

## Treaty Design and Duration: Effects on R&amp;D, Participation, and Compliance

Bard Harstad

January 2013



Climate policy is complicated. For a treaty to be beneficial, one must think through carefully how it will work, once it is implemented. Unfortunately, the effects are often difficult to predict.

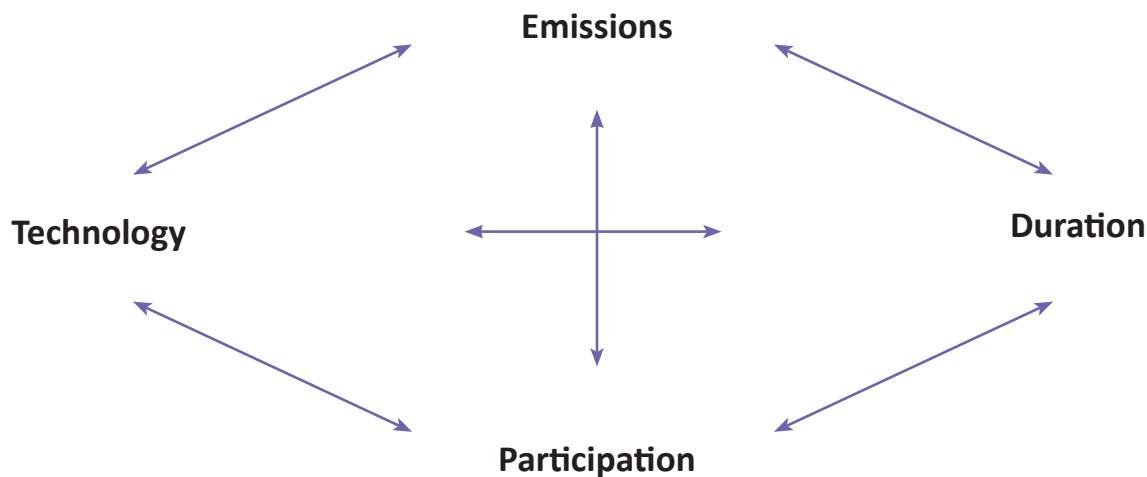
Crucial questions include the following: How should an international treaty be designed? Should one negotiate commitments for a five-year period, or for much longer? Assuming that the treaty specifies aggregate or country-specific emission caps—as I do in this *Viewpoint*—what should these caps be and how should they change over time? How should the agreement be updated once policymakers, scholars, and the public learn more about the severity of the climate-change problem, or about the effects of the policy? Can the treaty be designed to encourage investments in “green” abatement technology or renewable energy sources? Finally, how can one motivate countries to participate and comply with such an agreement?

Each of these questions will be addressed below — in brief. Further details can be found in the papers listed at the end, as this *Viewpoint* builds on an economic research agenda that has investigated these questions in detail. This research agenda has analyzed the interaction among four key variables: (1) investments in green technology; (2) emission caps; (3) duration of the climate treaty; and (4) incentives to participate. While these interactions, illustrated in the figure, are complicated, they will be discussed here in sequence. A natural table of contents is thus:

1. What drives *investments* in green technology?
2. The appropriate *emission caps*.
3. The appropriate *duration* of a treaty — and how to *update* it
4. How to motivate *participation*
5. How to motivate *compliance*

*Viewpoints* present policy proposals, considered opinions, and commentary by distinguished policymakers, leaders from business and non-governmental organizations, and scholars. The Harvard Project on Climate Agreements does not advocate any specific climate change policy proposals. Statements and views expressed in *Viewpoints* are solely those of the authors and do not imply endorsement by Harvard University, the Harvard Kennedy School, or the Harvard Project on Climate Agreements.

The discussion is based on a few assumptions. First, it is presumed that future climate treaties will specify aggregate or regional emission cuts (referred to as caps, allowances, or quotas) rather than quantifying investment levels directly (similar reasoning also holds if countries negotiate emission taxes or extraction quotas). On the other hand, I do not make any assumption regarding whether the emission allowances will be tradable across countries or not, as the following arguments will hold in both situations. Second, most of the discussion presumes that countries find a way to ensure compliance (although that issue is addressed at the end). Finally, this *Viewpoint* does not discuss conservation of tropical forests (using so-called REDD+-contracts) or other carbon sinks; that such conservation should be included in an effective climate treaty is sufficiently well documented elsewhere.



## 1. What drives investments in green technology?

(i) Investments in technology are mostly driven by demand. Demand for abatement technology is high if a great deal of abatement is required. The larger are the required cuts, the higher is the demand for abatement technology, and the larger is the profit from investing in alternative energy sources. In sum, the more environmentally-ambitious is the climate treaty, the larger are the incentives to invest in green technology. This is true whether the investments take the form of innovation (developing new patentable products) or diffusion (installation of existing technology). The result is also true whether the technology is developed by governments, domestic firms, or firms located in other countries.

(ii) Investments are more attractive under ambitious, long-lasting commitments to emission cuts. By definition, an “investment” is costly at first, but it may pay off in the future. An investment will thus be worthwhile only if one knows, or at least expects, that demand for such technology will indeed be high in the future. This will be true (following 1(i)) only if the climate policy is relatively ambitious, in that the future levels of the emissions caps are low. Thus, investments in green technology will take

place only if countries have committed to a long-lasting ambitious treaty (or if this can be expected by rational investors).

(iii) Countries may have little incentive to buy or develop green technology prior to international negotiations. The reason is that the country that has already installed or developed the best technology will be in a weak bargaining position, as they have more to gain, or less to lose, from signing an ambitious treaty. Countries that have not yet developed or installed green technology can claim or require more favorable treatment, as their temptation to opt out of the treaty is larger and more credible. The fact that investments prior to negotiations may weaken a negotiator's bargaining position is well-known and referred to as the "hold-up" problem in economics. This hold-up problem is another reason why long-term commitments are important for motivating investments in green technology, in addition to Section 1(ii).

## **2. The appropriate emission caps**

The severity of and uncertainty about the climate-change problem imply that the aggregate number of emission allowances (the caps) should be at the lowest level acceptable to potential participants in the treaty. But the previous section on the interaction between the level of the cap and incentives to invest in technology may also be consequential.

(i) First, the allowed emission level should be low if one hopes to encourage investments in green technology, following Section 1(ii)–(iii).

(ii) Second, one should anticipate that the cost of emission-reduction will be lower in the future, because one can realistically expect the development of new technology. The possibility of installing new technology was one of the reasons why firms found it much cheaper to comply with the quotas under the European Union Emissions Trading System than policymakers and economists had expected. (Improved technology contributed to a falling permit price).

(iii) Third, the aggregate quantity of emission allowances should decline over time. This is necessary both to motivate investments in technology (in line with Section (i)) and because it is realistic to anticipate that technology will reduce the future cost of abatement (in line with Section (ii)).

(iv) Fourth, as another consequence of points in Section (i)–(ii), countries that are technology leaders and face a relatively low cost of developing or installing green technology should face tougher requirements, in that the number of quotas allocated to these countries should be smaller than for other countries. Such an allocation is also "fair" and consistent with the differentiated responsibility principle.

The last point (iv) presumes that emission allowances are not tradable across countries. The other points discussed in this *Viewpoint* hold whether or not permits are tradable.

### 3. The appropriate duration of a treaty and how to update it

The importance of motivating investments in green technology implies that countries should seek long-term commitments regarding quantified emission allowances (this follows from Section 1(ii)–(iii)). This argument has not yet been sufficiently acknowledged in the public debate, in my view, relative to the scientific evidence regarding the argument’s importance. In contrast, the typical argument against long-lasting commitments is that optimal emission quantities many years ahead are unknown. However, this argument is flawed for two reasons.

(i) First, a treaty with short-term commitments is not likely to motivate sufficient investments in green technology, as explained above by Section 1(ii)–(iii). In fact, countries may invest less prior to the next bargaining round than if there were no agreement in place at all (Harstad, 2012b). This dramatically reduces the benefit of short-term agreements relative to no agreement at all.

(ii) Second, long-term commitments can in practice be renegotiated and updated once we learn more about the costs or benefits of a climate policy. The treaty will not be carved in stone and, if all signatories agree, the details can be changed. Note that such a renegotiation is crucially different from negotiating a new agreement once a short-term commitment period has expired. In the latter case, the default outcome (the threat point, if the negotiations should fail to succeed) is no agreement at all. In the former case, when countries renegotiate an existing and long-lasting treaty, then the default outcome is the existing treaty. This difference is crucial: While a technology-leading country has a weak bargaining position when a new treaty is to be negotiated (Section 1(iii) above), it has instead a sound and strong bargaining position when the countries renegotiate an existing treaty. The reason is that when the default is an existing treaty, then being a technology-leader makes the country comfortable with the status-quo of maintaining an existing treaty, as the technology provides that country with a relative advantage in abatement costs. Anticipating in this way how technology will affect the country’s bargaining position, each country (and, thus, corporation) will be more motivated to develop and install green technology under long-term commitments—even if these can be renegotiated—than under a short-term treaty that may be replaced following a new bargaining round. (For a detailed explanation, see Harstad, 2012a).

(iii) A fair reason for short-term commitments exists if the number of willing participants turns out to be small. With a small climate coalition, it may be better (for them, as well as for the world) to commit only for a few years in the hope that the coalition will be larger in the next negotiation. This strategy may also have a desirable effect on participation (see Section 4(ii) below).

#### 4. How to motivate participation

The temptation to opt out and free ride on international environmental agreements is large. Participants provide a “public good” (i.e., lower emissions), which is a benefit that can be enjoyed as well by those countries who decide to stay out. Several analyses based on economics and game theory do indeed predict that the number of participants can be very small. This is a very significant problem, of course, since fewer participants not only reduce the total amount of abatement, but also because it becomes more difficult, and more expensive, for the coalition to guarantee a certain amount of pollution reduction. The reason for this is so-called “carbon leakage” effect: the consumption of fossil fuel, as well as the companies that rely on energy, can easily move to non-participating countries once the climate coalition reduces the allowed amount of fossil-fuel consumption or makes such consumption more expensive for users.

(i) It is far from clear how new technology can influence the incentive to participate. On the one hand, a certain amount of pollution reduction becomes less expensive if someone has developed affordable technology that reduces the cost of abatement or replaces the need to consume fossil fuel. On the other hand, new technology makes participants inclined to further reduce emission quotas, since this becomes affordable, and this effect could weaken the incentive to participate. Related, new technology may to some extent contribute to “solving” the climate-change problem, perhaps therefore implying that potential participants to a climate treaty will find the problem less urgent and their participation unnecessary. So, while green technology is essential for the reduction of emissions, its effect on participation is unclear.

(ii) One way of increasing participation comes from the effect that participation has on the negotiated duration of the treaty, as mentioned in Section 3(iii). If few countries participate, it is in their interest to only sign short-term commitments, while waiting for the coalition to grow. A short-term treaty, however, is costly since the incentive to invest in green technology is then low (for countries as well as for firms), following Section 1(ii)–(iii). Thus, a country that contemplates whether to participate in a treaty may fear that, by opting out, the remaining countries end up signing only a short-term treaty (reducing the possibility to free ride) and this leads to low investments (which entails a cost even for the countries that opt out). In sum, participation may be more attractive (than what is normally predicted by economic theory) if the duration of the treaty is endogenously negotiated by the countries that actually have committed to cooperate. To further strengthen this effect, one may want to consider a clause requiring that a long-term treaty is to be established *only if* the number of participants is above a pre-specified number. Note that this has some resemblance to the “minimum participation rules” which have been applied earlier to the Kyoto Protocol as well as to other international environmental agreements (Barrett, 2005).

(iii) Another way of raising participation is to provide rewarding “carrots” to the members or applying costly “sticks” to the nonparticipants. However, international politics offer few such carrots or sticks.

Direct monetary side transfers could be one possibility, but raising equity may be difficult, and the possibility to be “purchased” as a member could paradoxically induce more countries to behave as if they were reluctant to voluntary participation (Hoel and Schneider, 1997). Thus, a more effective carrot could be to link climate participation to the benefit of becoming a “most favored trading partner” (that is; link climate negotiations to free trade agreements). Note that such a link would simultaneously create the “stick” of not achieving such a trading partner status if one opts out of the climate agreement.

## 5. How to motivate compliance

The proceeding sections have assumed that countries will find a way of motivating compliance once the commitments are negotiated and ratified. If compliance could not be expected, then the negotiation process would be quite meaningless. Compliance is thus essential.

(i) There are multiple ways of ensuring compliance. In international politics, most countries fear that if they do not comply with a treaty today, then they cannot expect that other countries comply in the future. In addition, they may lose the political sympathy that is important when cooperating in other areas. In economics, it is well-known that cooperation is easier to sustain if the “game” is frequently repeated over time.

(ii) In addition, some countries ratify international agreements by making them into national laws. Once international laws become national laws, then it becomes more costly for a government that is considering “breaking” the law, particularly if domestic stakeholders also have the right to hold the government accountable for such laws (citizens’ right to hold governments accountable to international laws are often limited, but this could change, perhaps as an outcome of international treaties).

(iii) If the above two points are not sufficient to guarantee compliance, then one may need to consider formal sanction. In the Kyoto Protocol’s first commitment period, the formal sanction was that a country that emitted more than permitted was supposed to “make up” for the difference (plus 1/3 in penalty) in the next “commitment period.” This sanction is flawed, however, for two reasons. First, such a penalty makes it even more tempting to not comply (to the commitment and the penalty) in the next commitment period, so the deviator becomes tempted to deviate forever. Second, the quantities for the next commitment period are yet to be negotiated, and the deviator’s increased incentive to opt out is strengthening its bargaining power, with the effect that the deviator may succeed in increasing its share of the next pool of emission allowances.

(iv) Not so many types of formal sanctions exist that can be used in international politics. This is related to Section 4 (iii) on carrots/sticks motivating compliance. As mentioned there, trade policy is

one of the few available carrots/sticks, and trade sanctions may remain as the only effective means of ensuring compliance when formal sanctions become necessary. This is, again, suggesting that one may need to create a link between a climate treaty (compliance as well as participation) and trade agreements.

## CONCLUSION

The interactions between (1) the incentives to invest in green technology, (2) the level of emission allowances, (3) the duration of the treaty, and (4) participation and compliance are complicated and well worth in-depth analyses. Recent research in economics suggest that to motivate the development and installation of green technology, (i) the commitments should be ambitious, (ii) they should be tougher at future dates, (iii) they should be tougher for technology-leading countries, and (iv) the commitments should be long lasting, although (v) the commitments may be renegotiated at later stages. However, (vi) the duration of the commitments should be short if relatively few countries end up participating, and (vii) such a strategy may in fact motivate countries to participate in the first place. Finally, (viii) participation and compliance may be further encouraged by the carrots/sticks that are available using trade policies and sanctions.

### Notes: The above discussion draws on the following research material

Aldy, Joseph and Stavins, Robert (Ed.) (2009): *Post-Kyoto International Climate Policy*, Cambridge University Press.

Barrett, Scott (1997): "[The Strategy of Trade Sanctions in International Environmental Agreements](#)," *Resource and Energy Economics* 19, p. 345–361.

Barrett, Scott (2005): "The Theory of International Environmental Agreements," *Handbook of Environmental Economics* 3, edited by K.-G. Mäler and J.R. Vincent.

Battaglini, Marco and Harstad, Bård (2012): "[Participation and Duration of Environmental Agreements](#)," NBER Working Paper 18585.

Buchholz, Wolfgang and Konrad, Kai (1994): "Global Environmental Problems and the Strategic Choice of Technology," *Journal of Economics* 60 (3): 299–321.

Calvo, Emilio and Rubio, Santiago (2012): "[Dynamic Models of International Environmental Agreements: A Differential Game Approach](#)", manuscript.

Carraro, Carlo and Siniscalco, Domenico (1993): "[Strategies for the International Protection of the Environment](#)," *Journal of Public Economics* 52 (3): 309–28.

Harstad, Bård (2012a): "[Climate Contracts: A Game of Emissions, Investments, Negotiations, and Renegotiations](#)," *Review of Economic Studies* 79 (4): 1527–57.

Harstad, Bård (2012b): "[The Dynamics of Climate Agreements](#)," manuscript.

Hoel, Michael and Schneider, Kerstin (1997): "[Incentives to Participate in an International Environmental Agreement](#)," *Environmental & Resource Economics*, 9, p. 153–170.

## AUTHOR AFFILIATIONS

### Bård Harstad

*Kellogg School of Management, Northwestern University*

*Department of Economics, University of Oslo*

*Frisch Centre for Economic Research*

*National Bureau of Economic Research*

## ACKNOWLEDGEMENTS

The Harvard Project on Climate Agreements is grateful to the Harvard University Center for the Environment for generous current support. The Harvard Project also receives support from Christopher P. Kaneb (Harvard AB 1990); the James M. and Cathleen D. Stone Foundation; ClimateWorks Foundation; and the Qatar National Food Security Programme. The Project also receives ongoing support from the Belfer Center for Science and International Affairs at the Harvard Kennedy School. The Project is grateful to the Doris Duke Charitable Foundation, which provided major funding during the period 2007 – 2010.

The closely affiliated, University-wide Harvard Environmental Economics Program receives additional support from the Enel Endowment for Environmental Economics at Harvard University, the Enel Foundation, the Alfred P. Sloan Foundation, the Mossavar-Rahmani Center for Business and Government at the Harvard Kennedy School, Bank of America, Chevron Services Company, Duke Energy Corporation, and Shell.

## ABOUT THE HARVARD PROJECT ON CLIMATE AGREEMENTS

The goal of the Harvard Project on Climate Agreements is to help identify and advance scientifically sound, economically rational, and politically pragmatic public policy options for addressing global climate change. Drawing upon leading thinkers in Argentina, Australia, China, Europe, India, Japan, and the United States, the Project conducts research on policy architecture, key design elements, and institutional dimensions of international and domestic climate policy. The Project is directed by Robert N. Stavins, Albert Pratt Professor of Business and Government at the Harvard Kennedy School.

**Project Email:** [climate@harvard.edu](mailto:climate@harvard.edu)

**Project Website:** <http://belfercenter.hks.harvard.edu/climate>