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How to Negotiate and Update Climate Agreements

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THE HARVARD PROJECT ON INTERNATIONAL CLIMATE AGREEMENTS

The goal of the Harvard Project on International Climate Agreements is to help identify key design elements of a scientifically sound, economically rational, and politically pragmatic post-2012 international policy architecture for global climate change. It draws upon leading thinkers from academia, private industry, government, and non-governmental organizations from around the world to construct a small set of promising policy frameworks and then disseminate and discuss the design elements and frameworks with decision-makers. The Project is co-directed by Robert N. Stavins, Albert Pratt Professor of Business and Government, John F. Kennedy School of Government, Harvard University, and Joseph E. Aldy, Fellow, Resources for the Future. For more information, see the Project's website: <http://belfercenter.ksg.harvard.edu/climate>

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Abstract:

Any climate change agreement ought to be negotiated and updated later on, as we learn more about the costs and benefits of abatements. Anticipating such negotiations, countries may distort domestic decisions (regarding R&D and adaptation, for example) trying to increase their future bargaining power. This can make a situation with an agreement worse than no agreement at all – unless one specifies rules governing the negotiation process. This paper argues that harmonization and the use of formulas, the time span for the agreement, the default outcome if the negotiations should fail, the voting rule and a minimum participation requirement can all be efficiency-enhancing rules. Each rule would be more credible and efficient if the climate agreement is linked to a trade agreement, since that would discourage members from opting out or free-riding if they should be adversely affected by the rules.

Key words:

Bargaining rules, updating, renegotiation, hold-up problems, time horizon, default outcomes, voting rules, minimum participation requirements, harmonization, issue linkages, trade and environment

*How to Negotiate and Update Climate Agreements**

Bård Harstad

Executive Summary

Climate change is a dynamic problem with uncertain consequences. As we learn more about the benefits and costs of abatements over time, any agreement made today is bound to be renegotiated and updated in the future. Anticipating such negotiations, every country may try to influence its future bargaining power to be able to negotiate a more favorable deal. Increasing the bargaining power can be done by (i) investing less than optimally in R&D, (ii) adapting more to climate change than what is socially optimal, (iii) signaling reluctance by delay, or (iv) by delegating bargaining authority to representatives that are less in favor of an agreement. Such strategic behavior makes an efficient agreement less likely. In fact, the situation with an agreement can be worse than a situation without any agreement at all. Thus, it is immensely important to determine in advance the rules governing how the countries should negotiate and update future climate change agreements.

This paper presents and discusses six such rules. First, the negotiations may be more efficient, and less strategic, if harmonization of contribution-levels is required across countries, or if the contribution-shares are pre-determined by some formula that itself is not subject to renegotiation. Second, the time horizon of an agreement should be long to prevent the above-mentioned strategies from being too influential. The more countries that choose to participate, the longer the time horizon should be. Third, the default (the outcome to which one reverts if the negotiations fail) should be the previous agreement or, even better, a very ambitious agreement. This provides an efficient starting point from which one may renegotiate the agreement. The fourth rule is to subsidize trade in abatement technology, in order to encourage R&D. Fifth, the unanimity requirement should be replaced by majority rules (or super-majority rules) when it comes to updating the agreement. Sixth, a minimum participation requirement should specify a lower number of countries that must ratify the

* I have benefitted from participants at the 2008 workshop of the Harvard Project on International Climate Agreements, in particular the detailed comments by Joe Aldy. This paper does not contain original theoretical results, but draws on several papers that are (or will be) published elsewhere.

treaty for it to be binding to anyone. Each rule can be employed even if the other rules are not. In fact, the rules are “strategic substitutes” in the sense that each of them is more important if the other rules are *not* implemented. For example, it is more important to subsidize trade in abatement technology if the time horizon of the agreement is short. The rules can also be modified and used to regulate the entry of new participants.

While each of these rules may help mitigating the hold-up problems described above, they may fail to be credible if countries are tempted to opt out of the agreement. Such exits are less likely to be attractive if the climate change treaty is bundled with a trade agreement, and the threat to exit is then less likely to be credible. Thus, linking trade and environmental agreements complements all the rules above: A linkage facilitates the optimal choices for formula, time horizon, default outcome, voting rule, and minimum participation requirement. In addition, bundling trade and environmental agreements makes it possible to sanction non-compliance in a credible way.

1. Introduction

The outcome of a bargaining game depends on the bargaining rules. Anyone hoping for good environmental agreements should thus pay attention to the rules governing the negotiation process.

There are several rules and norms that govern international negotiations. Some of these are informal, like the norm against threatening an opponent with war unless a trade agreement is signed. Other rules are explicit, like the voting rules in the United Nations (UN): Important decisions require a 2/3 majority, while other decisions require only a simple majority. While some of these rules are constant across a wide number of decisions, other rules are designed particularly for one specific bargaining round. Anticipating the negotiations in Copenhagen 2009, a number of decisions made in Bali, 2007, seek to influence the procedure of the forthcoming negotiations (UNFCCC, 2008). In international politics, it is quite common to make a pre-agreement concerning the bargaining agenda prior to the negotiations themselves.

This paper discusses the following “bargaining rules”: Harmonization requirements and the use of formulas, the time horizon of the agreement, the default outcome (i.e., the outcome if the negotiations should fail), subsidies on trade in abatement technologies, the voting rule and minimum participation requirements. Specifying these rules not only influences which of the feasible agreements is chosen; they crucially affect what is feasible in the first place.

To illustrate this point, suppose that my country is participating in climate negotiations next year. Suppose, further, that I anticipate that the countries owning the best technology are going to bear the lion's share of the burden, by being coerced to use (or share) this technology with the other participants. This may be a likely outcome, since a high-tech country will face the smallest cost of tough abatement requirements, it will not object strongly to demanding obligations, and it will thus have small bargaining power relative to the countries that are more tempted to walk away from the negotiation table. With these expectations, I prefer my country to invest less in technology today since I do not want my country to “pay” more than necessary for an international agreement. If, instead, my country’s contribution would be determined by a pre-specified formula, the other participants would be unable to force my country to pay more than what is actually specified by that formula. Gaining bargaining power is then less useful and my incentives to invest in R&D are going to be undistorted.

As the previous example suggests, bargaining rules are important no matter whether we are negotiating an agreement for the first time or rather updating an existing agreement. The same principles apply, and the lessons derived below hold for both cases.

To simplify the discussion in this paper, I am abstracting from firms and private investors. The private sector is, of course, going to be pivotal for the effectiveness of an agreement, and it is the private sector that for the most part is going to invest in abatement technology. However, each firm is relatively small compared to the size of a country, and the firms may thus not think strategically about how their actions can affect the country's bargaining power. On the other hand, the firms do respond to rules, regulations and incentives provided by the government. This way, the government can influence the firms' choices to a large degree, and the government is, in contrast to the individual firm, concerned with its future bargaining power. For simplicity, therefore, I will often say that the *government* decides the investment levels in abatement technology, even though it may be the private sector that pin them down in practice.

The next section argues that any agreement needs to be renegotiated, or updated, over time. The problem is that without any rules governing this process, the agreement can be worse than no agreement at all! Motivated by this claim, Section 3 discusses the use of formulas to structure negotiations, the optimal time horizon of agreements, the best default outcome, trade subsidies, the voting rule and minimum participation requirements. I also discuss how these rules can be modified to regulate the entry of new participants. Section 4 argues that a link to trade agreements would complement each of these rules, while the final section concludes.

2. Do We Need Rules for Negotiating and Updating Treaties?

2.1 Why Update in the First Place?

Although the literature on international agreements is quite large and growing, Schelling (2007, p. 346) provides a rare assessment of the need for updating when he asked “how a regime should adapt to evolving experience with emerging costs”. In a static environment or in a world where nothing changes over time, there may be no reason to update the agreement. What is wrong, for instance, with an agreement that allows every country to pollute a certain fraction of their 1990 emission-level, every year from today to the distant future?

The answer is: a lot. First, the technology is changing over time. Most likely, it is going to be cheaper to abate in the future than it is today. If so, the optimal abatement level should increase. But the future abatement level cannot be specified already today, since we do not yet know how much better the new technology is going to be. Second, the social cost of climate change is highly uncertain. The Intergovernmental Panel on Climate Change (IPCC, 2007) presents a variety of scenarios for how much the temperature may increase, and each of these are associated with very uncertain social costs. However, we are most likely going to learn the costs gradually over time. In several decades from now, it may turn out that modern agriculture can easily adapt to the new climate, or we may instead realize that important ecosystems are going to collapse unless we reduce emissions drastically. Then, and not before, is the best time to determine future emission levels. Third, individual countries have individual shocks. If a country discovers large coal reserves, or anticipates rapid economic growth, it may no longer be satisfied with the quota-share it is endowed with. Even if a country could purchase more quotas to meet its new demand, it may be tempted to instead exit the entire agreement. To prevent this, the agreement needs to be renegotiated, or updated.

Note that the agreement will need to be updated over time no matter which political instrument that is employed. Suppose, for instance, that abatement technology improves over time. Since the cost of abatement decreases, it becomes optimal, from a social point of view, to further reduce emissions. With a quota system, the total number of quotas should decline from q to q' , say. This change is illustrated in Figure 1. If, instead, emission taxes are used, the optimal tax decreases from t to t' in the same figure. The reason for this is that with a better abatement technology, pollution declines, and the social marginal cost of pollution is likely to decline. Suppose, next, that the

climate problem becomes more severe. Since the social cost of pollution jumps up, it is optimal to reduce pollution. Under a quota system, the total number of permits should decline from q' to q'' . If emission taxes are used, the optimal tax increases from t' to t'' . Thus, the policy needs to be updated no matter whether the technology or the severity of pollution changes, no matter whether emission taxes or quotas are used (and no matter whether these permits are tradable or not).

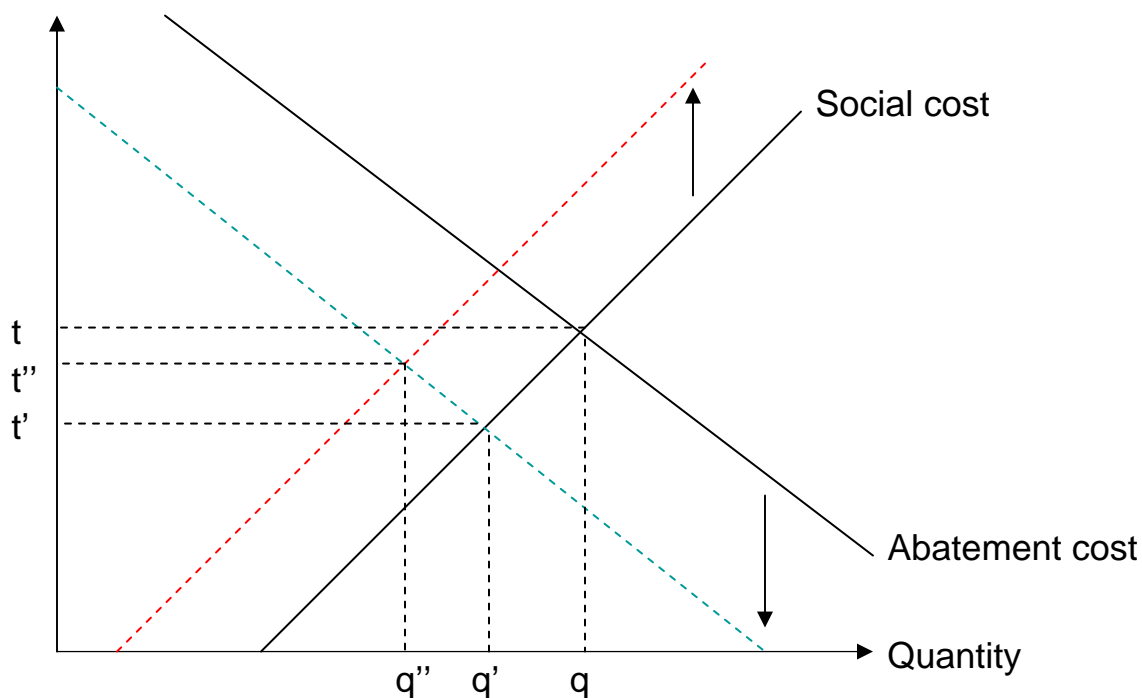


Figure 1: *If the social cost of pollution increases, while the abatement costs decrease, the total number of quotas should decrease (from q to q''), but an emission tax may not change much (only from t to t'').*

Nevertheless, the choice of instrument may be crucial for how often and how much the agreement ought to be updated. It may be reasonable to expect that, over time, the climate problem becomes more severe *and* the abatement technology improves. By combining the suggestions in the previous paragraph, the total number of quotas should be reduced by quite a lot, from q to q'' . If a tax is used, however, it may increase or decrease, depending on which of the two forces is strongest. In Figure 1, the tax should change only slightly, from t to t'' . Thus, a tax system may be in less of a need for updating than a quota system. Non-tradable permits may be in the most need for updating over

time, since the distribution of quotas ought to change whenever various countries develop differently with respect to their capacity to abate.

Not only should agreements be updated over time, but for sure they actually will in practice. Even if a treaty did not allow for updating, sooner or later the agreement would be obsolete and no longer fit the current state of the world. At some point in time, renegotiation will be requested by a sufficiently large number of participants, otherwise they will simply exit.

2.2 Negotiating Without Rules

Suppose that every country expects that at some point in time in the future, the countries are getting together to negotiate. They may then negotiate a new agreement, or they may renegotiate an existing agreement. Suppose, further, that no rules are in place putting a structure on the negotiations. Then, the bargaining outcome is going to be determined by the relative bargaining powers of the countries. But what, in turn, determines the distribution of bargaining power?

In negotiations, bargaining power typically depends on how “keen” a country is on arriving at an agreement. The keener a country is, the more it is willing to “pay” in order to get the agreement finalized. And, the more it is willing to pay, the more the other countries will *require* it to pay, i.e., contribute to the total abatement. Thus, a country has low bargaining power if it has a lot to gain from completing the agreement, or if it has a lot to lose if the negotiations fail. Such countries can expect to bear the lion’s share of the abatement burden. These predictions are in line with standard bargaining theory (going back to Nash, 1950; Rubinstein, 1982), and they explain why Russia, who may in fact benefit from global warming, ended up receiving quotas that exceeded its historical emission levels. Most of Europe, fearing that the Gulf Stream could change, ended up bearing a relatively large share of the burden. The fact that Europe could better afford abatement contributed to the same outcome. For current negotiations, “leaders of countries that want concessions say that nations like Denmark have a built-in advantage because they already depend more heavily on renewable energy” (*Financial Times*, October 17th, 2008, p. A6).

Anticipating such a bargaining outcome, a country may want to keep an eye to how its bargaining power can be affected by domestic policies. Investing in R&D, technologies that could reduce the abatement cost, is obviously beneficial if an agreement is signed and abatement requirements tighten. However, it also makes it tempting for other countries to require that the high-tech country, who has already paid much of the costs associated with abatement, contributes more.

This is possible if the high-tech country agrees to abate more domestically, or if it lends its technology cheaply to the others. This creates a “hold-up problem” that may give a country second thoughts before investing heavily in R&D, particularly if negotiations are around the corner.

In a working paper (Harstad, 2008b) I study a formalized model in which I show that such strategic considerations can be immensely costly relative to the value of environmental agreements. In fact, the costs may outweigh the gain from the agreement itself, making it better to have no agreement at all instead of an agreement that everyone anticipates is going to be negotiated or renegotiated. An agreement that is renegotiated frequently is particularly likely to be worse than no agreement at all, since every country is then inclined to pay more attention to how its policies affect its bargaining power in just a short while. This dismal result certainly does not hold *always*, but it *can* be true. The lesson should thus *not* be that we are better off without an agreement, but it does illustrate that it is important to think hard about the *rules* governing the negotiation process.

Before discussing such rules, notice that the desire to gain bargaining power can generate several other types of distortions as well. If a country has *adapted* well to the new climate, by appropriate investments in agriculture and infrastructure, then no-one can expect it to be willing to pay a lot to curb climate change, and such a country will be able to arrive at a quite good deal, without costly abatement commitments. Hence, to increase its bargaining power ahead of international negotiations, a country may end up investing *too much* in adapting to the new climate. These predictions are, again, in line with standard bargaining theory. A third way of gaining bargaining power exists if one country's valuation or cost of the agreement is only vaguely known to the negotiators representing other countries. Then, the country's representative may want to pretend that its valuation of the agreement is actually low, or that its cost of implementing the agreement is high. Such a preference may be signaled by delaying before making serious offers, or by proposing a less ambitious agreement (Harstad, 2007). If this signal is credible, the other participants understand that they must give in and offer the country a better deal to make sure it agrees. The outcome of such a process may be a less ambitious agreement than what is optimal or, at the worst, no agreement at all. A fourth strategy is to strategically appoint the country's representative that is negotiating and voting on behalf of the citizens (Schelling, 1956). If this representative is well-known for her carelessness about climate change, she may be a tougher negotiator and capable of landing a deal where the country contributes less than it would otherwise. Obviously, when every country acts in this way, the collection of reluctant representatives is not likely to set ambitious collective goals, and the citizens in every country may be worse off.

To summarize: a country can increase its bargaining power by (i) investing relatively little in abatement technology, (ii) undertaking substantial adaptation to climate change, (iii) pretending it is reluctant to the agreement or (iv) appointing a representative that indeed is reluctant to the agreement. These strategies have in common that they are intended to increase a country's bargaining power, and they distort domestic policies at the same time as they make an efficient international agreement less likely. The outcome is potentially worse than if there were no agreement at all. It is therefore immensely important to think hard about rules that could govern the bargaining game and mitigate these strategic effects.

3. Rules for Negotiating and Updating Treaties

This section discusses several rules that each has the potential of mitigating the inefficiencies described above. The rules are independent in the sense that one can be employed without the others. In fact, the rules are "strategic substitutes" in that each rule is more important if the other rules are *not* implemented. For each rule, I also notice that the main drawback is credibility, since the rules can make it tempting for certain countries to opt out if the rule is strictly enforced. This temptation may fade if non-participants face trade sanctions or risk losing its favored trading partner status. Thus, linkages to trade agreements, discussed in Section 4, are complementary to the bargaining rules discussed in this section.

3.1 Harmonization and Formulas

The problem of Section 2.2 arises because each country is able to exploit its bargaining power to get a better deal. This may not be possible, however, if the contributions are bound to be distributed according to a formula, determined in advance. Trade negotiations, for example, typically apply various formulas and a requirement that each country's tariff reduction should be of the same magnitude when the formula is applied. In the Kyoto negotiations, to take an environmental example, the initial goal was that every developed country should reduce its emission by the same fraction relative to its 1990 level. This formula is similar to a requirement that the policies should be "uniform" or "harmonized" across the various countries. If such formulas pin down the contribution-share of my

country, there is no point of strategically distorting domestic policies (such as R&D) in order to gain bargaining power.

Harstad (2007) shows that these arguments continue to hold in a context with asymmetric information. If there is no harmonization requirement, every country tries to signal to the other that it has a low valuation, or a high cost, of participating in the treaty. If this signal is credible, the other participants are likely to give in and offer the country a better deal with less costly obligations. Anticipating this, every country may try to pretend that it is not *that* interested in the agreement, and such reluctance can be signaled by delay or by proposing inefficient agreements. On the other hand, if harmonization of the policies is required, the countries only need to negotiate how ambitious this common policy should be. In that case, it is less rewarding to signal bargaining power, and the negotiations are going to proceed in a much more effective manner than if uniformity were not required.

The disadvantage of requiring harmonization and uniform policies is, of course, that countries are heterogeneous and they do have different needs (Hoel, 1992; Alesina, Angeloni and Etro, 2005). If the heterogeneity is large, the cost of imposing uniformity is likely to dominate the gains associated with a more efficient negotiation process.

However, the benefits of harmonization can be exploited without requiring complete uniform policies. If it is efficient (or fair) that developed countries contribute more than less developed ones, this could be captured by a well-designed formula, stating that developed countries should reduce emission levels by twice as much as developing ones, for example. The formula could also build in automatic responses, e.g. by making it a function of the countries' GDPs, economic growth or their energy productions. Then, the formula could automatically distribute, and re-distribute, the burdens over time in a way that is considered to be efficient or fair. A country's individual burden would still be hard to influence by investing in bargaining power, so domestic decisions are not likely to be much distorted. Such formulas are further discussed by Frankel (2007, 2008).

But are formulas credible? If uniformity is required, or if the formula specifies a certain distribution of the costs, individual countries may threaten to exit (Hoel, 1992). No matter how complicated the formula is, it may be unable to capture a country's sudden need for more quotas. If the other participants insist, in such a situation, that the formula should be applied nevertheless, the country that is affected by the shock may credibly threaten to exit the entire agreement. If, instead, the other participants give in by offering a better deal to the affected country, the formula is not effective and, anticipating this, it is less valuable. This second route was taken in the negotiations towards the

Kyoto commitments where several countries ended up being exempted and the target for industrialized countries varied between -8% and +10% of the 1990 emission levels.

3.2 A Longer Time Horizon

The emission commitments of the Kyoto Protocol expire in 2012, and they thus had a time horizon of only five years. As argued in Section 2.1, it may neither be desirable, nor feasible, that a fixed agreement lasts unchanged forever. How long should an agreement last?

The arguments above pull in opposing directions. On the one hand, Section 2.1 argued that the future is uncertain, with aggregate and country-specific preference shocks that are realized only gradually over time, and that any agreement should thus be updated periodically. This may be easiest to do if an agreement is set to expire, making it natural to negotiate a successor. On the other hand, Section 2.2 argued that frequent renegotiations are distorting the countries' strategic policies, since gaining bargaining power at the negotiation table is then relatively important for each country. The more frequently the agreement is renegotiated, or the shorter the time horizon is, the more domestic policies are distorted. This argument suggests that agreements should be long-lasting, without being renegotiated frequently.

The time horizon of an agreement should trade off these two concerns. For example, if the future is highly uncertain, the first argument dominates and the time horizon should be shorter. If R&D and the development of new technology are perceived to be crucial, the second argument dominates and the optimal time horizon is longer. The optimal time horizon may also depend on other aspects of the situation (this section draws on Harstad, 2008b. See also Frankel, 2007; Guriev and Kvasov, 2005).

The best choice of time horizon is also related to the number of participating countries. If every single country is participating, the optimal time horizon should be long, to make it harder for the participating countries to opt out at the next turning point, and to mitigate the hold-up problem described in Section 2.2. If, instead, only a few countries participate in the agreement, the time horizon should be shorter to facilitate the entry of new participants. If only a few countries are participating, then a participating country may be motivated to invest in R&D by the possibility that, with a new and better technology, the outsiders may find it worthwhile to enter the agreement later on, if this is possible. So, with only a few participants, a short time horizon may increase the investments in R&D.

There is also a reverse causality, in which the time horizon affects the number of participants. Suppose that every potential participant realizes that if only a few countries show up, the agreement is going to be short-lasting, just as suggested and predicted above. This fact makes it less tempting to opt out: With a shorter time horizon, the hold-up problems are large and it will not take long before every country is called upon to participate, once again. By joining the negotiation table immediately, the time horizon may end up being longer, solving the under-investment problem and leading to a more efficient agreement. Thus, making the time horizon an increasing function of the number of participants may facilitate and encourage participation. For this reason, it may be wise to commit to such a rule in advance, making clear to everyone that the reward for participating exists and it materializes as a more efficient agreement.

3.3 What if the Negotiations Fail?

It happens again and again: International negotiations do break down. The effect of a breakdown varies, however. When the Doha-round trade negotiations broke down in July, 2008, the outcome was simply the existing set of trade agreements. If, instead, the current climate change negotiations break down, the outcome is going to be no agreement at all, since the Kyoto Protocol commitments are bound to expire. Thus, the "default outcome" for the two bargaining games are quite different.

Is the default outcome of importance even if the negotiations succeed? Yes: The default outcome is important because it determines the allocation of bargaining power. The explanation is related to the reasoning in Section 2.2. If the current climate negotiations break down, a country that has a poor abatement technology has less to lose, since it would, in any case, find it quite costly to implement the required abatement. And, a country that is comfortable with the status quo (status-quo biased) has more bargaining power. If, instead, the default outcome were today's commitment levels, a participating low-tech country would not necessarily be more status-quo biased, since it would face costly abatements whether or not the current negotiations succeed. Thus, if the default outcome is the current agreement, instead of no agreement at all, a country cannot increase its bargaining power simply by investing relatively little in R&D. Similarly, adapting to climate change is not going to boost a country's bargaining power, because adaptation does not make a country relatively better prepared for the status quo, when the status quo is the previous agreement (instead of no agreement at all).

This argument suggests that the default outcome should be the previous agreement, rather than no agreement at all. But what is the very best default? This question is studied by the literature on “renegotiation design” (see e.g. Aghion, Dewatripont and Rey, 1994). For climate policies, Harstad (2008b) shows that the ideal default outcome is a very ambitious agreement. Then, the countries are likely to renegotiate towards a softer set of commitments. In this bargaining game, it is the low-tech countries that are the most keen ones, since they would find it very costly to comply under the default outcome. Thus, the high-tech countries have most bargaining power, and they can expect to have the upper hand when negotiating a new, more reasonable, agreement. A country that is concerned with its future bargaining power should then invest more in R&D, not less. These investments are going to be larger the more ambitious the default agreement is. Since investments in R&D should, from a social point of view, be larger if there are large spillovers between countries, the default agreement should be more ambitious if e.g. the patent system is bad.

The optimal threat point is also related to the time horizon, discussed above. If the time horizon is short, the countries are particularly eager to distort their policies in order to gain bargaining power. It is then especially important that the default outcome is ambitious.

This subsection assumes that the default outcome is a parameter that can be deliberately chosen by the participating countries. This assumption is reasonable, to some extent, since the default outcome is influenced by the rules for updating and what a treaty dictates should happen if the agreement fails to be renegotiated successfully at a particular point in time. However, even if a treaty states that the previous agreement, for example, should be the default outcome, it is a question whether this is *credible*. Suppose that a country realizes that it does not benefit from the current agreement, and it seeks to renegotiate the agreement. Suppose, further, that the default outcome is the current agreement. If the renegotiation breaks down, everyone is supposed to revert to and comply with the current agreement. But that is exactly the agreement which our country would like to exit, unless it can be renegotiated. If such an exit is possible, the default outcome may not be credible. The *effective* default, in this case, might be the current agreement minus the country that is leaving the agreement. Or, it may be no agreement at all, if the exit of one participant makes it all unravel. Thus, the discussion of what the default outcome should be is meaningful only if it is not too easy, or cheap, for the participants to exit agreements they dislike.

3.4 Trade Subsidies on Abatement Technology

Since a main problem of Section 2.2 is that countries under-invest in R&D, one may hope that such investments could be subsidized directly. Clearly, this must be done at the international level, since each national government certainly does not perceive its own chosen investment level as being too low. A difficulty with such subsidies is that it may be hard to verify domestic investment levels and thus how much a country should be granted in subsidies. However, if a country did in fact invest a lot, it may end up exporting abatement technology to other countries, and this export is simpler to measure and verify. By subsidizing trade in abatement technology, one may be able to encourage R&D. To be specific, the countries may all benefit by collectively removing tariffs and adding subsidies on e.g. solar panels, while at the same time enforcing intellectual property rights for such technologies. This would make it more attractive to develop new technology, since one can expect a better price when selling the products to other countries. To some extent, therefore, such subsidies mitigate the under-investment problem emphasized in Section 2.2. As discussed in Section 3.2, the under-investment problem is particularly severe if the time horizon of the agreement is short (and if the other above rules are not implemented). Thus, it is particularly important to subsidize trade in abatement technology if the time horizon is short, the default is no agreement at all and no specific formula regulates the use of bargaining power.

3.5 Majority Rules

Unanimity is typically required for the implementation of international treaties. Trade agreements, for example, are often halted thanks to only a couple of countries that resist the external pressure. At first sight, the unanimity requirement is fairly natural, and perhaps inevitable, when it comes to international cooperation, since there is no third party (or world government) that could coerce sovereign countries to implement decisions they do not like. On the other hand, unanimity is not at all *always* required for international decisions. The UN applies majority rules for several types of decisions. The European Union has over time replaced the unanimity requirement with majority rules for more and more types of decisions (Nugent, 2003). Hence, it is by no means obvious that all agreements should be approved unanimously, particularly not when it comes to *modifying* or *updating* existing agreements. In fact, the Kyoto Protocol (Article 20) explicitly states that amendments can be adopted by a three-fourths majority vote.

It is the unanimity requirement that creates the hold-up problems above. As argued in Section 2.2, each country may try to influence its future bargaining power by (i) investing little in R&D, (ii)

adapting more to climate change, (iii) signaling reluctance to a climate agreement, or (iv) delegating strategically to status quo biased representatives. These strategies enhance a country's bargaining power when every vote is needed for the treaty to be implemented, and a country that is reluctant to the agreement is going to be compensated by those demanding it more. On the other hand, if unanimity were not required, this strategy would not work. The vote of the most reluctant country would not be needed, and it would be easier to get the vote from a less reluctant country. The countries that had the least to gain from an agreement would thus be excluded from the "majority coalition", the group of countries that get together in an attempt of getting the proposal approved (Ferejohn, Fiorina and McKelvey, 1987). Investing little in R&D is then a risky strategy, and it may be wiser to invest more and ensure that the country's vote and voice is interesting when a majority coalition is formed among the most enthusiastic countries or representatives. Using a formal model, Harstad (2005) shows it is better to be a part of the majority coalition when the majority requirement is small, because it then does not have to compensate all the "losers". Consequently, the smaller is the majority requirement, the more a country invests in R&D or prepare for the collective project, hoping that it will not be excluded from the majority coalition. With the optimal majority requirement, investment in R&D is first best.

Harstad (2008a) proves that similar arguments hold when it comes to strategic delegation. Instead of investments in R&D, suppose that every country appoints a representative, negotiating and voting on the behalf of the citizens. Schelling (1956) suggested that, in a situation where unanimity is required, it may be wise for a country to appoint a status-quo biased representative (less worried about climate change), since such a tough negotiator is going to enhance the country's bargaining power. If all countries appoint reluctant negotiators, the agreement will certainly not be very ambitious (Buchholtz, Haupt and Peters, 2005). If the majority requirement is smaller, however, a reluctant delegate may be excluded from the majority coalition, and it may be wiser to appoint a representative that is somewhat more enthusiastic about the project, since she is going to have a greater chance of playing an important role in the majority coalition. By carefully selecting a moderate majority requirement, these two concerns cancel each other, and the representatives are not going to be strategically appointed.

Note that using the majority rule, instead of unanimity, is a substitute to the rules above: It is particularly important to encourage R&D by reducing the majority requirement if the agreement otherwise would lead to underinvestment in R&D. This is the case, as already noticed, if the time

horizon is short and the default outcome is no agreement at all. Thus, while a long-term agreement may do fine with a unanimity requirement, short-term agreements should relax this requirement.

Just as in the subsection above, however, credibility may be an issue. Suppose the U.S., to take an example, casts its vote against a proposed update of an existing climate agreement. Is it reasonable that the other participants can force the U.S. to ratify the modification, nevertheless? If the modification is perceived to be a big one, the U.S. may threaten to leave the agreement entirely if the update were to take place. If such a threat would be credible, unanimity is in effect required for the update to take place, no matter the requirement formally specified by the treaty (Maggi and Morelli, 2004).

3.6 Minimum Participation Rules

A minimum participation rule specifies how many countries that have to ratify the treaty before it becomes binding to anyone. If the number of countries that end up ratifying the treaty is larger than this number, then the agreement enter into force but otherwise, no-one needs to comply. Most environmental agreements do have a minimum participation rule, although the specified threshold varies quite a lot (Barrett, 2005). The Kyoto Protocol, for example, entered into force only if 55% of the countries, responsible for 55% of total CO₂ emissions, ratified the treaty.

There are, at least, two rationales for including a minimum participation rule in an environmental treaty. First, it may be a coordination device. It may simply not be worthwhile for only a few countries to implement policies that are radically different from those of other countries. Developing and introducing new technologies, for example, require substantial costs that are independent of the number of countries that end up using them, and this may be worthwhile only if the number of participants is sufficiently large. A minimum participation rule could then work like insurance for potential members fearing to bear these costs alone. Minimum participation rules as a coordination device is further discussed by Barrett (2005).

Another rationale for minimum participation rules is to discourage free-riding (Carraro, Marchiori and Oreffice, 2004; Harstad, 2006). If a country realizes that unless it ratifies the treaty domestically, the other countries are not committed either, it becomes impossible to free-ride on the other countries' participation. Thus, the rule can make each potential member pivotal for the agreement to enter into force. This was the situation for Russia when it contemplated whether to ratify

the Kyoto Protocol. If it did not, too few countries would have ratified it, and the emission commitments would not have been binding for anyone.

What should the minimum participation requirement be? The trade-off is the following: If the requirement is small, the outcome may be that only this small number of countries ends up participating, since the agreement will then enter into force even if other countries decide to free-ride. On the other hand, it is very likely that the agreement will enter into force for at least someone. If the requirement were too large, the problem would be that this threshold may not be possible to reach and, consequently, the agreement would not be binding for anyone. Clearly, this possibility is less likely if potential members found the agreement very attractive for various reasons. For example, if only the ratifying countries could obtain favorable trading partner status, participation would be more attractive, and the minimum participation rule could be larger.

3.7 Rules for Entry and Exit

The rules above can govern not only how an agreement should be negotiated or updated, but also the “collective” decisions related to new participants’ entry and exit. For example, should entry of new participants be allowed at any point in time, or only at the time when the current agreement expires or must be updated? The question may sound trivial: Of course one should welcome new participants at any point in time! It is certainly better for the existing participants if more countries would like to contribute to abatements. This appreciation for new participants is also, of course, going to be reflected when the potential entrant negotiates its entry conditions. Since every existing member welcomes new members and the default is the current agreement, which obviously isn’t too bad for a non-member, the entrant knows that it may manage to negotiate quite attractive entry conditions. In fact, the conditions may be much better than if it had negotiated at the point in time when the other countries first signed the agreement, since under those negotiations the default outcome could have been no agreement at all. If so, instead of signing initially, it is certainly better to instead wait until a later point in time before negotiating its entry. Thus, anticipating an easy entry later on makes it tempting to not enter at the initial negotiation stage. How can this kind of free-riding be prevented? It may help to apply the rules above.

Suppose the “time horizon” defines the points in time at which when entry is possible. If the time horizon is long and a country cannot expect to enter at any earlier point in time, it may think twice before opting out at the initial bargaining stage. The default outcome is also important: If one is

supposed to revert to the existing agreement if the negotiations with a potential entrant fail, then the potential entrant is in a good bargaining position, since the default outcome is quite attractive as well. In this case, the entrant is going to get a pretty good deal in the bargaining outcome, and postponing its entry is indeed going to prove worthwhile. If, instead, the threat point is no agreement at all, the entrant is willing to pay more to ensure that the negotiations succeed, and it may then not end up with a better deal than if it had participated from the outset. If unanimity is required for the entrant to be able to participate, the total set of participants is going to require more from the entrant than if only a majority were enough to allow it to enter. Thus, a small majority requirement makes it more attractive enter later. Finally, if harmonization is required, or a formula is used, the entrant's conditions are not negotiable. In this case, there is no point to delay before entering the agreement.

To summarize, the new potential entrant has a low bargaining power if it can enter only at certain (infrequent) points in time, if the default is no agreement at all rather than the existing agreement, if every participant can veto a potential entry, and if a pre-specified formula determines all the contribution levels. In these cases, one may not benefit much (if at all) by postponing entering the agreement. The drawback of these rules, however, is that late entry is less desirable, and a country may thus not be willing to enter later if it, for some reason, did not enter at the very first stage.

It may be less relevant to define the rules for exit. In international politics, nothing may prevent a sovereign country from leaving an agreement at any point in time, should it desire so. As noticed already, a country may be more tempted to opt out if the time horizon is long (and the agreement cannot be updated to meet a country's new demands), if the default is an ambitious agreement, if a decision was taken by a majority and not consensus, and if a formula is used (particular if harmonization is required). The threat to exit makes all the rules discussed above less credible or likely to be effective. For this reason, it is immensely important to find ways of discouraging exit and to make the agreement more attractive.

4. Linkages to Trade Agreements

Should environmental agreements be linked to trade agreements? This is a controversial issue. Exchanging favors across different political issues are often known as horse-trading, logrolling, or bundling agreements. This can be perceived negatively as threats, hold-ups or even corruption, or positively as a fair way of sharing favors and as efficiency-enhancing "oil in the negotiation machinery". There are several possible types of linkages, and there are a number of arguments for and

against each of them. One type of link is discussed in Section 3.4, while two others are discussed in this section.

The most straightforward linkage may be “joint membership”. If you sign here, I sign there. In other words, a country may be allowed to participate in a certain trade agreement (or in a certain free-trade area) only if it also participates in a particular climate change agreement. This would make it more costly to not participate in the latter, and the number of signatories is likely to increase. As is well-known, Russia’s ratification of the Kyoto Protocol was not unrelated to its entry into the WTO and the EU’s support for this. The disadvantage of bundling trade and environmental agreements is, of course, that countries that nevertheless choose to opt out from the climate agreement are going to meet distorting and socially costly trade barriers. Undermining international trade could then be an additional and costly price for a failed climate agreement.

On the other hand, linking trade and environmental agreements makes it less attractive to opt out of an existing climate agreement (Carraro and Marchiori, 2004; Cesar and de Zeeuw, 1996). As a result, the threat to exit unless one gets a better deal is less credible. Such threats have been referred to as the main obstacle to each of the suggested rules in Section 3. Therefore, if linkages to trade agreements make participation more attractive, the rules discussed above are more likely to be credible: Exemptions from specified formulas may then not be necessary to induce participation, the time horizon can be long without the fear that countries opt out half way, negotiating countries may take seriously a quite ambitious default agreement, countries may obey to collective decisions even if they did not secure unanimity and the minimum participation requirement can be large and still be met. In short, linkages to trade agreements complement the rules discussed above, making each of them credible. Without such a linkage, the rules might be impossible to use and the drive for bargaining power can undermine the value of climate agreements.

As a final remark, it is worth mentioning another value of bundling trade and environmental agreements. One issue largely overlooked in this paper is compliance. After an agreement is signed, it may be quite tempting for a country to simply break its promises, particularly if the consequences of doing so are negligible. And, indeed, the consequences are likely to be quite small. There is, as mentioned already, no third party that could enforce agreements signed by sovereign countries. One may, at best, try to impose some ad hoc sanctions on those not complying. In the Kyoto agreement, for example, a country that fails to comply in the first commitment period is required to make up the difference plus an additional 30%. However, such a rule only delays the compliance problem, for what prevents a country from failing to comply with the penalty as well as the agreement? Ultimately, the

sanctions must be more credible than what is the case for the Kyoto agreement. In international politics, there are not that many sanctions one can use. Fortunately, trade sanctions have already proven to motivate countries to comply with trade commitments, at least to some degree. Likewise, trade sanctions could threaten countries that fail to comply with environmental agreements (Barrett, 1997). Certain environmental agreements, like the Montreal Protocol, do indeed refer to such sanctions. Trade sanctions may, in the end, be the only way of ensuring that ambitious environmental commitments are worthwhile to comply with - even after the deal is signed.

5. Conclusions

Climate change agreements should and will be updated over time. If no rules govern this negotiation process, a situation with agreements may be less efficient than no agreement at all. This dismal result may hold because every country might be tempted to, for example, under-invest in abatement technology in order to gain bargaining power at the future negotiation stage. Related, countries may want to signal reluctance. The lesson from this is *not* that agreements should not be made in the first place, but that one should pay attention to designing *rules* governing the negotiation process.

This paper has discussed six such rules. Requiring harmonization or applying certain formulas for the commitment allocation constitutes one way of improving the bargaining game. If a formula is determining the distribution of contributions, it is hard for a country to affect its share of the burden, and the strategic concerns are not likely to be very detrimental. Harmonization is obviously harmful if countries are heterogeneous, but formulas can be cleverly designed (to depend on GDP and growth, for example) to mitigate these costs.

Rule number two is a long time horizon of the treaty. A longer time horizon reduces the frequency at which the agreement is negotiated, and the strategic motives are less distortionary. The time horizon should also be longer if a larger number of countries are participating in the agreement.

The third rule concerns the default outcome: What should happen if the (re)negotiations fail? If the default outcome then is the previous agreement (as for the trade rounds), the countries' incentives to gain bargaining power are less distortionary than if the default is no commitment at all (as for the current climate negotiations). The ideal default outcome is actually a quite ambitious agreement, since this would give the high-tech countries the most bargaining power, inducing countries to in advance invest a lot in R&D in their attempt of gaining bargaining strength.

The fourth rule is that international trade in abatement technology should be subsidized, in order to encourage R&D. If such subsidies are difficult to implement for the fear that they may be abused, the countries could, at least, eliminate tariffs for abatement technology as the same time as intellectual property rights are enforced.

Unanimity means that everyone must agree, and it is exactly this requirement that creates the benefit of gaining bargaining power. If unanimity were replaced by majority rule (or some super-majority requirement) when it came to updating agreements, the strategic considerations are mitigated and they may vanish entirely. Finally, a minimum participation requirement, specifying the number of countries that must ratify the treaty before it enters into force, is capable of reducing free-riding and encouraging participation.

Each rule can be implemented even if the others are not. In fact, these rules are “strategic substitutes” in that implementing each of them is *more* beneficial if the other rules are *not* implemented. For example, it is more important to subsidize trade in abatement technology if the time horizon of an agreement is short and no formulas pin down the distribution of commitments.

For all these rules, the chief problem is that they may not be credible *ex post*, once a country threatens to exit the agreement unless it gets a better deal. To reduce the likelihood (and the credibility) of such threats, it may be necessary to bundle the environmental agreement to a trade agreement. If one cannot exit one without exiting the other, countries are less tempted to opt out, and the rules discussed above become credible. Thus, a linkage to trade complements each of the rules above. Despite their drawbacks, such linkages may therefore be necessary to commit to the optimal time horizon, an ambitious default outcome, the best voting rule and the smartest formula. In addition, a linkage to trade agreements may be the only way of ensuring that the participants prefer to comply with their commitments – even after the agreement is signed.

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