The Role of Dispute Settlement Procedures in International Trade Agreements: Online Appendix

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1. Vagueness and interpretation in a richer model of language

In the printed version of our paper we work with a rudimentary model of language in order to capture in the simplest way the notion of vagueness as a form of contractual incompleteness. In this on-line Appendix we extend the basic model to consider a richer model of language. We explore the nature of optimal vague contracts in this richer environment, and we also describe how the results of our basic model can be reinterpreted within this more general setting. For simplicity, we develop the details of our richer model of language within the static setting described in section 2 of the printed version of the paper, and we adopt the same notation as employed there.

We begin by developing further the structure of the σ^P and σ^{FT} sets. Treating the desirability of free trade as the "default," we suppose that free trade is jointly desirable unless any of a number of specific contingencies arises, in which case protection is then jointly desirable. Each of these contingencies j is a set of states that we denote σ_j^P (i.e., contingency j arises if $s \in \sigma_j^P$) representing a sufficient condition for P to be desirable. These contingencies need not be mutually exclusive (they can occur at the same time).

To make our points it is sufficient to consider the case in which there are just two such contingencies, $j = 1, 2$. Formally, we assume that $\Gamma(s)$ is positive if $s \in \sigma_1^P \cup \sigma_2^P$ and negative otherwise. By definition, $\sigma^P = \sigma_1^P \cup \sigma_2^P$ and $\sigma^{FT} = \Sigma \backslash \sigma^P$.

Contingency σ_1^P (resp. σ_2^P) can be described at no cost (albeit vaguely) by the elementary vague sentence ν_1 (resp. ν_2). We let $\mathbf{T}_{\nu_j}$ and $\mathbf{F}_{\nu_j}$ denote respectively the true and false sets for sentence ν_j ($j = 1, 2$). We assume that $\mathbf{T}_{\nu_j} \subset \sigma_j^P$ and $\mathbf{F}_{\nu_j} \subset \Sigma \backslash \sigma_j^P$ ($j = 1, 2$). In words, if the vague sentence ν_j is clearly true then contingency σ_j^P is "on," and if ν_j is clearly false then contingency σ_j^P is "off." Thus, $\mathbf{T}_{\nu_1} \cup \mathbf{T}_{\nu_2} \subset \sigma^P$ and $\mathbf{F}_{\nu_1} \cap \mathbf{F}_{\nu_2} \subset \sigma^{FT}$: if either (or both) of the vague sentences ν_j is clearly true then P is desirable, and if both vague sentences ν_j are clearly false, then FT is desirable.

A simple example will help clarify our extended setting. In analogy with our basic model, contingency σ_1^P could be defined in terms of the underlying state variables as "there is a surge in imports, and there is a decrease in output of the domestic industry, and there are massive layoffs...", and ν_1 might sound like "there is substantial injury to the domestic industry due to increased imports." On the other hand, contingency σ_2^P could be defined in terms of the underlying state variables as "the imported product contains mineral x, and mineral x is a known carcinogen if inhaled, and mineral x is inhaled with standard use of the imported product; or the imported product contains chemical y, and chemical y is known to cause birth defects with exposure in the first trimester of pregnancy ..."; and the corresponding elementary vague sentence ν_2 might sound like "there is a health risk from imports."[1]

When writing a contract, the two elementary vague sentences can be combined and/or negated, as for example in "ν_1 or ν_2" or in "$\neg\nu_1$ and ν_2." The truth function of a composite sentence can be derived from the truth functions of the elementary sentences in a straightforward manner. We will use the notation $\mathcal{V}$ to indicate a composite sentence, and the notation $\mathbf{T}_{\mathcal{V}}$ and $\mathbf{F}_{\mathcal{V}}$ to indicate the set of states where $\mathcal{V}$ is clearly true and clearly false, respectively.

We continue to focus on vague contracts that specify necessary and sufficient conditions for P, but now we allow these conditions to be expressed in a composite sentence $\mathcal{V}$, as in "P allowed iff $\mathcal{V}$." And as in our basic model, in addition to these vague contracts we allow for the rigid contract "P never allowed" (R) and for the silent contract (D).

Aside from the new features we have described above, all other assumptions of the basic model continue to apply.

We focus on three potential DSB roles: enforcement only (n), interpretation (i) and gap-filling (g).[2] Notice that our richer model of language introduces a non-trivial role for the lower level of interpretation defined earlier (logical analysis of the text – see section 2 of the printed version of the paper).[3] But as it is obvious that this lower level of interpretation is always desirable (indeed, it is hard to conceive of a court that would not engage in textual analysis

[1] To clarify the structure we have imposed on the problem, notice that we express σ^P in terms of the contingencies σ_1^P and σ_2^P which define sufficient conditions for P to be desirable, while σ^{FT} is expressed as the complement of the state space, and we then associate a vague sentence ν_j with each contingency σ_j^P. Implicitly, then, we are assuming that the existing language is best equipped to express sufficient conditions for P rather than for FT. If the desirability of FT is taken to be the default as we have suggested above, and so P is desirable only in a set of relatively narrowly defined circumstances, then this assumption seems justified.

[2] Here we do not consider the modification (m) role for the DSB. In our basic model this role can never be strictly optimal, as we have shown, but in the richer model of language that we consider here there is one possible use of the m mandate that could in principle be optimal: this would entail writing a vague contract and giving the DSB the m mandate but *not* the i mandate. However this mandate can be optimal only under fairly special circumstances. One simple sufficient condition that rules out this mandate is that the expected loss from DSB mistakes in the "grey area" states (where both elementary sentences have undefined meaning) is not higher than in the "crisp" states (where one or both elementary sentences have clear meaning). Notice too that giving the DSB the m mandate *in addition to* the i mandate can never be optimal, as it is outcome-equivalent to a silent contract with the g mandate (and is dominated by the latter which costs nothing to write).

[3] To illustrate the logical analysis of the text that the DSB may have to perform, consider the contract "P is allowed if and only if v_1 or v_2." For the given state s, the DSB's lower level of interpretation would then conclude the following: if $s \in \mathbf{T}_{\nu_1} \cup \mathbf{T}_{\nu_2}$, then the contract dictates a crisp right to P; if $s \in \mathbf{F}_{\nu_1} \cap \mathbf{F}_{\nu_2}$, then the contract dictates a crisp obligation of FT; and for all other states s the contract is vague.

of the contract), we take the lower level of interpretation for granted, incorporate it in the "enforcement" role of the DSB, and keep it in the background. Thus, just as in the basic model, when we speak of "interpretation" we mean the higher level of interpretation defined earlier.

In principle we need to consider many vague contracts, since there are many possible composite sentences $\mathcal{V}$ that can be written, but the number of candidate contracts can be reduced considerably by imposing a relatively mild condition, namely $E(\Gamma|s \in \mathbf{T}_{\nu_j})\Pr(s \in \mathbf{T}_{\nu_j}) \geq E(\Gamma|s \in \mathbf{F}_{\nu_j})\Pr(s \in \mathbf{F}_{\nu_j})$ for $j = 1, 2$. In words, the expected joint gains from P conditional on sentence ν_j being true exceed the expected joint gains from P conditional on ν_j being false (when weighted by the relevant probabilities). Note that $E(\Gamma|s \in \mathbf{T}_{\nu_j}) > 0$ given our assumptions, so this condition is satisfied as long as $E(\Gamma|s \in \mathbf{F}_{\nu_j})$ is not too large and positive. This assumption rules out unintuitive contracts where $\mathcal{V}$ includes negated elementary sentences, such as for example "P allowed iff $\neg\nu_2$."

Under the condition described just above it is not hard to show that, within the class of vague contracts that we are considering, we can focus without loss of generality on just four possibilities: (i) "P allowed iff ν_1 or ν_2;" (ii) "P allowed iff ν_1 and ν_2;" (iii) "P allowed iff ν_1;" and (iv) "P allowed iff ν_2." With a slight abuse of language, we will refer to these four contracts simply as the "$\mathcal{V}$ contracts."

Notice that when the composite sentence $\mathcal{V}$ takes the form "ν_1 or ν_2," we have that $\mathbf{T}_{\mathcal{V}} \subset \sigma^P$ and $\mathbf{F}_{\mathcal{V}} \subset \sigma^{FT}$, and so the vague contract has the same qualitative features that we assumed in the basic model (i.e. if $\mathcal{V}$ is clearly true then P is desirable, and if $\mathcal{V}$ is clearly false then FT is desirable). Our richer model of language can therefore be viewed as a generalization of the basic model, with the new possibilities allowed by the richer language given simply by the remaining three ways in which the two elementary sentences may be used to construct $\mathcal{V}$ contracts, namely, "ν_1 and ν_2," just "ν_1" or just "ν_2." As we next argue, for a certain parameter region the optimal vague contract indeed has the same features as in the basic model, but there is also a parameter region in which the optimal vague contract displays a kind of "rigidity," in the sense that it specifies fewer conditions for P than in the first-best contract and/or imposes FT "wrongly" in some states. In this sense, our richer model suggests that "vagueness begets rigidity."

We now argue that each of the four candidate $\mathcal{V}$ contracts can indeed be optimal, and then discuss further the points raised above. A simple way to see this is to consider a specific comparative-statics exercise. Suppose that $\Gamma(s)$ is increased proportionally for all s in σ^P, without changing $\Gamma(s)$ in σ^{FT}. We let θ denote the scaling factor for $\Gamma(s)$ in σ^P.[4] This thought experiment can be interpreted as increasing the "stakes" of getting the policy right in σ^P relative to σ^{FT}, or in a broad sense increasing the downside risk versus the upside potential from globalization.

The following remark (which is straightforward to establish) focuses on the optimal contract within the $\mathcal{V}$ class (which we refer to simply as "the optimal $\mathcal{V}$ contract"), and highlights how it varies with θ, given the DSB role (note that only n and i are relevant for $\mathcal{V}$ contracts):

Remark 1. *Conditional on the DSB role (n or i), the optimal $\mathcal{V}$ contract is: "P allowed iff ν_1 or ν_2" for θ sufficiently high; "P allowed iff ν_1 and ν_2" for θ sufficiently low; "P allowed iff ν_j" ($j \in \{1, 2\}$) for intermediate values of θ.*

As Remark 1 indicates, the optimal $\mathcal{V}$ contract includes a vague description of each contingency as a sufficient condition for P when θ is high, because then the importance of a right to P in σ^P is paramount, and the optimal $\mathcal{V}$ contract is designed to provide this right in the broadest possible set of states in σ^P while avoiding the imposition of a crisp FT obligation in any state in σ^P. By contrast, the optimal $\mathcal{V}$ contract includes a vague description of both contingencies as *necessary* conditions for protection when θ is low, because it is then more important to achieve FT in σ^{FT}, and so the contract is designed to secure a crisp FT obligation in the broadest possible set of states in σ^{FT}; and while this contract may impose a crisp FT obligation in some states in σ^P, it is not very costly to do so when the stakes in σ^P are low. And finally, the optimal $\mathcal{V}$ contract may include a vague description of just one of the contingencies when θ lies in an intermediate range, because such a contract can be the most effective way of delivering the balance of crisp rights to P in σ^P and crisp FT obligations in σ^{FT} that is most valued when the stakes in σ^P are moderate.

Remark 1 focuses on $\mathcal{V}$ contracts and fixes the DSB role, so it does not by itself ensure that each of the considered contracts is *globally* optimal for some parameter values. But given how little structure we have imposed on $\Gamma(s)$ and $q(s)$, it is not hard to show that for each of the above contracts one can find a parameter costellation $(\Gamma(s), q(s), \theta)$ for which that contract is globally optimal.

[4]Formally, we are supposing that the joint gains from protection are given by $\theta\Gamma(s)$ for $s \in \sigma^P$ and by $\Gamma(s)$ for $s \in \sigma^{FT}$.

Notice that the contract "P allowed iff ν_j" ($j \in \{1, 2\}$) featured in Remark 1 may be optimal even though vague sentences are costless to write. The possibility that it may be optimal to include vague descriptions of only a subset of the relevant contingencies takes on special significance when contrasted with an alternative benchmark scenario in which the sentences ν_1 and ν_2 are perfectly crisp, so that each ν_j describes the corresponding contingency σ_j^P ($j = 1, 2$) in a perfectly crisp way. Then clearly the optimal contract would be "P allowed iff ν_1 or ν_2," i.e. it would include both sufficient conditions for P, in line with the "fundamental" structure of the σ^P set.[5] In this way, Remark 1 suggests that the vagueness of language can lead to contracts that appear "rigid," in the sense that they include a shorter list of conditions than would be optimal if the language were crisp.

The comparison between the contracts featured in Remark 1 and the alternative benchmark scenario where sentences are crisp also suggests a further insight. When the language is vague, the optimal contract may impose a crisp FT obligation in states where FT is undesirable (i.e. in σ^P) – which is the case for both the contracts "P allowed iff ν_j" and "P allowed iff ν_1 and ν_2" – whereas if the sentences ν_1 and ν_2 were perfectly crisp, the optimal contract would be "P allowed iff ν_1 or ν_2" (as we observed above), which never imposes an FT obligation when it is undesirable. Hence, as this comparison indicates, the possibility that a contract may impose obligations that are crisp and "wrong" in some states (and therefore again appear "rigid") can arise solely as a consequence of the vague nature of the language.

It is interesting as well to consider how the degree of vagueness relates to the structure of the contract. In particular, we may ask how the $\mathcal{V}$ contracts highlighted in Remark 1 rank in terms of vagueness. A simple measure of the vagueness of a contract is the probability that the contract will have undefined meaning (which for a $\mathcal{V}$ contract is given by $\Pr(s \notin \mathbf{T}_{\mathcal{V}} \cup \mathbf{F}_{\mathcal{V}})$). Adopting this measure of vagueness, it follows that conditional on $s \in \sigma^{FT}$ the contract "P allowed iff ν_1 or ν_2" is more vague than "P allowed iff ν_j" which is in turn more vague than "P allowed iff ν_1 and ν_2;" but this ranking is exactly reversed for $s \in \sigma^P$. The overall ranking of contracts by their degree of vagueness is therefore in general ambiguous, but this ranking can be gauged in a natural separable and symmetric benchmark.

Suppose that the contingencies under which P is desirable, σ_1^P and σ_2^P, are separable in the sense that σ_1^P depends only on state variables $(s_1, ..., s_{N'})$ and σ_2^P depends only on state variables

[5] Recall that we have assumed $\mathbf{T}_{\nu_j} \subset \sigma_j^P$ and $\mathbf{F}_{\nu_j} \subset \Sigma \backslash \sigma_j^P$. In the limiting case of this model where sentences are crisp, we have $\mathbf{T}_{\nu_j} = \sigma_j^P$ and $\mathbf{F}_{\nu_j} = \Sigma \backslash \sigma_j^P$, in which case it is clear that the optimal contract would be "P allowed iff ν_1 or ν_2."

$(s_{N'+1}, ..., s_{N''})$, where these two vectors are stochastically independent. And suppose further that the vague sentences ν_1 and ν_2 are symmetric in the sense that they are characterized by equal probabilities of being true ($\Pr(s \in \mathbf{T}_{\nu_1}) = \Pr(s \in \mathbf{T}_{\nu_2}) \equiv p^T$) and equal probabilities of being false ($\Pr(s \in \mathbf{F}_{\nu_1}) = \Pr(s \in \mathbf{F}_{\nu_2}) \equiv p^F$). In this case, it can be shown that the contract "P allowed iff ν_1 or ν_2" is more vague than "P allowed iff ν_j," which is in turn more vague than "P allowed iff ν_1 and ν_2," provided $p^F > p^T$. This latter condition seems plausible, given our interpretation that FT is the default optimal policy. Combining this result with Remark 1, we can also conclude that, in the separable and symmetric benchmark with $p^F > p^T$, the degree of vagueness of the optimal $\mathcal{V}$ contract tends to be higher when the policy stakes in σ^P are higher, reflecting the fact that in this case a high likelihood of vagueness is a "small price to pay" for ensuring that FT is not unduly imposed.

Finally, our extended model can suggest a novel reason why a contract might be left *deliberately vague*. To illustrate, suppose that one of the two contingencies, say σ_1^P, can be described in a crisp way at no cost, while the other contingency σ_2^P can only be described in vague terms. In this setting, it may be optimal to leave the contract vague about contingency σ_1^P. To see intuitively why this is possible, compare the contract "P allowed iff ν_1" with the contract "P allowed iff $\mathcal{V}_1$," where $\mathcal{V}_1$ is a composite sentence that describes contingency σ_1^P in a crisp way. The latter contract may be worse than the former, because the false set of $\mathcal{V}_1$ has a larger overlap with σ^P than the false set of ν_1, and hence the latter contract imposes FT "incorrectly" in more states; this adverse effect of increasing the crispness of the contract may outweigh the benefits of doing so. For the same reason, the contract "P allowed iff ν_1 and ν_2" may be better than the contract "P allowed iff $\mathcal{V}_1$ and ν_2": the latter contract unduly imposes FT in a larger number of states. Using this logic, it can be shown that the optimal contract may include the vague sentence ν_1 instead of its crisp version $\mathcal{V}_1$. We record this feature in:

Remark 2. *Suppose that one of the contingencies can be described in a crisp way, while the other cannot. Then it may be optimal to leave both contingencies vague.*

While it is beyond the scope of our paper to provide a systematic exploration into the optimal degree of vagueness in a contract, the result of Remark 2 illustrates a reason why optimal contracts might display a degree of vagueness which seems "excessive" in light of the feasible contracting possibilities.

Finally, it should now be easy to see that all of the propositions from the printed version of our paper extend naturally to this more general setting as well, with the role of the V contract from the basic model played by some $\mathcal{V}$ contract in the extended model.