. As we discuss further below, this result contrasts sharply with a central conclusion of the law-and-economics literature, namely, that when transfers are costless bargaining frictions tend to favor liability rules over property rules (Calabresi and Melamed, 1972, and Kaplow and Shavell, 1996).[10] Interestingly, if transfers were costless, the effect of introducing renegotiation frictions in our model would be *reversed*, that is, liability rules would be favored as the law-and-economics literature concludes. This explains why our result diverges from the conclusion of the law-and-economics literature: unlike that literature, we focus on a world with costly transfers, which as we observed above are a distinctive feature of contracting between governments in an international environment.

The themes outlined above are virtually unexplored in the existing economics literature on trade agreements, in part because those models do not accommodate the possibility of renegotiation in a meaningful way.[11] One partial exception is Beshkar (2010b), but he only allows for a limited form of renegotiation and focuses instead on the role of the WTO as a provider of non-binding arbitration for its member governments. Another partial exception is Bagwell and Staiger (1999), who study the properties of a limited form of renegotiation that is restricted to satisfy the GATT/WTO principle of reciprocity, but their focus is also very different from ours. Finally, in Maggi and Staiger (2013) we consider a setting which is similar to this paper except that the joint benefits of free trade are imperfectly verifiable, and more

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[10]This is widely seen as a fundamental result in law-and-economics. Wikipedia for example states: "With the opportunity to use either liability or property-based rules to protect entitlements, the academic community soon concluded that the key to figuring out which rule to use turned on the transaction costs. Therefore, if there were low transaction costs, then property rules should be used. If the transaction costs were high, then liability rules should be used." (see the entry "Property Rules, Liability Rules and Inalienability").

[11]For example, a number of papers (such as Bagwell and Staiger, 2005, Martin and Vergote, 2008, Bagwell, 2009, Beshkar, 2010a and Park, forthcoming) consider the optimal design of trade agreements with privately observed political pressures, but none of these papers considers the possibility of renegotiation of the agreement. Howse and Staiger (2005) investigate whether the GATT/WTO reciprocity rule might be interpreted as facilitating efficient breach, but they do not consider the possibility of renegotiation either.

speecifically, the DSB (if invoked) can observe a noisy signal of these benefits. In that paper we impose further structure, but an advantage of studying a noisy-verification setting is that it allows us to study in detail the rich possibilities for the resolution of trade disputes, and in particular generates positive predictions regarding the propensity of governments to settle early versus "going to court" (i.e., invoking the DSB to generate a noisy signal and issue a ruling).[12]

By contrast, in the law and economics literature analogous issues have been extensively studied in a domestic context. There are two related literatures. A fundamental question in the literature concerned with domestic contracts (see, for example, Schwartz, 1979, Shavell, 1984 and Ulen, 1984) is when contracting parties would want specific performance as a remedy for contract breach and when they would instead prefer damage payments. There is also a vast literature (the seminal contributions are Calabresi and Melamed, 1972, and Kaplow and Shavell, 1996) that is concerned with the related question of when property rules are preferred to liability rules in the design of domestic law. But all of this literature maintains the assumption that cash transfers are available (as seems appropriate given the literature's domestic-context focus). By introducing costly transfers, our paper forges a link between the law-and-economics theory of optimal legal rules and the economic theory of trade agreements.

The rest of the paper proceeds as follows. Section 2 lays out the basic model. Section 3 considers a benchmark where no renegotiation is possible. Section 4 characterizes the optimal agreement in the presence of renegotiation. Section 5 concludes with a brief description of several extensions. The Appendix contains proofs not presented in the text.

2. The Model

We focus on a single industry in which the Home country is the importer and the Foreign country is the exporter. We consider a two-country world to to make the key points in a transparent way, but in the Conclusion we discuss the extension to a multi-country setting.

The Home government chooses a trade policy $T \in \{FT, P\}$ ("Free Trade" or "Protection"), while the Foreign government is passive in this industry. The binary policy instrument helps to keep our analysis tractable, though as we describe in the Conclusion we have extended the analysis to a setting with three policy levels (free trade, "low" protection, "high" protection) and believe

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[12]The possibility of renegotiation is emphasized also in the papers by Ludema (2001) and Klimenko et al. (2008), but their focus is on the renegotiation of punishment strategies in repeated-game models of self-enforcing agreements.

that our main results will hold under reasonable conditions for any number of discrete policy levels. Our analysis should therefore apply to a variety of non-tariff policies that are discrete in practice, such as trade-related regulatory regimes or product standards, on which many of the renegotiations in the GATT/WTO have focussed.[13]

At the time that the Home government makes its trade policy choice, a transfer may also be exchanged between the governments, but at a cost. Here we seek to capture the feature that cash transfers between governments are seldom used for providing compensation to trading partners,[14] while indirect (non-cash) transfers, such as tariff adjustments in other sectors or even non-trade policy adjustments, are more easily available.[15] To allow for this possibility in a tractable way, we let b denote a (positive or negative) transfer from Home to Foreign, with $c(b) \geq 0$ the deadweight loss associated with the transfer level b. The transfer cost $c(b)$ is convex and smooth everywhere, with the natural features that $c(0) = 0$ and $c(b) > 0$ for $b \neq 0$. For simplicity, we assume that the Home country bears the deadweight loss $c(b)$, and that the total cost of the transfer inclusive of deadweight loss, $b + c(b)$, is increasing for all b.[16]

The Home government's payoff is given by $\omega(T, b) = v(T) - b - c(b)$, where $v(T)$ is the Home government's valuation of the domestic surplus associated with policy T in the sector under consideration. We have in mind that $v(T)$ corresponds to a weighted sum of producer surplus, consumer surplus and revenue from trade policy, with the weights possibly reflecting political economy concerns (as in, e.g., Baldwin, 1987, and Grossman and Helpman, 1994). As the Foreign government is passive in this industry, its payoff is $\omega^*(T, b) = v^*(T) + b$, where $v^*(T)$ is the Foreign government's valuation of foreign surplus associated with policy T. The joint payoff of the two governments is then given by $\Omega(T, b) = v(T) + v^*(T) - c(b)$.

We assume that Home always gains from protection, and we denote this gain as $\gamma \equiv v(P) - v(FT)$. This gain may be interpreted as arising from some combination of terms-of-trade

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[13]We have in mind here the renegotiations associated with settlement agreements in GATT/WTO disputes.

[14]For example, there are no known cases of cash compensation being provided within the context of the escape clause provisions in GATT Article XIX or the provisions for permanent tariff modifications in Article XXVIII, and the resolution of GATT/WTO disputes has, with two exceptions, never involved cash transfers either (the two exceptions to date are the *US-Copyright* case – see WTO, 2007, pp. 283-286 – and the *Brazil-Cotton* case – see Schnepf, 2010). However, countries do sometimes achieve indirect payment of compensation through various forms of policy adjustments in other sectors (e.g., the GATT/WTO "self-help" method of tariff-retaliation).

[15]Our implicit assumption is that these other policies are set efficiently, so that any adjustments to them then entails a deadweight loss.

[16]If the deadweight loss were borne by the Foreign country, none of our qualitative results would change, provided $b - c(b)$ is increasing for all b. Note that both of these assumptions ($b + c(b)$ and $b - c(b)$ increasing for all b) are satisfied if $|c'(b)| < 1$ for all b.

and political considerations. On the other hand, we assume that Foreign always loses from protection, and we denote this loss as $\gamma^* \equiv v^*(FT) - v^*(P)$. The joint (positive or negative) gain from protection is then $\Gamma \equiv \gamma - \gamma^*$. Below we will refer to the outcome that maximizes joint payoff as the "first best" outcome. This outcome is easily described: if $\Gamma > 0$ (or $\gamma > \gamma^*$), the first best is $T = P$ and $b = 0$, and if $\Gamma < 0$ (or $\gamma < \gamma^*$), the first best is $T = FT$ and $b = 0$.

We assume that governments are ex-ante uncertain about the joint gains from protection Γ, but they observe Γ ex post. We also assume that Γ is not verifiable, i.e. not observed ex post by the court/dispute-settlement-body (DSB), so that governments cannot write a complete contingent contract.[17] We consider the simplest environment of this kind that allows us to make the relevant points. We assume that γ^* is known ex-ante, so that all the uncertainty in Γ originates from γ, and that γ is not verifiable.[18] But there is also a further motivation – besides simplicity – for considering the case in which γ^* is known ex ante. This is the case that is most favorable to the so-called "efficient breach" argument, according to which efficiency can be induced if Foreign is fully compensated with a damage payment of γ^* in the event of breach. We will show that, even in this most-favorable case, the standard argument for a liability rule must be qualified in our setting along a number of important dimensions.

We assume that the ex-ante distribution of γ is common knowledge. The associated density, denoted $h(\gamma)$, is defined over the positive real line, $\gamma \in [0, \infty)$. We let $\underline{\gamma}$ and $\bar{\gamma}$ denote the bounds of the support of γ, or more formally, $\underline{\gamma} = \inf\{\gamma : h(\gamma) > 0\}$ and $\bar{\gamma} = \sup\{\gamma : h(\gamma) > 0\}$. To make things interesting, we assume that γ^* is strictly positive and that the value $\gamma = \gamma^*$ is in the interior of the support of γ, so that the first-best is P in some states (when $\gamma > \gamma^*$, and hence $\Gamma > 0$) and FT in some states (when $\gamma < \gamma^*$, and hence $\Gamma < 0$).

The fact that governments cannot write a complete contingent contract does not *necessarily* imply inefficiencies. If transfers were costless (no deadweight loss), governments could achieve the first best by engaging in ex-post (i.e., after observing γ) negotiations over policies and transfers. With costly transfers, on the other hand, the first best cannot be achieved in general, but efficiency may be enhanced by writing a contract ex ante (before γ is realized). We look

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[17]Other papers that also model trade agreements as incomplete contracts include Copeland (1990), Bagwell and Staiger (2001), Horn (2006), Costinot (2008), Horn, Maggi and Staiger (2010) and Maggi and Staiger (2011). We will use the expressions "court" and "DSB" interchangeably. Note that in our model the role of the court/DSB is simply that of an external enforcer of the contract, as in standard models of contracting.

[18]These informational assumptions, namely that uncertainty is one-dimensional and that the uncertain parameter is not verifiable by the court but is observed by both parties, are relatively standard in the literature on mechanism design with renegotiation. Also, whether the uncertainty over γ reflects underlying uncertainty about $v(FT)$ or $v(P)$ or both is immaterial for our results.

for the contract that maximizes ex-ante joint surplus.

Our emphasis on the maximization of ex-ante joint surplus implicitly assumes that ex-ante transfers (i.e., transfers at the time the institution is created) are costless. We emphasize that this assumption is not in contradiction with that of costly ex-post transfers. In an ex-ante setting such as a GATT/WTO negotiating round, many issues are on the table at once, and it is therefore possible for governments to orchestrate more efficient ways to compensate each other than would typically be possible in the context of ex-post renegotiations.[19] Assuming costless ex-ante transfers is an extreme way to capture this notion. In the Conclusion we discuss briefly the extension of our model to the case where ex-ante transfers are costly.[20]

The contract can be of two different types. The first type is a *property rule*, which either assigns the right of free trade to the exporter (we will sometimes refer to this as a "prohibitive" property rule), or assigns the right to protect to the importer (we refer to this as a "discretionary" property rule). The second type is a *liability rule*, which is an option contract that gives the Home country a choice between (i) setting FT and (ii) setting P and compensating the Foreign country with a payment b^D (damages).

Note that a prohibitive property rule is outcome-equivalent to an extreme liability rule in which b^D is set prohibitively high (i.e. such that the importer chooses FT in all states of the world), and a discretionary property rule is outcome-equivalent to a liability rule at the other extreme in which $b^D = 0$. Therefore, at a formal level we can focus without loss of generality on the family of liability contracts described above and simply optimize the level of b^D. However, we will call the contracts at the two extremes ($b^D = 0$ and b^D prohibitively high) "property rules."[21] We choose to emphasize the property-rule interpretation rather than the extreme-

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[19]For example, in their description of a typical GATT/WTO round of multilateral trade negotiations (MTNs), Hoekman and Kostecki (1995, Ch 3) put the point this way: "To a large extent MTNs comprise barter, that is, trades occur in a setting where there is no generally accepted medium of exchange (money)... To ensure that these traders do not come for nothing (i.e., that there is something to trade), a great deal of care is taken to establish an agenda beforehand. This agenda will have some topics (issues) of interest for all the parties that are willing to trade. Prior to an MTN, national authorities, industries and bureaucracies will be engaged in a domestic negotiation to determine interests, priorities, and possible trade-offs. It is this work by potential participants that leads eventually to the establishment of the agenda of the MTN. The setting of the agenda of an MTN is a negotiation in itself. Prior to the launching of the Uruguay round it took five years of work in a GATT Senior Officials Group and elsewhere to prepare the agenda that was mostly embodied in the Punta del Este Declaration." (pp. 61-62)

[20]We note as well that the need for ex-ante transfers would be greatly diminished if we considered a more symmetric setting with a second sector where the countries' roles are reversed. Indeed, if the ex-ante contracting problem were fully symmetric, the governments would select the symmetric point of the Pareto frontier in their ex-ante bargain, which would maximize the sum of their payoffs.

[21]Kaplow and Shavell (1996) make the same observation and adopt a similar approach.

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liability-rule interpretation in order to connect with the ongoing debate on the optimal design of trade agreements that we described in the Introduction. We also note that a liability rule is in essence a "separating" contract, since it induces the importer to choose different policies in different states of the world, while a property rule is in essence a "pooling" contract, since it induces a noncontingent policy choice.[22]

In the Conclusion we discuss the extension of our results under a more general type of contract that may specify a transfer also for the FT choice; in the basic model we focus on the simpler type of contract because it makes the main insights more transparent.[23]

We allow the governments to renegotiate the initial contract after the state of the world γ is realized, and assume that this negotiation is a Nash bargaining game with symmetric bargaining powers and the disagreement point given by the initial contract.[24] We will later consider the implications of asymmetric bargaining powers. We abstract from underlying issues of enforcement and simply assume that bargaining outcomes between the two governments are enforced (see also note 9). To summarize, the timing of events is as follows: (0) Governments write the contract; (1) γ is realized and observed by the governments; (2) governments can renegotiate the terms of the contract (b and T).

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[22]Given the simple informational environment we have assumed, with a single ex-ante uncertain parameter (γ) that is ex-post observable but not verifiable, property rules and liability rules are non-contingent in nature. But in a richer setting where some contingencies are uncertain ex-ante but (perhaps imperfectly) verifiable ex-post, property rules and liability rules could be made contingent, as they sometimes are in real-world trade agreements. See Maggi and Staiger (2013) for a setting of this type, where γ is imperfectly verifiable ex-post (in the sense that the court/DSB can observe a noisy signal of γ), and the contract can take the form of a contingent property rule or a contingent liability rule.

[23]In this paper we only consider option contracts, that is, contracts based on the choice of just one player (in our case the importer). In principle, one could design a more sophisticated mechanism that is based on messages sent by both players. However, it is an open question whether and to what extent more elaborate mechanisms can improve upon option contracts in settings such as ours. For example, in the related setting considered by Segal and Whinston (2002), a (continuous) mechanism that is based on two-sided messages may or may not improve upon an option contract, depending on the contracting environment. As a practical matter it should also be noted that in situations where a policy is applied on a continuing basis, as in the trade policy context, the high frequency with which such message games would have to be played in response to potentially changing states of the world would likely make them exceedingly costly to run. In any case, we leave the consideration of more sophisticated mechanisms as a question for future research.

[24]The type of renegotiation assumed in our model is known in the literature as "interim" renegotiation. As an alternative, in principle one could consider "ex-post" renegotiation, which in our setting would mean that renegotiation occurs after the importing government has chosen between the two contractual options (FT or protect-and-compensate), in which case the *chosen option* would constitute the disagreement point for the renegotiation. We note, however, that this implicitly assumes that the importing country can *commit* to implement the chosen option in case of disagreement. This assumption does not seem warranted in the context of trade agreements, and thus for our purposes we believe that the timing assumed in our model is the more appropriate one.

We conclude this section by highlighting an alternative interpretation of the contract-design problem described above. The literal interpretation is that governments write a contract that specifies two options for the importer (choosing FT, or choosing P and compensating the exporter with the payment b^D), and the DSB simply enforces the contract. The alternative interpretation is that governments design an *institution* consisting of two parts: (i) a simple $\{FT\}$ contract with no contractually specified means of escape; and (ii) a mandate for the DSB to implement a certain *remedy for breach* (the payment b^D). Our analysis applies equally well under either of these interpretations (i.e., whether the contract includes an escape provision, or rather a remedy for breach is specified in the DSB mandate), and both of these interpretations are relevant for the GATT/WTO: some WTO clauses take the form of explicit option contracts, for example the escape clause in GATT Article XIX and the provisions for tariff modifications in Article XXVIII; but there are also many contractual commitments for which, when they apply, there is no escape provision (e.g., the rules governing "actionable" production subsidies, and the ban on export subsidies), and in this case the relevant question is what should be the appropriate remedy applied by the DSB in case of breach. Under either interpretation, the level of b^D is important for the same reason: it serves to define the disagreement point provided by the legal system should efforts to renegotiate after the resolution of uncertainty fail.[25]

3. The No-Renegotiation Benchmark

Before characterizing the optimal agreement in the presence of renegotiation, it is instructive first to consider the simpler setting where ex-post negotiation is not possible. In this setting governments can be viewed as simply designing a contract ex ante (to maximize ex-ante joint surplus) and then implementing it ex post, and choosing a level of damages b^D amounts to stipulating the actual level of damages that must be paid by Home if it chooses P.

We start by noting that, given b^D, the importer will choose FT if and only if its gain from protection, γ, is below some threshold level $\hat{\gamma}$. The threshold level $\hat{\gamma}$ is the value of γ for which the importer is indifferent between FT and P-plus-damages-b^D, and is given by $\hat{\gamma} = b^D + c(b^D)$. The threshold $\hat{\gamma}$ summarizes the policy "allocation" induced by the contract, and we say that $\hat{\gamma}$ is "implemented" by the level of damages b^D if $\hat{\gamma} = b^D + c(b^D)$.

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[25] There is a semantic distinction in the law-and-economics literature according to which, if a trade agreement is viewed as a piece of international law then the property-rule/liability-rule terminology would be used, whereas if a trade agreement is viewed as a contract then the analogous distinction is between a contract that requires "specific performance" and one that specifies "damages for breach." We use these terms interchangeably.

It is useful to highlight how the notions of property rules and liability rules map into values of $\hat{\gamma}$. For this purpose, we define the "prohibitive" level of damages b^{prohib} as the minimum value of b^D such that the importer chooses FT for all γ in the support $(\underline{\gamma}, \bar{\gamma})$, which is defined implicitly by $b^D + c(b^D) = \bar{\gamma}$. Clearly, then, setting a discretionary property rule $(b^D = 0)$ corresponds to setting $\hat{\gamma} = 0$; a prohibitive property rule $(b^D \geq b^{prohib})$ corresponds to $\hat{\gamma} \geq \bar{\gamma}$; and a liability rule $(b^D \in (0, b^{prohib}))$ corresponds to a value $\hat{\gamma}$ that is strictly between 0 and $\bar{\gamma}$.

It is helpful to write the optimal contracting problem as choosing the transfer b^D and the policy allocation $\hat{\gamma}$ to maximize the ex-ante joint surplus, subject to the "implementation constraint" $b^D + c(b^D) = \hat{\gamma}$. Letting $E\Omega_\varnothing(b^D, \hat{\gamma})$ denote the ex-ante joint surplus given b^D and $\hat{\gamma}$ when no ex-post negotiation is possible, we can state the optimal contracting problem as

$$\max_{b^D, \hat{\gamma}} E\Omega_\varnothing(b^D, \hat{\gamma}) = V(FT) + \int_{\hat{\gamma}}^{\infty} (\gamma - \gamma^*) dH(\gamma) - c(b^D)[1 - H(\hat{\gamma})] \qquad (3.1)$$

$$s.t. \ b^D + c(b^D) = \hat{\gamma},$$

where $V(FT) \equiv v(FT) + v^*(FT)$. The expression for $E\Omega_\varnothing(b^D, \hat{\gamma})$ in (3.1) is the sum of three terms. The first is the joint surplus under a rigid FT policy and no transfers; the second captures the gains in joint surplus associated with allowing the policy P for $\gamma > \hat{\gamma}$; and the third reflects the deadweight loss associated with the transfer b^D and policy allocation $\hat{\gamma}$.

Note that, if there is no cost of transfers $(c(\cdot) \equiv 0)$, the objective in (3.1) is clearly maximized by $\hat{\gamma} = \gamma^*$, the first best allocation; but if $c(\cdot) > 0$, it may be optimal to deviate from this allocation. Next note that, if $c(\cdot) > 0$, implementing the first best allocation implies a deadweight loss, which is given by $c(b^D)[1 - H(\gamma^*)]$; this can be interpreted as the "sorting cost." This cost is incurred for all states higher than γ^*, which explains why it is weighted by $[1 - H(\gamma^*)]$. Thus, in the absence of renegotiation, the tradeoff in choosing $\hat{\gamma}$, and hence the optimal level of damages, can be understood in very simple terms: the choice of $\hat{\gamma}$ hinges on the comparison between the efficiency cost of deviating from the first best allocation and the savings in sorting costs that can be achieved by doing so.

To maximize the objective in (3.1), we can use the implementation constraint to solve for the value of b^D that implements $\hat{\gamma}$, plug this into the objective function and optimize $\hat{\gamma}$. We let $b_\varnothing^D(\hat{\gamma})$ denote the value of b^D that implements $\hat{\gamma}$. Differentiating $E\Omega_\varnothing$ with respect to $\hat{\gamma}$, and

noting that $\frac{dc(b_\varnothing^D(\hat{\gamma}))}{d\hat{\gamma}} = \frac{c'(\cdot)}{1+c'(\cdot)}$, we obtain

$$\frac{dE\Omega_\varnothing(b_\varnothing^D(\hat{\gamma}), \hat{\gamma})}{d\hat{\gamma}} = (\gamma^* - \hat{\gamma}) \cdot h(\hat{\gamma}) + c(\cdot) \cdot h(\hat{\gamma}) - \frac{c'(\cdot)}{1 + c'(\cdot)} \cdot [1 - H(\hat{\gamma})]. \qquad (3.2)$$

The first term of $\frac{dE\Omega_\varnothing}{d\hat{\gamma}}$ captures the marginal efficiency gain of increasing $\hat{\gamma}$: this is positive if $\hat{\gamma} < \gamma^*$ and negative otherwise. The second term and third term together capture the marginal savings in sorting costs (positive or negative) from increasing $\hat{\gamma}$: the second term is positive because increasing $\hat{\gamma}$ reduces the range of states for which the importer government chooses to pay the transfer, while the third term is negative because increasing $\hat{\gamma}$ requires an increase in the transfer, which will be paid for all states higher than $\hat{\gamma}$.

At this point one might proceed with a "local" approach, and ask how the objective can be improved starting from the first best allocation $\hat{\gamma} = \gamma^*$: Does improvement require increasing or decreasing $\hat{\gamma}$? Or formally, what is the sign of $\frac{dE\Omega_\varnothing}{d\hat{\gamma}}$ at $\hat{\gamma} = \gamma^*$? Clearly, the sign is positive if and only if sorting costs are saved by increasing $\hat{\gamma}$ slightly from γ^*, but this is ambiguous because, as explained above, the marginal savings in sorting costs are composed of two effects that go in opposite directions. More specifically, it is direct to verify that the sign of $\frac{dE\Omega_\varnothing}{d\hat{\gamma}}$ at $\hat{\gamma} = \gamma^*$ is positive if and only if $\frac{d\ln c}{d\hat{\gamma}} < \frac{h(\hat{\gamma})}{1-H(\hat{\gamma})}$: thus the answer hinges on a comparison between the proportional change in the deadweight loss and the (inverse of) the hazard rate at $\hat{\gamma}$, and a local approach cannot therefore take us very far.

Partly because of the feature we just highlighted, the predictions about the nature of the optimal rules in the no-renegotiation case are somewhat ambiguous. The only sharp prediction obtains under the scenario in which uncertainty about γ is small, in the sense that the support of γ around γ^* is small: in this case, a property rule must be optimal. To see why, consider a liability rule, that is a value of $\hat{\gamma}$ within $(0, \bar{\gamma})$. It is easy to see that such a value of $\hat{\gamma}$ is dominated by $\hat{\gamma} = 0$: the key is to notice from (3.2) that $\frac{dE\Omega_\varnothing}{d\hat{\gamma}} = -\frac{c'(\cdot)}{1+c'(\cdot)} < 0$ for all $\hat{\gamma}$ between 0 and $\underline{\gamma}$ (because $h = 0$ for all these values).[26] This implies that $\hat{\gamma} = 0$ dominates all values of $\hat{\gamma}$ between 0 and $\underline{\gamma}$, and moreover $\hat{\gamma} = 0$ dominates $\hat{\gamma} = \underline{\gamma}$ by a discrete margin, and by continuity will dominate any $\hat{\gamma}$ within the support $(\underline{\gamma}, \bar{\gamma})$ provided that this support is sufficiently small.[27] Intuitively, a liability rule can achieve a contingent, and hence more efficient, policy allocation,

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[26]Recall that $\gamma^* > 0$, and so when the support of γ around γ^* is sufficiently small we must have that $\underline{\gamma} > 0$.

[27]It can be shown that a liability rule is dominated also by the prohibitive property rule $\hat{\gamma} \geq \bar{\gamma}$. This cannot be seen easily from (3.2), but one way to see it intuitively is to focus on the symmetric case where $E\gamma = \gamma^*$: in this case the two property rules yield the same expected joint surplus, and hence if a liability rule is dominated by one property rule it is also dominated by the other.

but the associated gain is small when the support of γ is small, and it is overwhelmed by the deadweight loss from the transfer.

Let us focus now on the opposite case, in which uncertainty is large. We find that, if the support of γ is sufficiently large, a prohibitive property rule $\hat{\gamma} \geq \bar{\gamma}$ is necessarily suboptimal, but the discretionary property rule cannot be ruled out. To understand the first of these two claims, start by noting that the first two terms in (3.2) collapse to $(\gamma^* - b_\varnothing^D(\hat{\gamma})) \cdot h(\hat{\gamma})$ (using the definition of $b_\varnothing^D(\hat{\gamma})$). Next note that $b_\varnothing^D(\hat{\gamma}) > \gamma^*$ for $\hat{\gamma}$ large enough, and hence $\frac{dE\Omega_\varnothing}{d\hat{\gamma}} < 0$ for $\hat{\gamma}$ in a left neighborhood of $\bar{\gamma}$. This implies that $\hat{\gamma} \geq \bar{\gamma}$ is dominated by setting $\hat{\gamma}$ slightly lower than $\bar{\gamma}$. On the other hand, the discretionary property rule $\hat{\gamma} = 0$ *can* under some conditions be a maximum. To see why, notice that, since $b_\varnothing^D(0) = 0$ and $c'(0) = c(0) = 0$, we have $\frac{dE\Omega_\varnothing}{d\hat{\gamma}}|_{\hat{\gamma}=0} = \gamma^* \cdot h(0)$. If $h(0) = 0$ then $\hat{\gamma} = 0$ is a stationary point, and in this case one can show that if $h'(0)$ is sufficiently small then $\hat{\gamma} = 0$ is a local maximum, and it is straightforward to construct examples in which $\hat{\gamma} = 0$ is a global maximum. Intuitively, when uncertainty is large and renegotiation is not possible, it may be best to allow full discretion (P always), because inducing FT even for just the lowest levels of γ – i.e. those states where FT is most desirable for joint surplus – requires a transfer that will occur in equilibrium for all higher levels of γ – i.e. those states in which the importer will choose P – and the resulting transfer costs may be too high to be worthwhile.

To summarize our analysis thus far, in the no-renegotiation scenario the key tradeoff is conceptually simple. A liability rule can insure against extreme realizations of γ but it entails transfer costs, while a property rule avoids transfer costs but it entails downside risk associated with extreme realizations of γ. However, the predictions about the optimal rules are somewhat ambiguous, at least in the case of large uncertainty. As we will show in the next section, introducing renegotiation complicates the trade-offs, but perhaps surprisingly, leads to sharper predictions about the optimal rules.

4. The Optimal Agreement in the Presence of Renegotiation

We now turn to the analysis of the optimal agreement in the presence of renegotiation. We can build on the analysis of the no-renegotiation case in the previous section, because for any level of damages b^D the contract characterized there provides the *disagreement (threat) point* for any renegotiation in the present setting. But to characterize where governments will actually end up for any realization of γ given a level of b^D, we must consider the incentives to renegotiate

the initial contract, and this necessitates some new notation and a more involved analysis.

The first question we need to address is the following: Given a contract that specifies damages b^D, when does renegotiation occur (i.e., for what realizations of γ), and in what direction does it occur (i.e., from P to FT or from FT to P)? As we observed just above, the threat point in the renegotiation is given by the initial contract, which gives the importer the option to choose between $(T = FT, b = 0)$ and $(T = P, b = b^D)$. Clearly, the importer is indifferent between these two options if $\gamma = b^D + c(b^D) \equiv S(b^D)$. In words, $S(b^D)$ is the total cost of the transfer b^D inclusive of deadweight loss, and it is the level of γ at which the threat point "switches": under disagreement, for $\gamma < S(b^D)$ the importer chooses $(T = FT, b = 0)$, while for $\gamma > S(b^D)$ it chooses $(T = P, b = b^D)$. We depict the curve $S(b^D)$ in Figure 1. As Figure 1 reflects, $S(b^D)$ is increasing and convex and goes through the origin, and the threat point is $(T = FT, b = 0)$ below $S(b^D)$ and $(T = P, b = b^D)$ above it.

Having characterized how the threat point varies with γ for a given b^D, we next identify the realizations of γ for which the initial contract will be renegotiated and determine the direction of the renegotiation. Note that the analysis of renegotiation is not straightforward because utility is not transferrable, due to the cost of transfers, and for this reason we cannot simply focus on the governments' ex-post joint surplus to determine whether the contract will be renegotiated.

Let us focus first on the case $\gamma < S(b^D)$, where the threat point is $(T = FT, b = 0)$. Clearly, the governments will renegotiate to the policy P if and only if there exists a transfer b^e such that both governments gain by switching from $(T = FT, b = 0)$ to $(T = P, b = b^e)$, which requires $\gamma > S(b^e)$ (for the importer) and $b^e > \gamma^*$ (for the exporter). The equilibrium b^e will then fall somewhere in the interval $[\gamma^*, S^{-1}(\gamma)]$.[28] Furthermore, it is clear that there is a Pareto improvement over the threat point if and only if the interval $[\gamma^*, S^{-1}(\gamma)]$ is nonempty, or $\gamma > S(\gamma^*)$. Thus, we can conclude that the contract is renegotiated toward policy P for values of γ such that $S(\gamma^*) < \gamma < S(b^D)$. This condition identifies a region in (γ, b^D) space, which is highlighted in Figure 1 by the vertical shading (and labeled P_R). Notice that $b^e < b^D$ in this region, given that $S(b^e) < \gamma < S(b^D)$ with $S(\cdot)$ increasing.

It is useful at this juncture to observe that it can never be strictly optimal to set $b^D > \gamma^*$. To see why, notice from Figure 1 that setting $b^D > \gamma^*$ induces the same policy allocation as setting $b^D = \gamma^*$ (namely FT for $\gamma < S(\gamma^*)$ and P for $\gamma > S(\gamma^*)$). Therefore, any $b^D > \gamma^*$ is

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[28]Note that the function $S(\cdot)$ is invertible, because we assumed that $b + c(b)$ is increasing everywhere.

weakly dominated by $b^D = \gamma^*$ because the latter implies a weakly lower expected transfer.[29] A consequence of this observation is that it will never be the case that *in equilibrium* the contract is renegotiated towards P: this follows because renegotiation from FT to P is only possible in the case where $\gamma < S(b^D)$ and the threat point is FT, and as Figure 1 depicts when $\gamma < S(b^D)$ the contract is renegotiated toward P only when $b^D > \gamma^*$, which we have just observed can never be strictly optimal. Instead, as we will confirm and discuss further below, the only kind of renegotiation that can occur in equilibrium is from P to FT.

Let us now focus on the case $\gamma > S(b^D)$, where the threat point is $(T = P, b = b^D)$. In this case, the governments will renegotiate toward the policy FT if and only if there exists a (negative) transfer b^e such that both governments gain by switching from $(T = P, b = b^D)$ to $(T = FT, b = b^e)$, which requires $S(b^D) - S(b^e) > \gamma$ (for the importer) and $\gamma^* > b^D - b^e$ (for the exporter). Again using the definition of $S(\cdot)$, the equilibrium b^e will then fall somewhere in the interval $[b^D - \gamma^*, S^{-1}(S(b^D) - \gamma)]$. Clearly, there exists a Pareto improvement over the threat point if and only if this interval is nonempty, or $\gamma < S(b^D) - S(b^D - \gamma^*) \equiv R(b^D)$, hence we can conclude that the contract is renegotiated toward policy FT when $S(b^D) < \gamma < R(b^D)$. This condition identifies a region in (γ, b^D) space that is highlighted in Figure 1 by the horizontal shading (and labeled FT_R).[30]

Our findings on the equilibrium pattern of renegotiation are recorded in the following:

Proposition 1. *(i) If $b^D < \gamma^*$, the contract is renegotiated for $\gamma \in (S(b^D), R(b^D))$, in which case the governments agree on FT and the exporter compensates the importer. (ii) If $b^D > \gamma^*$, the contract is renegotiated for $\gamma \in (S(\gamma^*), S(b^D))$, in which case the governments agree on P and the importer compensates the exporter; however, setting $b^D > \gamma^*$ is weakly dominated, and this kind of renegotiation does not happen in equilibrium.*

Proposition 1 implies two interesting predictions regarding the pattern and direction of equilibrium renegotiation. The first prediction is that, as long as damages are set optimally,

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[29]To see this, fix a level of b^D above γ^*, say $b^D = \tilde{b}^D > \gamma^*$, and replace it with $b^D = \gamma^*$. This decreases the expected equilibrium transfer (weakly) for two reasons: (1) if $\gamma > S(\tilde{b}^D)$, so that the importer chooses $(T = P, b = b^D)$ without renegotiating, the transfer obviously decreases, and (2) if $\gamma \in (\gamma^* + c(\gamma^*), S(\tilde{b}^D))$, so that the contract is renegotiated, the equilibrium transfer b^e is higher than γ^*, as we showed in the text. We also note the reason for the qualifier that $b^D > \gamma^*$ is "weakly" dominated by $b^D = \gamma^*$: if the support of γ around γ^* is small, the expected equilibrium transfer is the same in the two cases, because all states $\gamma > \gamma^* + c(\gamma^*)$ have zero density. But note that, if this is the case, even if $b^D > \gamma^*$ renegotiation from FT to P cannot occur with positive probability. This explains the sentence that follows in the text.

[30]Note that $R(0) = -S(-\gamma^*) > 0$, so this region is guaranteed to be nonempty, and note also that $R''(b^D) < S''(b^D)$ for all b^D, which ensures that the point of intersection between the R curve and the S curve is unique.

any observed ex-post renegotiation of the ex-ante contract must result in liberalization (from P to FT), not protection (from FT to P). That is, according to Proposition 1, equilibrium renegotiations all take a particular form in which the importer (respondent) agrees to liberalize and the exporter (claimant) agrees to pay something for this. What should not occur in equilibrium according to Proposition 1 is a renegotiation wherein the importer's threat point is FT but the governments agree to a policy of P and a level of damages to the exporter that is less than the contractually-specified level ($b^e < b^D$). Intuitively, if renegotiation took this latter form, it would imply that the contractually-specified damages b^D are suboptimally high, because for the exporter government to agree to such a renegotiation would require $\gamma^* < b^e$, and hence $\gamma^* < b^D$; but this cannot be optimal, as we have explained previously. This asymmetry in the predicted direction of equilibrium renegotiations reflects two features: first, that in the context of trade agreements, the contractual obligations are to liberalize policies (moving towards FT); and second, that it is never optimal to induce renegotiation in states of the world where the threat point is the contractual policy obligation itself.[31]

The second prediction is that, if $b^D > 0$, renegotiation can occur in equilibrium only for intermediate values of γ. This is perhaps surprising, since intuition might suggest that renegotiation should occur in extreme circumstances where the ex-ante contract turns out to be highly inefficient ex-post. The reason this intuition is not correct in our model is that, in extreme states of the world, the initial contract performs well, in the sense that it induces the importer to make the correct policy choice. Instead, in our model governments may have incentive to

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[31] Examples of renegotiation that conform to the model's equilibrium predictions, in which the respondent agrees to liberalize and the complainant agrees to pay something for this, are not hard to find. For instance, in an early GATT dispute between India and Pakistan regarding export fees levied by Pakistan on jute sold to India that India claimed violated the MFN obligation, India withdrew its complaint under a settlement (see GATT, 1953) in which Pakistan agreed to eliminate the discriminatory features of its export taxes in exchange for an agreement by India to reduce its (non-discriminatory) export tax on coal. A more recent example is provided by the 2001 compliance settlement for the U.S.-EU "Banana" dispute in the WTO (see USTR, 2001). In this settlement, the EU (respondent) agreed to come into compliance with the DSB ruling, but not fully until 2006. Hence, the U.S. (a claimant), by accepting the EU's non-to-partial compliance over the 2001-2006 period, allowed the EU to take some compensation (by being able to deviate from its WTO commitment over this period) in exchange for the promise of eventual full compliance. Of course, we cannot provide here anything approaching a systematic empirical investigation of the direction of renegotiations in trade agreements, but we do emphasize that such an investigation would require extending the model to allow for the possibility of equilibrium disputes and rulings by the court/DSB. In Maggi and Staiger (2013) we develop such an extension, in which DSB rulings can be triggered in equilibrium, and there an interesting qualification arises about the predicted direction of renegotiations: if governments renegotiate after the DSB ruling, or if they reach "early settlement" and are certain about the would-be outcome of the ruling, then the direction of renegotiation is always liberalizing; but if governments settle early and the outcome of the would-be ruling is uncertain, the settlement can go in either direction.

renegotiate (for the relevant range of b^D) only if the importer government is relatively close to indifferent between the options placed before it by the initial contract, and this indifference occurs for an intermediate state of the world ($\gamma = S(b^D)$): if the importer prefers P and is far from this indifference point, the exporter will have to pay a large transfer to convince the importer to switch its policy choice to FT, and this will entail a large deadweight loss. In this sense, the reason the contract may be renegotiated in equilibrium in our model reflects the inefficiencies of the transfers more than the inefficiencies of the policy itself.

Having characterized the pattern and direction of renegotiation, we can now turn to the analysis of the optimal contract. An important step towards characterizing the optimal b^D is to ask the following question: What allocations $\hat{\gamma}$ can be implemented in the presence of renegotiation, and what is the level of damages b^D that implements a given $\hat{\gamma}$?

This question is immediately answered by Figure 1. First note that there exists *no* level of damages b^D that can implement values of $\hat{\gamma}$ outside the interval $[R(0), S(\gamma^*)]$: regardless of b^D, the policy outcome for $\gamma > S(\gamma^*)$ is always P, and for $\gamma < R(0)$ it is always FT. This is an important difference relative to the case of no renegotiation: there, any allocation $\hat{\gamma}$ can be implemented by an appropriate choice of b^D. But when renegotiation is feasible, it is impossible to induce FT for values of γ above $S(\gamma^*)$, or P for values of γ below $R(0)$.

Notice also that the range of implementable values of $\hat{\gamma}$ is smaller when the cost of transfer is lower (it can be verified that decreasing $c(\cdot)$ leads to an increase in $R(0)$ and a decrease in $S(\gamma^*)$). This feature is very intuitive in the limiting case where transfers are costless: then the parties will always renegotiate to the efficient outcome regardless of b^D, and hence only the allocation $\hat{\gamma} = \gamma^*$ is implementable. This is a manifestation of the Coase theorem: in the absence of transaction costs the ex-ante contract is irrelevant and the efficient outcome always obtains ex-post. When transfers are quite costly, on the other hand, the renegotiation outcome is very sensitive to the level of damages b^D specified in the initial contract, and hence the range of implementable allocations is wider. Thus *renegotiation limits the scope of implementation, and the more so the lower the transfer cost.* We let $IM_{\hat{\gamma}} \equiv [R(0), S(\gamma^*)]$ denote the set of implementable values of $\hat{\gamma}$.

In spite of the fact that renegotiation imposes bounds on implementation, *renegotiation is beneficial* for ex-ante joint surplus. To see this notice that, for each given b^D and γ, governments renegotiate only if this leads to an ex-post Pareto improvement. Since renegotiation leads to a weak ex-post Pareto improvement for all (b^D, γ), it follows that the ex-ante joint surplus must

also be weakly higher. The following lemma summarizes:

Lemma 1. *Renegotiation limits the range of allocations $\hat{\gamma}$ that can be implemented. The implementable range of $\hat{\gamma}$ is given by $IM_{\hat{\gamma}} = [R(0), S(\gamma^*)]$. However, renegotiation is (weakly) beneficial for the ex-ante joint surplus.*

We next ask, what level of b^D is required to implement a given $\hat{\gamma}$? From Figure 1 it is clear that implementing a given $\hat{\gamma}$ in $IM_{\hat{\gamma}}$ requires $b^D(\hat{\gamma}) = R^{-1}(\hat{\gamma})$. Note that $b^D(\hat{\gamma})$ is increasing in the relevant range; and, recalling that the definition of $b_\varnothing^D(\hat{\gamma})$ implies $b_\varnothing^D(\hat{\gamma}) = S^{-1}(\hat{\gamma})$, we note as well that $b^D(\hat{\gamma}) \leq b_\varnothing^D(\hat{\gamma})$ for all $\hat{\gamma} \in IM_{\hat{\gamma}}$: in spite of the fact that renegotiation limits the scope of implementation, it takes a lower level of contractually-specified damages to implement a given $\hat{\gamma}$ than in the absence of renegotiation (for $\hat{\gamma}$ in the implementable set).

Finally, it is important to recall that the level of damages $b^D(\hat{\gamma})$ specified in the contract is not necessarily the transfer that occurs in equilibrium, since the contract may be renegotiated, so Lemma 1 does not tell us the *cost* of implementing $\hat{\gamma}$. For $\hat{\gamma} \in IM_{\hat{\gamma}}$, this cost includes two components: (1) the cost of the transfer $b^e(\cdot)$ made when the contract is renegotiated, which is the case for $\gamma \in (S(b^D(\hat{\gamma})), \hat{\gamma})$, and (2) the cost of the transfer b^D made when the contract is not renegotiated and the importer chooses $(T = P, b = b^D)$, which is the case for $\gamma > \hat{\gamma}$.

Armed with the observations above, we can now write down the optimization problem in the presence of renegotiation. Recalling that we can focus on $b^D \leq \gamma^*$ and that for this range of b^D we have $\hat{\gamma} = R(b^D)$, we can write the problem as follows:

$$\max_{b^D, \hat{\gamma}} E\Omega(b^D, \hat{\gamma}) = V(FT) + \int_{\hat{\gamma}}^{\infty}(\gamma - \gamma^*)dH(\gamma) - c(b^D)[1 - H(\hat{\gamma})] - \int_{S(b^D)}^{\hat{\gamma}} c(b^e(b^D; \gamma))dH(\gamma)$$
$$s.t. \ \hat{\gamma} = R(b^D), \ b^D \leq \gamma^*$$

There are two main differences between this optimization problem and the optimization problem in (3.1) that applies when renegotiation is not possible: first, the expected cost of transfers now includes not only the cost of the transfer b^D for states in which the contract is not renegotiated and the importer chooses $(T = P, b = b^D)$, but also the cost of the transfer b^e that is paid by the exporter when renegotiation occurs; and second, the level of b^D required to implement a given $\hat{\gamma}$ is lower than in the case of no renegotiation, as we highlighted above.

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A final ingredient for finding the optimal level of contractually-stipulated damages b^D is understanding how the level of b^D affects the transfer b^e paid by the exporter when renegotiation occurs. Intuitively, increasing b^D strengthens the bargaining position of the exporter and hence decreases b^e in absolute size. Formally, note that in the FT_R region b^e solves the Nash bargaining problem:

$$\max_b \quad NB(b; b^D) \equiv \left(\omega(FT, b) - \omega(P, b^D)\right)\left(\omega^*(FT, b) - \omega^*(P, b^D)\right).$$

By standard monotone comparative-statics results, $\frac{\partial b^e}{\partial b^D}$ has the same sign as $\frac{\partial^2 NB(b, b^D)}{\partial b \partial b^D}|_{b=b^e}$ which, using the explicit expression $NB(b; b^D) = \left(S(b^D) - S(b) - \gamma\right)\left(\gamma^* + b - b^D\right)$, is positive. As $b^e < 0$ in the FT_R region, it follows that $\frac{\partial |b^e|}{\partial b^D} < 0$. We record this finding in

Lemma 2. *For (b^D, γ) in the FT_R region, where governments renegotiate to FT and $b^e < 0$, an increase in b^D leads to a decrease in (the absolute size of) the equilibrium transfer: $\frac{\partial |b^e|}{\partial b^D} < 0$.*

We are now ready to study the optimal level of b^D, and in particular compare property rules with liability rules in the presence of renegotiation. Recall that the discretionary property rule is defined as $b^D = 0$; the prohibitive property rule as $b^D \geq \bar{b}^{prohib}$ (where $\bar{b}^{prohib}$ is determined by $S(\bar{b}^{prohib}) = \bar{\gamma}$); and a liability rule as $b^D \in (0, \bar{b}^{prohib})$.

Before proceeding, however, it is important to emphasize how the introduction of renegotiation changes the tradeoff involved in the choice between liability rules and property rules. Recall that, in the absence of renegotiation, the tradeoff is fairly simple: property rules avoid the cost of transfers but imply rigid policy outcomes, whereas liability rules can introduce policy flexibility but imply some waste associated with the use of transfers. If governments are able to renegotiate the contract, on the other hand, this tradeoff is complicated by the fact that the policy outcome is no longer necessarily rigid under property rules; by the fact that renegotiation imposes a limit on the policy allocations that can be implemented; and perhaps most importantly, by the fact that the level of b^D affects the equilibrium payments that are made when governments renegotiate.

We focus first on the case of small uncertainty. In this case, a property rule must be optimal, and the logic is similar to the case of no renegotiation. Figure 2 depicts the relevant features of the small-uncertainty case. First note from Figure 2 that, if the support of γ around γ^* is sufficiently small, a property rule ($b^D = 0$ or $b^D \geq \bar{b}^{prohib}$) is not renegotiated for any γ, and hence it induces zero transfers in equilibrium. A liability rule may achieve a more efficient policy allocation than a property rule, since the policy can be made contingent on γ, but the

associated benefit is small because the support of γ around γ^* is small. On the other hand, the cost of achieving this state-contingency is not small, because implementing a threshold $\hat{\gamma}$ close to γ^* requires a level of damages b^D that is close to $R^{-1}(\gamma^*)$ and hence does not become negligible as the support shrinks.[32] In this case, it is straightforward to establish that the optimum is $b^D = 0$ if $E\gamma > \gamma^*$ and $b^D \geq \bar{b}^{prohib}$ if $E\gamma < \gamma^*$.

Let us focus next on the case where uncertainty is sufficiently large. It is helpful to refer back to Figure 1 for this case. Suppose that $\underline{\gamma} < R(0)$ and $\bar{\gamma} > S(\gamma^*)$. Recalling that the implementable range of $\hat{\gamma}$ is $IM_{\hat{\gamma}} = [R(0), S(\gamma^*)]$, this is the case in which the support includes high-γ states in which the policy outcome is P regardless of the initial contract, and it includes low-γ states in which the policy outcome is FT regardless of the initial contract. In this case, a liability rule must be optimal. To see why, first note that in this case $\bar{b}^{prohib} > \gamma^*$, and recall from Proposition 1 that $b^D > \gamma^*$ can never be optimal, so a prohibitive property rule cannot be optimal (this follows with our assumption that $\bar{\gamma} > S(\gamma^*)$, see note 29). Next consider the discretionary property rule $b^D = 0$. Note that, given $b^D = 0$, for all $\gamma > R(0)$ the contract is not renegotiated and the outcome is $(P, b = 0)$; for these states, increasing b^D slightly from zero entails only a second-order loss, since the marginal cost of the transfer is zero at $b = 0$. But for all $\gamma < R(0)$, given $b^D = 0$ the contract is renegotiated and the exporter pays a sizable transfer b^e, and recall from Lemma 2 that increasing b^D reduces the size of b^e: this is a first-order benefit, and hence increasing b^D slightly from zero improves the objective. We can conclude that if the support of γ is sufficiently large, both property rules are dominated by a liability rule.

The following proposition summarizes:

Proposition 2. *(i) If the support of γ is sufficiently small, a property rule is optimal (specifically, the optimum is $b^D = 0$ if $E\gamma > \gamma^*$ and $b^D \geq \bar{b}^{prohib}$ if $E\gamma < \gamma^*$). (ii) If the support of γ is sufficiently large (on both sides of γ^*), the optimum is a liability rule, and in particular the optimal b^D satisfies $0 < b^D < \gamma^* < \bar{b}^{prohib}$.*

As Proposition 2 reflects, the introduction of renegotiation leads to sharper predictions about the optimal rules, despite the fact that the trade-offs involved become more subtle. In particular, when renegotiation is possible, with sufficiently large uncertainty a liability rule

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[32]To be more precise, if $\hat{\gamma}$ is close to γ^* then for states above $\hat{\gamma}$ the transfer b^D will be close to $R^{-1}(\gamma^*)$, which is non-negligible; for states below $\hat{\gamma}$ the contract will be renegotiated, and the equilibrium transfer may be lower, but this renegotiated transfer is unrelated to the size of the support of γ and hence does not become small as the support shrinks.

dominates both the prohibitive property rule and the discretionary property rule, whereas in the absence of renegotiation we have shown that the discretionary property rule can be optimal even when uncertainty is large. And as we have explained, the reason a liability rule dominates the discretionary property rule in the presence of renegotiation is surprising: introducing a small $b^D > 0$ in the contract leads to a *saving* in transfer costs by strengthening the bargaining position of the exporter, while the *policy* allocation remains unaffected.

We have used the support of γ as a measure of ex-ante uncertainty. If uncertainty about γ is small in the sense that the density of γ is very concentrated around γ^* but the support is large, then the optimum will be *approximately* a property rule, in the sense that the optimal b^D will be either close to 0 or it will be prohibitive with probability close to 1.

Proposition 2 states that a liability rule is optimal if uncertainty about γ is sufficiently large, but in this case the optimal level of b^D is lower than the level that fully compensates the exporter, i.e. γ^*.[33] This result qualifies the argument often made in the law-and-economics literature that the efficient level of damages is the one that fully compensates the injured party; and this qualification arises even under the conditions that are most favorable to this argument, namely that γ^* is verifiable. The source of this qualification comes from our assumption of costly transfers, and so it applies with particular force to international trade agreements. Specifically, in the context of the WTO compensation often takes the form of tariff-retaliation by the injured party, hence it entails inefficiencies, and therefore from an ex-ante perspective it should not be utilized to an extent that fully compensates the injured party for its loss. This qualification gains special relevance in light of the emphasis placed on reciprocity in the GATT/WTO system of remedies: it is sometimes suggested that reciprocity falls short as a mechanism for inducing efficient outcomes because it does *not* fully compensate the injured party (see Charnovitz, 2002, Lawrence, 2003 and Pauwelyn, 2008), but Proposition 2 suggests that this may in fact be a desirable feature of reciprocity in light of the deadweight loss associated with tariff retaliation.

Moreover, as Proposition 2 indicates, if uncertainty about γ is sufficiently small, *any* liability rule is suboptimal (let alone the specific liability rule with $b^D = \gamma^*$), and instead the optimum is a property rule. Under the interpretation that uncertainty in γ reflects primarily political-economy shocks, Proposition 2 therefore suggests an interesting empirical prediction: we should tend to observe more liability rules for issue areas where political-economy shocks are more intense; and conversely, the use of property rules should be more frequent for issue areas

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[33]A similar result has been shown by Beshkar (2010b).

where political-economy shocks are less important. Whether or not this empirical prediction is borne out in observed trade agreements is an open question, but it is tempting to link this prediction to what we observe in the GATT/WTO: as we mentioned in the Introduction, export subsidies and quantitative restrictions (QRs) are prohibited by property rules, while tariffs and production subsidies are regulated through a liability-rule approach. One can argue that tariffs and production subsidies are subject to considerable political-economy shocks. On the other hand, export sectors are typically less subject to political pressures than import-competing sectors;[34] hence, export subsidies are arguably less sensitive to political pressures than tariffs and production subsidies. And while QRs can in principle be the target of strong lobbying pressures, the GATT/WTO has successfully "tariffied" most QRs, thereby channeling political pressures to a large extent away from QRs and into tariffs (and perhaps production subsidies), so QRs are arguably less subject to political economy shocks as well.[35]

We next highlight an interesting prediction of our model that derives from the underlying pattern of equilibrium renegotiation: we find that an optimal property rule is never renegotiated. This can be seen as follows. Consider a prohibitive property rule ($b^D \geq \bar{b}^{prohib}$). By definition, this entails a b^D high enough that for all γ in the support the importer's threat point is FT (or $S(b^D) > \bar{\gamma}$); but we know from Proposition 1 that under an optimal contract there can never be renegotiation from FT to P, hence when a prohibitive property rule is optimal it is never renegotiated. Now consider a discretionary property rule ($b^D = 0$). We have established previously that a necessary condition for this to be optimal is that when $b^D = 0$ there is no renegotiation for any γ (or $R(0) < \underline{\gamma}$). Our claim then follows immediately. We record this in

Proposition 3. *When a property rule is optimal, it is never renegotiated, and therefore entails no equilibrium transfers.*

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[34]This claim has a long history, and it reflects the twin observations that it is declining industries rather than expanding industries that typically receive trade policy support and that it is import-competing industries rather than exporting industries that are typically in decline. Empirically, these observations have been extensively documented in the literature. As for why the asymmetric political influence of import-competing relative to export sectors arises, there have been a number of proposed answers, including the free-riding and rent-erosion problems faced by lobbyists in expanding sectors as a result of new entrants (Grossman and Helpman, 1996, and Baldwin and Robert-Nicoud, 2007) and the "identity bias" reflecting asymmetries in the political market (Krueger, 1990, and Fernandez and Rodrik, 1991).

[35]We also note that the degree of uncertainty was a key consideration in the discussions of GATT trade negotiators on the potential benefits of liability rules. As Pauwelyn (2008, p. 137) writes: "...trade negotiators cannot foresee all possible situations, nor can they predict future economic and political developments, both at home and internationally. As a result of this uncertainty, they wanted the flexibility of a liability rule." This kind of consideration seems broadly in line with the message of our Proposition 2.

Intuition might have suggested that the possibility of renegotiation should enhance the performance of property rules, because it insures the contracting parties against the intrinsic rigidity of such rules. Proposition 3 however tells us that this intuition is not really correct. The possibility of renegotiation can enhance the performance of a property rule only if such a rule is suboptimal. If a property rule is optimal, the possibility of renegotiation is immaterial. The logic behind this result is simple: renegotiation of a property rule would occur only in extreme states of the world, but if extreme states are possible then a property rule is dominated by a liability rule.

In light of Proposition 3, it is relevant to observe that the frequency of renegotiation and compensation in the GATT/WTO has diminished through time.[36] And as we mentioned in the Introduction, in the view of most legal scholars the GATT/WTO began as a liability-rule system but has developed over time into a system of property rules.[37] Proposition 3 links these two observations, and suggests that the observed drop in the use of compensation might be a consequence of this shift in the GATT/WTO from liability to property rules.[38] Finally, we have emphasized the implications of Proposition 3 for changes through time, but we note that Proposition 3 suggests an analogous cross-sectional prediction: there should be more renegotiation and compensation in issue areas regulated by liability rules.

4.1. Asymmetric bargaining powers in a 2-sector setting

Thus far we have assumed that bargaining powers are symmetric across governments. We now depart temporarily from this assumption to ask: How is the tradeoff between property rules and liability rules affected by the presence of bargaining power asymmetries across countries? To answer this question, we consider a 2-mirror-image-sectors version of the model along the lines

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[36] This feature has been noted by, among others, Hoda (2001), Goldstein and Martin (2002), Pauwelyn (2008), and Pelc (2009).

[37] Representing this majority view, Jackson (1997, pp. 62-63), argues that the GATT/WTO has evolved from what was in effect a system of liability rules in the early GATT years to a system of property rules under the reforms introduced with the creation of the WTO and embodied in the DSB. On the dissenting view, see Hippler Bello (1996) and Schwartz and Sykes (2002), who view the changes in the DSB that were introduced with the creation of the WTO as serving instead to return the system to one based squarely on liability rules.

[38] It is not obvious what may have caused this shift from liability to property rules. According to our model a reduction in uncertainty could have this effect, but it is not clear that uncertainty has diminished over time. For this reason, here we emphasize only the prediction of the model concerning the co-variation between contract form and frequency of renegotiation, which seems consistent with observations. However, in the next section we present results on the impact of power asymmetries for the choice between liability and property rules, and there we suggest that through its implications for power asymmetries the increasing GATT/WTO membership can be interpreted as providing one possible cause of this shift.

described in note 20, but we now allow for country-specific bargaining powers. In particular, we let $\sigma \in (0,1)$ denote the Home country's bargaining power and $(1-\sigma)$ the Foreign country's bargaining power.[39] To examine the effect of asymmetric bargaining powers, we consider the impact of moving σ away from $\frac{1}{2}$; without loss of generality, we will increase σ above $\frac{1}{2}$ so that the Home government becomes the more powerful of the two.

We start by highlighting how the possibility of asymmetric bargaining powers affects the analysis of renegotiation given b^D. It is direct to verify that the two renegotiation regions highlighted in Figure 1 are independent of σ. Also, σ has no impact on the equilibrium policy. The only effect of changing σ is to change the amount of transfer b^e that is exchanged inside these regions. And it is easy to check that all the Lemmas and Propositions stated thus far extend to the case $\sigma \neq \frac{1}{2}$ in a straightforward manner. With this we are now ready to examine how bargaining power asymmetries affect the tradeoff between property rules and liability rules.

Consider first the sector where Home imports. In this sector, an increase in σ worsens the performance of a liability rule. The reason is simple: first, as noted just above, σ has no impact on the equilibrium policy; and second, as σ rises, the expected transfer as a result of renegotiations goes up, because by Proposition 1 equilibrium renegotiations always entail a transfer from the exporter to the importer, and an increase in σ means an increase in the importer's (Home's) bargaining power. Next consider the sector where Home exports. In this sector an increase in σ *improves* the performance of a liability rule. The logic is the same as above, except that in this sector it is now Home who makes a transfer to Foreign in any renegotiation by Proposition 1, and the increase in its bargaining power reduces the expected size of this transfer. Finally, note that in the 2-mirror-image-sectors version of the model, with symmetric bargaining powers the expected transfer that Home receives as an importer in any renegotiation is equal in magnitude to the expected transfer it pays as an exporter. Hence, beginning from this symmetric point and as σ is increased above $\frac{1}{2}$, the convexity of $c(b)$ ensures that the increase in transfer-cost in the sector where Home is an importer is larger in magnitude than the decrease in transfer cost in the sector where Home is an exporter.

We may thus conclude that the governments' ex-ante joint surplus under the liability rule must fall as σ is increased from $\frac{1}{2}$, as a result of the higher expected transfer costs that arise once asymmetries in bargaining power across governments are introduced. And in combination

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[39]In the mirror-image sector, Foreign chooses the trade policy and is subject to a political-economy shock (say γ^*); to ensure symmetry and separability between the two sectors we require the shocks γ and γ^* to be *iid*.

with Proposition 3, which implies that the ex-ante joint surplus under an optimal property rule is independent of σ, it then follows that, as σ rises from $\frac{1}{2}$, the optimum can switch from a liability rule to a property rule, but not vice-versa. The following proposition states the result:[40]

Proposition 4. *As $|\sigma - \frac{1}{2}|$ increases, so that bargaining powers become more asymmetric, the optimum can switch from a liability rule to a property rule, but not vice-versa.*

If one interprets the evolution of the GATT/WTO membership from its original 23 GATT signatories of 1947 to the 159 WTO members today as implying a significant increase in power asymmetries across countries in a typical GATT/WTO renegotiation, then Proposition 4 suggests one possible reason for the observation of many legal scholars that the GATT/WTO began as a liability-rule system but has developed over time into a system of property rules.

Finally, there is a further observation suggested by the model regarding bargaining powers. According to the model, bargaining powers are irrelevant under an optimal property rule (because, as we have observed, by Proposition 3 an optimal property rule is never renegotiated), while under a liability rule a country with low bargaining power will receive a low payoff because it will get the shorter end of the stick at the renegotiation stage. Hence our model indicates that, where significant power imbalances exist between countries, moving between a liability rule system and a property rule system will not be distributionally neutral, suggesting in turn that developed and developing countries might naturally have differing preferences with regard to reforms that would move an institution in one direction or the other.[41]

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[40]We have assumed that the contract sets a single b^D across the 2 sectors. If we were to allow a different b^D in each sector, so that the commitments made by one country could be treated as a property rule while those made by the other country treated as a liability rule, then with similar arguments to those made in the text it is easy to see that as σ is increased from $\frac{1}{2}$, it could become optimal to treat the Home country's commitments as a property rule and the weak Foreign country's commitments as a liability rule, but not vice versa.

[41]For instance, suppose that $\sigma > \frac{1}{2}$ as considered in the text and that model parameters are such that property and liability rules are equally efficient. Then under the property rule, Home and Foreign payoffs are equal, but under the liability rule, Home does better than Foreign. And since the two rules are equally efficient by assumption, a move from the property rule to the liability rule would then require that Home compensate Foreign. In the case of the GATT/WTO, one might expect based on our results that developing countries would take a skeptical view of reforms that had the impact of moving the system away from property rules and toward liability rules. This prediction is broadly in line with bargaining positions taken by member governments over proposed institutional reforms that would have elevated the role of compensation as a "buy out" of one's obligations in the GATT/WTO (see, for example, the discussion in Pelc, 2009, and the references cited therein, as well as the complementary discussion in Pauwelyn, 2008, pp. 90-93). Notice, too, that the discussion in note 40 suggests an interesting alternative proposal: that the commitments of developing countries be treated as liability rules while those of developed countries be treated as property rules.

4.2. Costly renegotiation

Thus far we have considered two contracting scenarios: one where renegotiation is frictionless (earlier in this section), and one where renegotiation is not feasible at all (in section 3). We now examine a range of intermediate scenarios where renegotiation is feasible but is costly. Our main objective is to understand how renegotiation frictions impact the choice between property rules and liability rules. This question is interesting in its own right, but a further motivation for considering this extension comes from the law-and-economics literature. As mentioned in the Introduction, a central result in this literature is that an increase in renegotiation frictions favors liability rules over property rules (Calabresi and Melamed, 1972, and Kaplow and Shavell, 1996), and indeed this result is very intuitive: property rules are rigid in nature, so they work well only if renegotiation is easy.[42] In our setting, as we show next, this result is reversed, and the reason lies in the fact that utility is nontransferable in our model, whereas the above-mentioned law-and-economics models assume transferable utility.

We consider a simple extension of our basic model, wherein governments must pay a fixed (deadweight) cost K if they want to renegotiate the contract. Let α (resp. $(1-\alpha)$) be the share of this cost borne by Home (resp. Foreign). This is a cost that is incurred only if the renegotiation is successful, so it reduces the available surplus but does not affect the disagreement utilities.[43]

To gain intuition, let us first compare the two extreme scenarios: the case of costless renegotiation ($K = 0$) and the case where renegotiation is not feasible ($K = \infty$). Proposition 3 implies that removing the possibility of renegotiation favors property rules over liability rules. This is because an optimal property rule is never renegotiated, while as we have established above, when renegotiation occurs it increases joint surplus; hence, removing the possibility of renegotiation can only increase the attractiveness of a property rule relative to a liability rule.

The above reasoning suggests that increasing K should favor property rules. However this reasoning is incomplete, because a change in K affects b^e when renegotiation occurs, and this indirect effect can in principle offset the direct intuitive effect. But as we now show, even if this indirect effect works in the "wrong" direction, it can never outweigh the direct effect.

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[42]In fact, it is this result, applied to the GATT/WTO context, that leads Pauwelyn (2008, p. 66) to the following statement: "On balance, one can therefore expect that Calabresi and Melamed's third reason for liability rules (high transaction costs) can find particular application in the international context."

[43]If the cost of renegotiation were a sunk cost, rather than a fixed cost, it could potentially introduce a hold-up issue in the process of renegotiation, since incurring this cost would be akin to an ex-ante investment from the point of view of an individual government. We abstract from this aspect here.

We start by deriving the regions in (b^D, γ) space where the contract is renegotiated, for a given renegotiation cost K. Focus first on the region where $\gamma < S(b^D)$, so that the importer's threat point is FT. For the contract to be renegotiated, there must exist a b^e such that (i) the importer is better off, which requires $\gamma > S(b^e) + \alpha K$, and (ii) the exporter is better off, which requires $b^e > \gamma^* + (1-\alpha)K$. Clearly, this is the case if and only if $\gamma > S(\gamma^* + (1-\alpha)K) + \alpha K > S(\gamma^*)$. It follows that the P_R region is as depicted in Figure 3. Intuitively, as K increases, the horizontal line $\gamma = S(\gamma^* + (1-\alpha)K) + \alpha K$ shifts up, thus the P_R region shrinks.

Next focus on the region where $\gamma > S(b^D)$, so that the importer's threat point is P. For the contract to be renegotiated, there must exist a b^e such that (i) the importer is better off, which requires $\gamma < S(b^D) - S(b^e) - \alpha K$, and (ii) the exporter is better off, which requires $b^e > b^D - \gamma^* - (1-\alpha)K$. This is the case if and only if $\gamma < S(b^D) - S(b^D - \gamma^* + (1-\alpha)K) - \alpha K \equiv R(b^D; K)$. The FT_R region is also depicted in Figure 3. Note that as K increases the curve $R(b^D; K)$ shifts down, thus the FT_R region shrinks.

Having derived the renegotiation regions in the presence of the renegotiation cost, the next step is to assess how an increase in K affects the relative performance of property versus liability rules. The key steps of the argument, spelled out in the Appendix, are two. First we show that, as in the case of costless renegotiation, an optimal property rule is never renegotiated. And second, we then argue that a small increase in K has two first-order effects on the performance of a liability rule: a direct (weakly) negative effect, since it reduces the renegotiation surplus; and an indirect effect through b^e, which can be positive or negative, but even if positive, can never outweigh the negative direct effect.

The following proposition (proved in the Appendix) states the result:

Proposition 5. *As the cost of renegotiation K increases, the optimum may switch from a liability rule to a property rule, but not vice-versa.*

Proposition 5 highlights the impact of renegotiation costs, which is a distinct type of transaction cost from the one that we have focused on more directly – the cost of transfers. It is interesting to observe that, if utility were transferable, renegotiation costs would have the *opposite* effect, that is, they would favor liability rules.[44] This suggests that these different

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[44]To see this, suppose that transfers are costless (i.e., $c(b) \equiv 0$). In this case, with frictionless renegotiation, liability rules are equivalent to property rules, because both achieve the first best; while if renegotiation is costly, the unique optimum is a liability rule with $b^D = \gamma^*$ (i.e. the exporter must be made "whole"). Hence, if transfers are costless, renegotiation costs favor liability rules, in contrast with the case of costly transfers.

forms of transaction costs *interact* in nontrivial ways, and it points to the importance of taking transfer costs into account when evaluating the effects of bargaining frictions. Moreover, this observation explains why our result is at odds with the conclusion of the law-and-economics literature mentioned above, that renegotiation frictions tend to favor liability rules over property rules. Relative to that literature, our novel finding arises because of our focus on a world with costly transfers, which as we have indicated are an important feature of the international government-to-government contracting environment.[45]

Finally, notice that Propositions 3 and 5 taken together suggest a kind of complementarity between liability rules and renegotiation when transfers are costly. In this environment, lowering the cost of renegotiation makes liability rules more attractive, and the adoption of liability rules makes renegotiation more likely in equilibrium.

5. Extensions and Conclusion

We conclude with a brief discussion of some issues from which our model has abstracted, a description of several extensions, and some suggested directions for future research.

We have considered a simple class of contracts that give the importing country a choice between (i) setting FT and (ii) setting P and paying damages b^D. We now ask whether it might be desirable to introduce a "carrot" $b^{FT} < 0$ attached to the choice of FT. We analyze this question formally in our Online Appendix A, by considering a more general class of option contracts of the type $\{(P, b^D), (FT, b^{FT})\}$, and we summarize our key findings here.[46]

We find that a pure liability rule can always be improved upon by a liability-cum-carrot rule. To gain some intuition, focus on the case in which γ has full support. Under a pure liability rule, there will be some γ's where the importer would be willing to select FT for a small transfer from the exporter, but the importer can extract a sizable transfer b^e from the exporter in order

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[45] It is true that the type of renegotiation friction that we consider here differs from that typically considered by the law-and-economics literature (namely, the presence of private information). Nevertheless, as we have observed above and shown in note 44, the reason for the reversal of the results has to do with non-transferable utility, not the exact nature of the bargaining friction.

[46] In this extended setting we continue to define a property rule as a contract that simply assigns property rights without specifying any ex-post transfers, that is either a strict-FT contract or a fully discretionary contract. Note that in terms of the contract class $\{(P, b^D), (FT, b^{FT})\}$, a strict-FT property rule is outcome-equivalent to setting $b^D = b^{prohib}$ and $b^{FT} = 0$, while a discretionary property rule is outcome-equivalent to setting $b^D = 0$ and $b^{FT} \geq \bar{b}^{FT}$, where $\bar{b}^{FT}$ is the (negative) threshold level above which Home would choose P for all γ in its support. Furthermore, we refer to a contract specifying $b^D \in (0, b^{prohib})$ and $b^{FT} = 0$ as a "pure liability" rule, and to a contract specifying $b^D \in (0, b^{prohib})$ and $b^{FT} < 0$ as a "liability-cum-carrot" rule.

to be induced away from the threat point (P, b^D) to a policy of FT. Introducing a small carrot $b^{FT} < 0$ flips the importer's threat point for these γ's from (P, b^D) to (FT, b^{FT}) and thereby undercuts the ability of the importer to hold out for a bigger transfer, ensuring that for these γ's the importer will select FT and be paid the contractually specified b^{FT}. And from the point of view of ex-ante efficiency, the elimination of large transfers (b^e) for some γ's is clearly worth the addition of a small transfer (b^{FT}) for some other γ's, since a small transfer has only a second-order cost. Thus, a small carrot for FT can be a useful complement to a liability rule (and paradoxically, offering a reward to the importer for FT hurts the importer, by taking away from him the credible threat of choosing P). This, then, raises a second question: Can a property rule still be optimal when a carrot is available for use with a liability rule? Here we find that the answer is "Yes." In particular, a property rule is optimal if uncertainty is sufficiently small, while a liability-cum-carrot is optimal if uncertainty is large; and while it may be optimal to include a carrot b^{FT} in the contract, its inclusion (it can be shown) does not alter in a substantive way our results from the previous sections.[47]

To preserve tractability and focus on the main points, we have limited our attention to dichotomous policies (FT or P). In our Online Appendix B we extend the analysis to allow for three policy levels: FT, "low" protection (P_1) or "high" protection (P_2). Maintaining our definition of a property-rule contract as a contract that specifies the allowable levels of protection without providing a buy-out option (that is, each level of protection FT, P_1 or P_2 is either allowed with no compensation owed or not allowed at all), we argue that within the class of property-rule contracts there is no loss of generality in focusing on three contracts: a strict FT obligation specifying that only FT is allowed, a "protection cap" contract specifying that only FT and P_1 are allowed, and a fully discretionary contract specifying that any level of protection (FT, P_1 or P_2) is allowed. And under some conditions that keep the analysis tractable in this extended setting (in particular, a linear cost of transfers and sufficient concavity of the benefits of protection to Home) we are able to show that our central Propositions 1 and 2 go through.

Based on our extension to three policy levels, we believe that our main results will hold under reasonable conditions for any number of discrete policy levels, and therefore should apply as long as the policy in question is discrete in nature, a condition that we have noted is often met by real-world trade policies. Still, providing a formal confirmation of this broader claim

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[47]Specifically, in addition to the extension of Proposition 2 that we describe in the text, Proposition 1 extends with modification only in the critical levels of b^D and γ, while Propositions 3-5 extend without modification.

remains an important task. And extending our results to the case of continuous policies is an important task as well. Here the result of Amador and Bagwell (2013) seems relevant. They show that with a continuous policy – but absent transfers and absent renegotiation – a tariff cap is optimal. An interesting question is then the following: If costly transfers are available and renegotiation is allowed, under what conditions would a simple tariff cap be optimal, versus a contract that provides for buy-out options (i.e., a liability rule)? We see providing an answer to this question as a promising direction for future research.

We have assumed that governments design trade agreements to maximize their ex-ante joint surplus, which when countries are asymmetric requires the availability of efficient ex-ante transfers. And as we have observed, there are good reasons to think that more efficient forms of compensation can be found within the context of a GATT/WTO multilateral round than in the context of ex-post renegotiation. But an important question is whether our main results require costless ex-ante transfers, or rather require only that the cost of transfers ex ante is weakly lower than the cost of transfers ex post. In fact, we can show that our main results will hold as long as this latter condition is met.

The key to understanding this claim is to note that our central Figure 1 is unaffected by the cost of ex-ante transfers; thus, for a *given* contract, equilibrium outcomes (the policy outcome, whether or not there is renegotiation, and if there is renegotiation the negotiated transfer level) are unaffected by the cost of ex-ante transfers. Next note that, as long as the cost of ex-ante transfers is weakly lower than the cost of ex-post transfers, it remains true that setting $b^D > \gamma^*$ is weakly dominated. To see this, suppose for a moment that transfer costs are linear (i.e., $c(b) \equiv c \cdot |b|$ – we will argue that convex costs can only work in our favor) and that ex-ante and ex-post transfer costs are equal (also the worst case scenario for this claim); this ensures that the total expected cost of transfers is proportional to the sum of the ex-ante transfer and the expected ex-post transfer. Then as in our proof of Proposition 1, moving from $b^D > \gamma^*$ to $b^D = \gamma^*$ has no effect on the equilibrium policy and reduces the expected ex-post transfer; this implies a redistribution of ex-ante payoffs, but this can be offset with at most an equal increase in the ex-ante transfer,[48] so that the overall expected cost of transfers does not increase and a (weak) ex-ante Pareto improvement is achieved; hence, $b^D = \gamma^*$ weakly dominates $b^D > \gamma^*$. And when transfer costs are strictly convex and/or the cost of ex-ante transfers is strictly less

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[48]We say "at most an equal increase" because if the initial ex-ante transfer is negative then the ex-ante transfer will rise by strictly less than the fall in the expected ex-post transfer.

than the cost of ex post transfers, this domination can only become strict. Furthermore, it remains true in this extended setting that if the support of γ is sufficiently small (large), a property (liability) rule is optimal,[49] thus Proposition 2 extends as well.[50]

Finally, we have focused on a two-country model. We believe that this is a natural first step to understand the implications of renegotiation for trade agreements, and that such a setting captures some of the fundamental forces governing the tradeoff between property rules and liability rules. Nevertheless, it is important to assess the robustness of our results to a multi-country setting. To make some progress in this direction, we have analyzed a three-country version of our model, where country H can import a good from two exporting countries, say F1 and F2. The presence of competing exporters can in principle affect results, especially if trade barriers are constrained to be non-discriminatory (i.e. satisfy the most-favored-nation or "MFN" restriction) because in this case, when renegotiating the agreement, the importer must secure the consensus of both exporters in order to change its trade policy, so renegotiation is intrinsically a multilateral bargaining process. However, we find that our qualitative results extend to this setting with little modification. More specifically, we assume that the importer can choose a single trade policy (P or FT) for both exporters.[51] Exporters can suffer different levels of harm from protection and can have different bargaining powers. We also assume that the deadweight cost of transfers takes the form $C = c(b_1) + c(b_2)$, where b_i is the transfer from the importer to exporter i. In this setting, a contract specifies a level of damages for each exporter, (b_1^D, b_2^D). The contract is defined as a property rule if (b_1^D, b_2^D) is prohibitive or if $b_1^D = b_2^D = 0$, and as a liability rule otherwise.

In the three-country setting just described, we can show that our results continue to hold, provided some regularity conditions are satisfied.[52] The only interesting difference that arises

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[49]The argument to confirm this point is slightly more involved, but is also straightforward. In particular, for the large-support case the argument proceeds analogously to our preceding discussion in the text. For the small-support case, it is in principle possible that a liability rule may remain undominated by either of the property rules $b^D = 0$ or $b^D \geq \bar{b}^{prohib}$ no matter how small the support becomes, because the policy state-contingency associated with the liability rule can work as a randomization device that facilitates the distribution of surplus across Home and Foreign in the presence of ex-ante transfer costs; but the small-support result of (ii) is guaranteed to hold if a property rule that randomizes over $b^D = 0$ and $b^D \geq \bar{b}^{prohib}$ is allowed. Hence, Proposition 2 generalizes when the possibility of randomized property rules is included.

[50]And with Propositions 1 and 2 established, it is straightforward to show that Proposition 3 also holds.

[51]In this way we are imposing the MFN restriction exogenously. In principle this restriction should be derived endogenously as an optimal rule, and in a complete analysis of the multi-country setting this would be an important objective; but explaining the MFN rule is not the focus of our model, so the interpretation of the exercise we undertake here is that we are optimizing the agreement rules *conditional on* the MFN restriction.

[52]In particular, we can prove Propositions 1-5 if the function $c(b)$ is not too asymmetric around $b = 0$.

compared with our basic model is that, when the contract is renegotiated (toward free trade), it may happen that one of the exporters compensates the importer ($b_i^e < 0$) while the other is compensated by the importer ($b_j^e > 0$). But at least under the regularity conditions mentioned in note 52, this does not affect our results.

One may argue that in a multilateral setting, renegotiation frictions (which in our model are captured by the parameter K) are likely to be quite different than in a bilateral setting. But note that this does not affect our qualitative results, because for these results the number of countries is held fixed (two in our basic model, three in the multilateral extension) and the impact of changes in other parameters is examined, for example the degree of uncertainty. Having said this, there is a separate and interesting question that arises in a multi-country setting: How does an expansion of the agreement membership affect the tradeoff between property and liability rules? Some scholars have argued that, if trade policies are constrained to be nondiscriminatory, renegotiation frictions are likely to become more severe as the number of member countries expands, because in case of renegotiation each individual exporter may attempt to hold up the bargain in order to extract rents. This consideration, together with the standard result from the law-and-economics literature that higher renegotiation frictions tend to favor a liability-rule approach, leads these scholars to conclude that the expansion of WTO membership should make a liability-rule approach more attractive (see Schwartz and Sykes, 2002, and Pauwelyn, 2008, pp. 56-59). In our model, renegotiation frictions (K) are a black box, so the model is not designed to investigate how these frictions may vary with the number of countries involved; but if one accepts the premise that renegotiation frictions increase with the number of member countries, our model then leads to the opposite conclusion: as we have emphasized, in the presence of costly transfers it is property rules rather than liability rules that are more likely to be optimal when renegotiation frictions are higher. This in turn suggests an intriguing possibility: though for a different reason than the bargaining power asymmetries suggested by our Proposition 4, the expansion of the GATT/WTO membership may have been a contributing factor in causing the shift from a liability- to a property-rule approach, which according to many legal scholars has taken place over time. We leave a more formal and complete exploration of this and other extensions to future work.

Alternatively, we can prove these results for a general $c(b)$ if the exporting countries are not too asymmetric.

6. Appendix

Proof of Proposition 5: Let $\hat{b}^D$ denote the level of b^D for which the $S(b^D)$ curve intersects the $R(b^D; K)$ curve, and $\tilde{b}^D$ the level of b^D for which the $S(b^D)$ curve intersects the horizontal line $\gamma = S(\gamma^* + (1 - \alpha)K) + \alpha K$, as in Figure 4.

The first step is to establish that, as in the case of costless renegotiation, under an optimal contract there can never be renegotiation from FT to P. With reference to Figure 4, this can be easily established by arguing that it is never optimal to set $b^D > \tilde{b}^D$.

The second step is to argue that, for any K, if a property rule is optimal it is never renegotiated. This step implies that, conditional on a property rule being optimal, a change in K does not affect the performance of that property rule. Consider first the discretionary property rule $b^D = 0$: if the contract is renegotiated for some γ, then an analogous argument as in the case of costless renegotiation establishes that joint surplus can be increased by raising b^D slightly above zero. Consider next a prohibitive property rule $b^D \geq b^{prohib}$: by definition this implies that the importer's threat point is FT for all γ in the support; and we know from the argument just above that under an optimal contract there can never be renegotiation from FT to P.

The third step is to argue that an increase in K weakly worsens the performance of a liability rule. We need to distinguish between two cases: at the initial level of K the contract may or may not be renegotiated for some γ, depending on whether b^D is higher or lower than $\hat{b}^D$. If $\hat{b}^D < b^D < b^{prohib}$, a marginal increase in K will have no effect. If $0 < b^D < \hat{b}^D$, a marginal increase in K will lower the expected joint payoff, as we now show.

Let us fix a value of b^D in $(0, \hat{b}^D)$, and consider the effect of a marginal increase in K. We can write the expected joint payoff as

$$E\Omega = V(FT) + \int_{R(b^D;K)}^{\infty} [\gamma - \gamma^* - c(b^D)]dH(\gamma) - \int_{S(b^D)}^{R(b^D;K)} [c(b^e(b^D, \gamma; K)) - K]dH(\gamma)$$

where the notation $b^e(b^D, \gamma; K)$ highlights the dependence of the renegotiated transfer b^e on K.

It is clear from the expression above that a marginal increase in K has three effects. First, it decreases $R(\cdot)$, the level of γ for which governments are indifferent between renegotiating and not; however this is a second-order effect, because (a) the probability distribution is atomless, and (b) as in the costless-renegotiation case, (it can easily be shown that) Ω is continuous at $\gamma = R(\cdot)$. Second, for γ in the renegotiation interval $(S(\cdot), R(\cdot))$, it has a direct negative effect,

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since it is a deadweight cost. And third, for $\gamma \in (S(\cdot), R(\cdot))$, it has an indirect effect through b^e
We now argue that this indirect effect may be positive or negative, but it can never outweigh
the direct negative effect.

Recall that, when b^D and γ are in the relevant renegotiation region (FT_R), the joint payoff
in this region is $\gamma^* - \gamma - c(b^e) - K$. We will show that any indirect effect of the increase in
K through b^e cannot outweigh its direct negative effect. Note that this indirect effect may be
positive or negative, and it is more likely to be positive when α is low, so that the exporting
country bears a large share of the cost. To see this intuitively, recall first that in the FT_R
region the exporting government makes a transfer to the importing government $(b^e < 0)$. If the
exporter bears most of the renegotiation cost, the transfer b^e will need to go down (in absolute
value), in order to satisfy the exporter's individual-rationality constraint, and this is beneficial
to joint surplus because it reduces the deadweight loss. However we now argue that even if the
indirect effect is positive, it cannot outweigh the direct negative effect.

Focusing on the FT_R region, Home's surplus over its disagreement utility is $S(b^D) - S(b) - \gamma - \alpha K$, and Foreign's surplus is $\gamma^* + b - b^D - (1 - \alpha)K$. The renegotiated transfer b^e is the
value of b that maximizes the Nash product

$$NB(b, b^D) = [S(b^D) - S(b) - \gamma - \alpha K]^\sigma \cdot [\gamma^* + b - b^D - (1 - \alpha)K]^{1-\sigma}$$

Recalling that $c'(b) > -1$ for all b by assumption, it suffices to show that $\frac{\partial b^e}{\partial K} < 1$.

It is convenient to work with the logarithm of NB, which is legitimate provided that σ is
strictly between zero and one, so that each government gets a strictly positive surplus $(S(b^D) - S(b) - \gamma - \alpha K > 0$ and $\gamma^* + b - b^D - (1 - \alpha)K > 0)$. The extension of the proof to the extreme
cases $\sigma = 0$ and $\sigma = 1$ is straightforward.

By the implicit function theorem, $\frac{\partial b^e}{\partial K} = -\frac{\partial^2 \ln NB/\partial b\partial K}{\partial^2 \ln NB/\partial b^2}|_{b=b^e}$. We will show that $\frac{\partial^2 \ln NB}{\partial b\partial K} < -\frac{\partial^2 \ln NB}{\partial b^2}$ for all b.

Differentiating $\ln NB$, we obtain

$$\frac{\partial \ln NB}{\partial b} = -\frac{\sigma S'(b)}{S(b^D) - S(b) - \gamma - \alpha K} + \frac{1 - \sigma}{\gamma^* + b - b^D - (1 - \alpha)K}$$

$$\frac{\partial^2 \ln NB}{\partial b\partial K} = -\frac{\alpha\sigma S'(b)}{[S(b^D) - S(b) - \gamma - \alpha K]^2} + \frac{(1 - \alpha)(1 - \sigma)}{[\gamma^* + b - b^D - (1 - \alpha)K]^2}$$

$$\frac{\partial^2 \ln NB}{\partial b^2} = -\frac{\sigma S''(b)}{S(b^D) - S(b) - \gamma - \alpha K} - \frac{\sigma S'(b)^2}{[S(b^D) - S(b) - \gamma - \alpha K]^2} - \frac{1 - \sigma}{[\gamma^* + b - b^D - (1 - \alpha)K]^2}$$

Notice that $\frac{\partial^2 \ln NB}{\partial b^2} < 0$, ensuring that the SOC is satisfied. Next note that if α is sufficiently

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close to zero $\frac{\partial^2 \ln NB}{\partial b \partial K}$ is positive, and hence $\frac{\partial b^e}{\partial K} > 0$, consistently with the intuitive discussion above.

Recalling that $S'(b) > 0$, it follows that

$$\frac{\partial^2 \ln NB}{\partial b \partial K} < \frac{1 - \sigma}{[\gamma^* + b - b^D - (1 - \alpha)K]^2}.$$

Moreover, recalling that $S''(b) > 0$ and noting that the importer's surplus from the renegotiation $S(b^D) - S(b) - \gamma - \alpha K$ is nonnegative, we obtain

$$-\frac{\partial^2 \ln NB}{\partial b^2} > \frac{1 - \sigma}{[\gamma^* + b - b^D - (1 - \alpha)K]^2}$$

which implies $\frac{\partial^2 \ln NB}{\partial b \partial K} < -\frac{\partial^2 \ln NB}{\partial b^2}$ for all b, and hence $\frac{\partial b^e}{\partial K} < 1$, as claimed.

We have established that an increase in K weakly worsens the performance of a liability rule, and does not affect the performance of an optimal property rule. The claim of Proposition 5 can then be proved as follows. Suppose that at the initial level of K the optimum is a property rule; then an increase in K will make a liability rule (weakly) less attractive than the optimal property rule, hence the optimum will still be a property rule. It remains to argue that, if at the initial level of K the optimum is a liability rule, an increase in K *may* cause a switch to a property rule. This can be established by example. Consider changing K from a prohibitive level (such that renegotiation never occurs) to zero, and focus on a case where uncertainty is large but without renegotiation a discretionary property rule is optimal, along the lines described in section 3. In this case, a liability rule must become optimal as K is dropped to zero, as indicated by Proposition 2. **QED**

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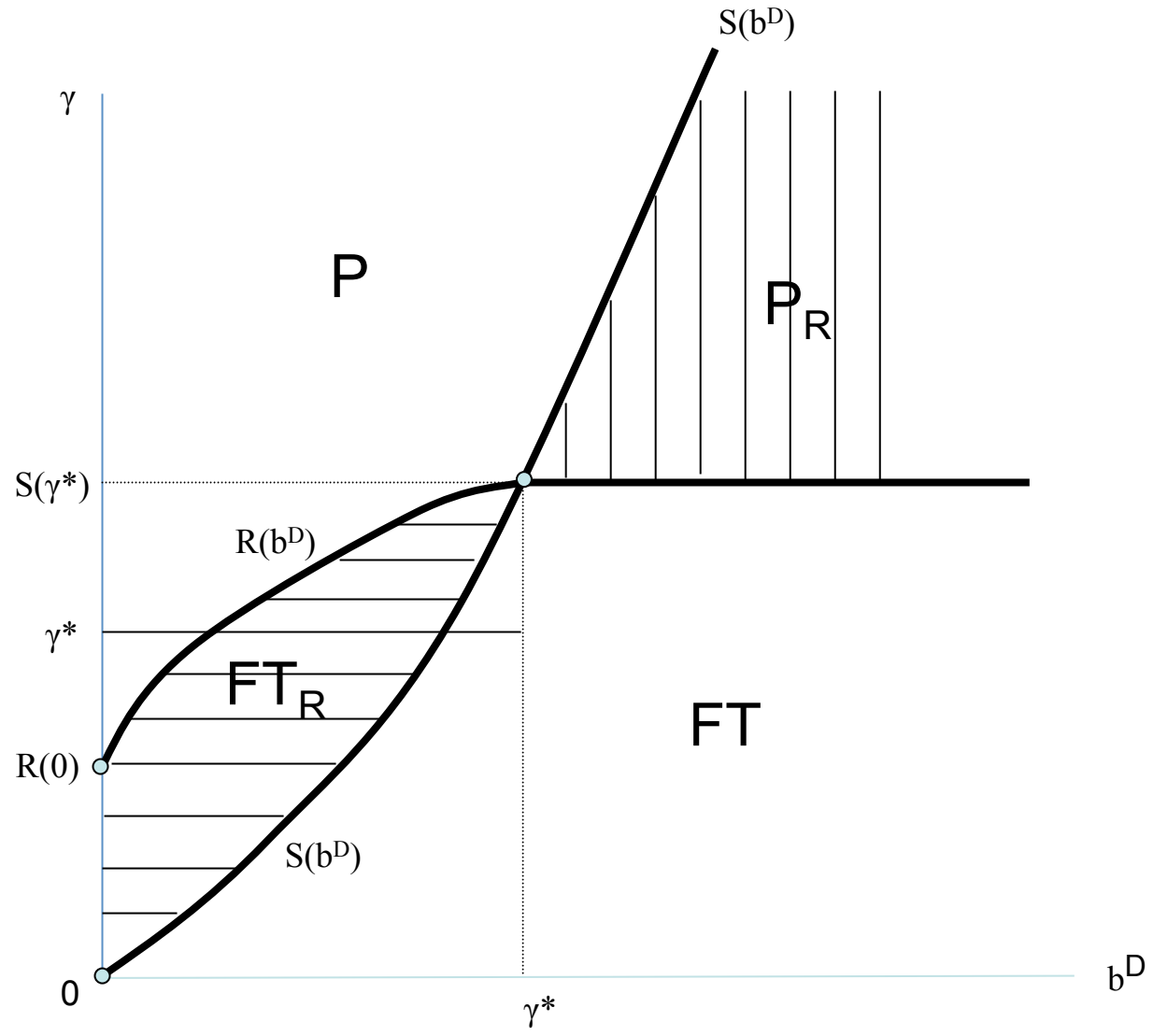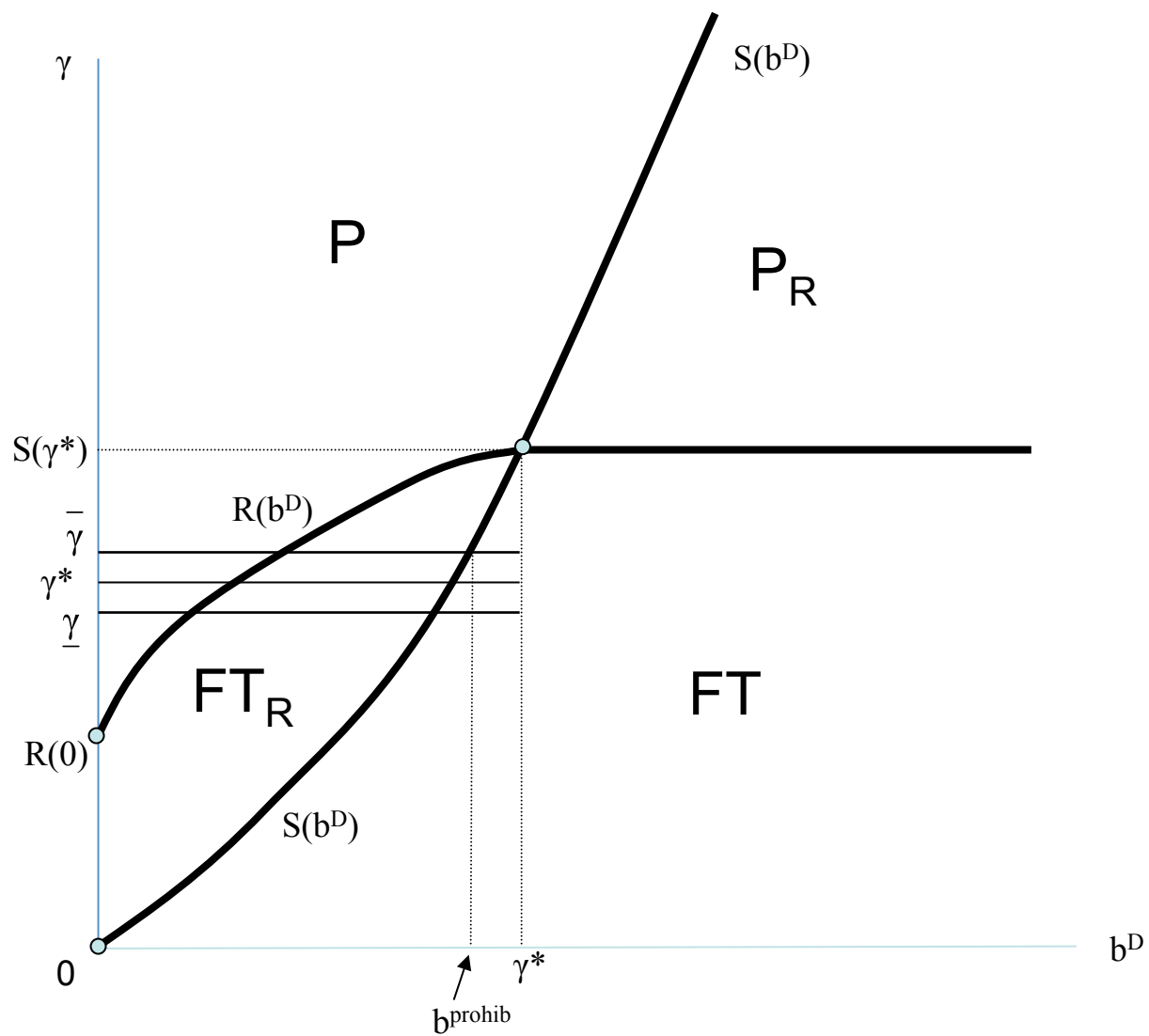
Figure 1

Figure 2

Figure 3