7 Climate Clubs and Carbon Pricing*

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Much progress has been made by scientists and economists in understanding the science, technologies, and policies involved in climate change and reducing emissions. Notwithstanding this progress, up to now it has proved difficult to induce countries to join in an international agreement with significant reductions in emissions.

The Kyoto Protocol was an ambitious attempt to construct an international climate-change agreement to harmonize the policies of different countries. High-income countries agreed to limit their emissions to 5% below 1990 levels for the 2008–2012 budget period. Under the Protocol, important institutional features were established, such as reporting requirements and methods for calculating the relative importance of different greenhouse gases.

However, countries did not find the Kyoto Protocol economically attractive. The United States withdrew in 2001. The Protocol did not attract any new participants from middle-income and developing countries. As a result, there was significant attrition in the coverage of emissions under the Protocol. Also, emissions grew more rapidly in noncovered countries, particularly developing countries such as China. The Protocol as first designed would have covered 63% of global emissions in 1990, but the actual scope in 2012 was barely one-fifth of world emissions. Analyses showed that, even if indefinitely extended, the Kyoto reductions would have a limited impact on future climate change. It died a quiet death, largely unnoticed and mourned by few, on December 31, 2012.

It was apparent even before its demise that the Kyoto Protocol would not make a substantial contribution to slowing climate change or, indeed, that

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it would meet its limited goals. Nations have struggled through a series of summits and conferences to find a replacement, with the Paris meeting in late 2015 being the latest attempt to reach an agreement that would replace Kyoto with an effective international agreement.

The present chapter suggests that the Kyoto Protocol ran aground, and that current approaches are unlikely to do better, because of the tendency of countries to free-ride on the efforts of others for global public goods. The chapter suggests that a "club" model is the most fruitful approach to overcoming free-riding and describes a Climate Club. The current approaches, starting with the Kyoto Protocol, have little chance of success unless they adopt some of the strategies associated with the club model of international agreements.

But the abstract idea of a club is insufficient; many architectural and practical details of club design need careful analysis. One important aspect is the question of exactly what the international agreement is to agree on. In Kyoto, nations agreed on quantity limits. I suggest here that price agreements—more specifically, agreements on an internationally harmonized minimum carbon price—will be the most fruitful way to organize an international club agreement.

The Nature of Global Public Goods

Most of economic life involves voluntary exchange of private goods, such as bread or blue jeans. These commodities are consumed by one person and directly benefit no one else. However, many activities involve spillovers or externalities among producers or consumers. An extreme case of an externality is a public good. Public goods are commodities where the cost of extending the benefits to an additional person is zero and where it is impossible or expensive to exclude individuals from enjoying.

More precisely, public goods have two key properties: nonrivalry and nonexcludability. Nonrivalry denotes that the consumption of the public good by one person does not reduce the quantity available for consumption by another person. Take global positioning systems (GPSs) as an example. These systems are used for hiking, missile guidance, and finding a restaurant. These goods are public because people who use them are not reducing the value of signals for others. The second feature of a pure public good is nonexcludability. This means that no person can be

excluded from benefiting from or being affected by the public good (or can only be excluded at a high exclusion cost). In the case of smallpox eradication, once smallpox was eradicated, no person could be excluded from the benefits. Herd immunity from vaccines is an important and little-understood public good that is one of the important reasons for mandatory vaccination.

The important economic point about public goods is that private markets do not guarantee efficient production. In this respect, then, production of public goods such as GPS signals or herd immunity differs from production of bread. Efficient production of public goods requires collective action to overcome the inability of private agents to capture the benefits.

The inefficiencies are the greatest for global public goods, whose benefits are spread most widely across space and time. Consider issues as different as greenhouse warming and ozone depletion, terrorism and money laundering, the discovery of antibiotics and nuclear weapons. These are global public goods because their impacts are indivisibly spread around the entire globe. These are not new phenomena. However, they are becoming more important in today's world because of rapid technological change and the sharp decline in transportation and communication costs.

Global Public Goods, Federalism, and the Westphalian Dilemma

Although global public goods raise no new analytical issues, they do encounter a unique political hurdle because of the structure of international law. Whenever we encounter a social, economic, or political problem, one of the first questions concerns the level at which the problem should be addressed. We expect households to deal with children's homework assignments and take out the trash; we expect local or regional governments to organize schools and collect the trash; we expect national governments to defend their borders and manage their currencies.

For the case of global public goods, there exist today no workable market or governmental mechanisms that are appropriate for the problems. There is no way that global citizens can make binding collective decisions to slow global warming, curb overfishing of the oceans, efficiently combat Ebola, form a world army to combat dangerous tyrants, or rein in dangerous nuclear technologies.

The decision-making difficulties of global public goods raise what might be called the Westphalian dilemma. National governments have the actual power and legal authority to establish laws and institutions within their territories; this includes the right to internalize externalities within their boundaries and provide for national public goods. Under the governing mechanisms of individual countries, whether they are acts of democratic legislatures or despotic decrees, they can take steps to raise taxes or armies and command their citizens to clean their air and water.

By contrast, under international law as it has evolved in the West and then the world, there is no legal mechanism by which disinterested majorities or supermajorities short of unanimities can coerce reluctant free-riding countries into mechanisms that provide for global public goods. Participants of the Treaty of Westphalia recognized in 1648 the *Staatensystem*, or system of sovereign states, each of which was a political sovereign with power to govern its territory. As the system of sovereign states evolved, it led to the current system of international law under which international obligations may be imposed on a sovereign state only with its consent.

Because nations, particularly the United States, are deeply attached to their sovereignty, the Westphalian system leads to severe problems for global public goods. The requirement for unanimity is in reality a recipe for inaction. Particularly where there are strong asymmetries in the costs and benefits (as is the case for nuclear nonproliferation or global warming), the requirement of reaching unanimity means that it is extremely difficult to reach universal, binding, and effective international agreements. Whether bargaining can lead to such treaties is examined shortly.

To the extent that global public goods are increasingly important in the decades ahead, one of our major challenges is to devise mechanisms that overcome the bias toward the status quo and the voluntary nature of current international law in life- or civilization-threatening issues. Just as national laws recognize that consumer sovereignty does not apply to children, criminals, and lunatics, international law must come to grips with the fact that nations acting under the Westphalian system cannot deal effectively with critical global public goods.

Free-Riding as the Key Obstacle for Climate-Change Treaties

As we look at climate change, the dilemmas raised by their global nature take a particular form. Slowing climate change requires expensive national investments in reducing CO_2 and other greenhouse gas emissions. But the benefits are diffuse in space and time. Emissions reduced anywhere benefit people everywhere, and indeed most of the benefits come to generations in the future, perhaps distant future.

The concentrated costs and dispersed benefits provide strong incentives for free-riding in current international climate agreements. *Free-riding* occurs when a party receives the benefits of a public good without contributing to the costs. In the case of the international climate-change policy, countries have an incentive to rely on the emissions reductions of others without taking proportionate domestic abatement. The failure of the Kyoto Protocol, and the difficulties of forging effective follow-up regimes, is largely due to free-riding.

As suggested by the earlier discussion, although free-riding is pervasive, it is particularly difficult to overcome for global public goods. Arrangements to secure an international climate treaty are hampered by the lack of ability to induce reluctant nations to join international agreements. In essence, all international agreements are essentially voluntary (see the Treaty of Vienna, 1969, article 34).

Clubs as a Mechanism to Overcome Free-Riding

In light of the failure of the Kyoto Protocol, it is easy to conclude that international cooperation is doomed to failure. This is the wrong conclusion. Despite the obstacles of international law, nations have in fact overcome many transnational conflicts and spillovers through international agreements. There are more than 200,000 UN-registered treaties and actions that are presumptive attempts to improve participants' welfare. Countries enter into agreements because joint action can take into account the spillover effects among the participants. Although global warming is to date a failed club, there are many examples of successes. Important examples are the international trading system, international financial arrangements, military alliances, and the protocols to reduce ozone-depleting chemicals. These achievements are a reminder that patient efforts to improve relations

among nations are not a fruitless task. In these and other cases, the tendency toward free-riding associated with the Westphalian system has been overcome through the mechanism of clubs.

So what is a club? Although most of us belong to clubs, we seldom consider their structure. A club is a voluntary group deriving mutual benefits from sharing the costs of producing a shared good or service. The gains from a successful club are sufficiently large that members will pay dues and adhere to club rules to gain membership benefits.

The theory of clubs is a little-known but important corner of the social sciences. The major conditions for a successful club include the following: (1) there is a public good–type resource that can be shared (whether the benefits from a military alliance or the enjoyment of a golf course); (2) the cooperative arrangement, including the dues, is beneficial for each of the members; (3) nonmembers can be excluded or penalized at relatively low cost to members; and (4) membership is stable in the sense that no one wants to leave.

The basic idea suggested here is that we can make progress in international climate agreements if we adopt the club model rather than the current voluntary model. The idea of a Climate Club should be viewed as an idealized solution of the free-riding problem. Like free trade or physics in a vacuum, the Climate Club described here will never exist in its pure form. Rather, it is a blueprint that can be used to understand the basic forces at work and sketch a system that can overcome free-riding.

A Sketch of the Climate Club

Here is a brief description of the proposed Climate Club: an agreement by participating countries to undertake harmonized emissions reductions. The agreement envisioned here centers on an "international target carbon price" that is the focal provision of an international agreement. For example, countries might agree that each country will implement policies that produce a minimum domestic carbon price of $25 per ton of CO_2. Countries could meet the international target price requirement using whatever mechanism they choose—carbon tax, cap-and-trade, or a hybrid.

A key part of the club mechanism (and the major difference from all current proposals) is that nonparticipants are penalized. The penalty analyzed here is uniform percentage tariffs on the imports of nonparticipants into

the club region. Calculations suggest that a relatively low penalty tariff rate will induce widespread participation among countries as long as the target carbon price is in the range up to $50 per ton.

Games and International Behavior

An important aspect of the Climate Club—and a major difference from current proposals—is that it creates a strategic situation in which countries acting in their self-interest will choose to enter the club and undertake high levels of emissions reductions because of the structure of the incentives. To understand the nature of the incentives and strategies, I discuss the application of game theory to international environmental treaties.

There is a large literature on the strategic aspects of international environmental agreements, including those focused on climate change. One important strand is the analytical work on global public goods. The clear message is that without special features, the outcome will be a prisoners' dilemma or tragedy of the commons, in which there is too little abatement.

This analysis usually takes place in the framework of noncooperative (NC) game theory. In the NC framework, countries act in their national self-interest. Hence, when a country designs its environmental, macroeconomic, or labor-market policies, it considers the impacts on its own citizens and largely ignores the impacts on other countries. Although the idea of countries acting in their self-interest may seem narrow-minded or parochial, it is actually the foundation of democratic theory. Most of the world's ills (think particularly of wars) arise because countries, or more often their leaders, do not act in their countries' national self-interest. For national public goods with minimal cross-border spillovers, the world's welfare is appropriately optimized when countries act in their self-interest. The problems we consider here arise for global public goods, where the NC approach leads to inefficient outcomes.

Analysis of NC agreements (either one-shot or repeated) leads to three major conclusions for climate change. First, the overall level of abatement in the NC equilibrium will be much lower than in the efficient (cooperative) strategy. A second and less evident point is that countries will have strong incentives to free-ride by not participating in strong climate-change agreements. Finally, the difficulty of escaping from a low-level, NC equilibrium

is amplified by the intertemporal trade-off because the current generation pays for the abatement while future generations are the beneficiaries of lower damages. To a first approximation, international climate policy as of 2015 looks like a NC equilibrium.

Elements of Treaties

NC outcomes assume that countries never bargain to improve the outcomes. Might coalitions of countries form cooperative arrangements or treaties that improve on NC arrangements? This question has been extensively studied analytically using game theory, through modeling, and by examination of history.

Theoretical and empirical studies indicate that coalitions concerned with global public goods tend to be fragile and unstable. More precisely, these studies find virtually universally that coalitions tend to be either small or shallow, a result I will call the "small coalition paradox."

Here is the background. Suppose that countries can form treaties to provide global public goods, whether for climate change, public health, financial regulation, or whatever. A successful agreement would require the participation of most countries. However, to be stable, each country must determine that participation—which requires investments with large national costs but diffuse benefits—has a higher payoff than nonparticipation. The problem is that stable coalitions tend to have few members; therefore, as the number of countries rises, the fraction of global emissions covered by the agreement declines. Studies by Scott Barrett have found, based on a comprehensive review of existing environmental treaties, that few treaties for global public goods succeed in inducing countries to increase their investments significantly above the NC levels. Moreover, the ones that do succeed include external penalties.

This point was foreseen more than three centuries ago in a discussion by David Hume on collective action and free-riding:

> Two neighbors may agree to drain a meadow, which they possess in common; because 'tis easy for them to know each other's mind; and each must perceive, that the immediate consequence of his failing in his part, is, the abandoning the whole project. But 'tis very difficult, and indeed impossible, that a thousand persons shou'd agree in any such action; it being difficult for them to concert so complicated a design, and still more difficult for them to execute it; while each seeks a pretext to

free himself of the trouble and expence, and wou'd lay the whole burden on others. (Hume, A Treatise of Human Nature, Section VII, 1739)

How can we understand the small coalition paradox? Here is the intuition for climate change. Clearly, two countries can improve their welfare by combining and raising their abatement (or carbon price) to the level that would maximize their joint welfare. Just as with Hume's neighbors, either country is worse off by dropping out. The 2014 agreement between China and the United States to join forces in climate policy might be interpreted as an example of a small bottom-up coalition.

Does it follow that, by increasing the number of countries in the treaty, this process would accumulate into a grand coalition of all countries with efficient abatement? That conclusion is generally wrong. The problem arises because, as more countries join, the level of abatement, and its costs, becomes ever higher and ever further from the NC level. The discrepancy gives incentives for individual countries to defect. When a country defects from an agreement with many countries, the remainder coalition (of many-minus-one countries) would reoptimize its levels of abatement. The revised levels of abatement would still be well above the NC levels for the remainder coalition, while the defector free-rides on the abatement of the remainder coalition. The exact size of the stable coalitions would depend on the cost and damage structure as well as the number of countries, but for most analyses using realistic number, stable coalitions are small and perform only slightly better than the NC equilibrium.

As noted previously, the syndrome of free-riding along with the international norm of voluntary participation appears to doom international climate agreements such as the Kyoto Protocol. The suggestion here is that a club structure—where external sanctions are imposed on nonmembers—will be necessary to induce effective agreements.

Sanctions for International Agreements about Global Public Goods

Although it is easy to design potential international climate agreements, the reality is that it is difficult to construct ones that are *effective and stable.* Effective means abatement that is close to the level that passes a global cost–benefit test. The concept of stability used here is that a coalition is stable if no group (subcoalition) among the countries can improve its welfare by changing its participation status. The small coalition paradox motivates

the current approach. The goal here is to find a structure that is stable and has a large number of participants for a wide variety of country preferences, technologies, and strategies.

Both theory and history suggest that some form of sanction on nonparticipants is required to induce countries to participate in agreements with high levels of abatement. A sanction is a governmental withdrawal, or threat of withdrawal, of customary trade or financial relationships. A key aspect of the sanctions analyzed here is that they benefit senders and harm receivers. This pattern contrasts with most cases, where sanctions impose costs on senders as well as receivers and thereby raise issues of incentive compatibility.

The major potential instrument is sanctions on international trade. Two approaches to trade sanctions might be considered. A first approach, and one that has been widely advocated and examined, is called carbon duties; it would put tariffs on the imports of nonparticipants in relation to the carbon content of these imports. For technical reasons, I do not suggest this route. A second approach, called uniform penalty tariffs and discussed here, would apply uniform percentage tariffs to all imports from nonparticipating countries. Under this approach, participating countries would levy a uniform percentage tariff (perhaps 2%) on all imports from nonparticipants. This mechanism has the advantage of simplicity and transparency, although it does not relate the tariff specifically to the carbon content of the import.

A major feature of tariff sanctions is that they are incentive-compatible. Many sanctions have the disadvantage that they penalize the penalizer. For example, if Europe puts sanctions on Russian energy companies, then this is likely to raise energy prices in Europe, hurt European consumers, and therefore have costs on Europe as well as Russia. The tariff-sanction mechanism analyzed here imposes costs on the nonparticipating country but benefits participants that levy the penalty tariffs. Moreover, because tariffs apply bilaterally, they can support an efficient equilibrium for global public goods for a large number of countries.

The Central Role of Carbon Prices

There are many issues in club design. A central question is how to harmonize countries' policies. What exactly are countries negotiating over? In a

Kyoto design, and all the linear descendants through Paris, the negotiations are about quantities. This has proved a slippery slope without much to hold on to. A more promising approach is harmonizing carbon prices, and the proposed Carbon Club follows this route.

Start with the positive reasons to use carbon prices: The economics of climate change is straightforward. Virtually every activity directly or indirectly involves combustion of fossil fuels, emitting carbon dioxide into the atmosphere. If there is a single bottom line from economics, it is that we need to correct this market failure by ensuring that everyone, everywhere, and for the indefinite future faces a market price of carbon that reflects the social costs of their activities. Economic participants—thousands of governments, millions of firms, billions of people, all taking trillions of decisions each year—need to face realistic carbon prices if their decisions about consumption, investment, and innovation are to be appropriate.

The most efficient strategy for slowing or preventing climate change is to impose a universal and internationally harmonized carbon tax levied on the carbon content of fossil fuels. An alternative would be a hybrid cap-and-trade system, but this approach has many subtle flaws.

Move next to the negative reasons not to use quantitative targets: Quantitative targets in the form of tradable emissions limits have failed in the case of the Kyoto Protocol. They have shown excessive price volatility, lose precious governmental revenues, and have not lived up to their promise of equalizing prices in different regions. They are unattractive bargaining tools because they can be tailored to favor the strong and disadvantage the weak. To the extent that carbon-price targets lead to carbon taxes, the administrative aspects of taxes are better understood around the world than marketable emissions allowances, and they are less prone to corruption.

It will be useful to use an analogy. Assume a country wishes to reduce its gasoline consumption. It could do so by issuing ration coupons (either to consumers or companies) and then having a market in tradable coupons. This would give a firm idea of the quantity reduction, but the history of rationing shows that it is highly inefficient and tends to become increasingly distorted over time. No country in the modern world takes this approach. A simpler approach would be to tax gasoline. This is administratively simple, raises revenues for governments, can have unfavorable

distributional impacts offset through income-tax changes, and is clearly a system that can endure decade after decade.

Now go a step further and assume that countries desire to harmonize their gasoline policies. Harmonization of gasoline taxes is simple. By contrast, the design of a harmonized rationing system would be challenging and subject to endless games and lawyerly disputes. The same logic applies to negotiating tax treaties or international trade regimes.

Modeling a Climate Club

To understand how a Climate Club would operate, it is necessary to move beyond description to analytical and numerical modeling of the incentives and behavior of regions with realistic economic and geophysical structures. The challenge of analyzing and modeling the science and policy associated with global warming is particularly difficult because it spans many disciplines and parts of society. An important approach to bringing the different fields together has been the development of integrated assessment models (IAMs). These pull together in a single model a wide variety of geophysical, economic, and political relationships so that projections, analyses, and decisions can consider simultaneously all important endogenous variables at work. IAMs generally do not aspire to have the most detailed and complex representation of each of its components. Rather, they aspire to have at a first level of approximation the most important relationships and ones that can operate simultaneously and with reasonable accuracy.

In the major study on which this article is based, I describe an integrated-assessment model (the Coalition-DICE [C-DICE] model) of economics, tariffs, and climate change that examines the effects of different potential Climate Clubs. I will not give a detailed report on the results of those simulations but refer interested readers to the original source for an extended discussion.

The C-DICE model is designed to find whether countries join a coalition of high-abatement countries and to find stable coalitions. It examines 44 different "regimes," where a regime is defined as an international target carbon price and a penalty tariff rates. The assumed target prices are \$12.5, \$25, \$50, and \$100 per ton of CO_2, and uniform penalty tariffs range from 0% to 10%. For reference purposes, the US government estimates the global social cost of carbon (or the damage imposed by an additional ton of CO_2

emissions) to be around $35 per ton of CO_2. In most models, a carbon tax of this magnitude would lead to emissions reduced 15% to 20% relative to a business-as-usual path in the near term. Most economic studies would recommend that the carbon price rise over time to reduce more sharply and even eliminate greenhouse gas emissions over this century.

Some Illustrative Results

I close by highlighting some of the conclusions of the modeling studies of a Climate Club. The first major result is to confirm that a regime without trade sanctions will dissipate to the low-abatement, NC equilibrium. A second surprising result is that, when trade sanctions are imposed, the Climate Club structure generates stable coalitions for virtually all sets of parameters.

A next set of results concerns the impact of different Climate Club parameters on the participation structure. For the lowest target carbon prices ($12.5 and $25 per ton of CO_2), full participation and efficient abatement are achieved with relatively low tariffs (2% or more). However, as the target carbon price rises, it becomes increasingly difficult to achieve full participation. For a $50 per ton target carbon price, the Club can attain 90%+ efficiency with a tariff rate of 5% or more. However, for a target carbon price of $100 per ton, it is difficult to induce more than the NC level of abatement. Figure 7.1 illustrates these results.

What is the pattern of gains and losses? The benefits of a Climate Club are widely distributed among countries. A few regions have losses in some regimes. However, the losses are small relative to gains for other regions. There are no regimes with aggregate losses.

A paradoxical result is that all regions would prefer a Climate Club regime with penalties and modest carbon prices to a regime with no penalties. This is even the case for countries that do not participate. The reason is that the gains from strong mitigation measures of participants outweigh the losses from the tariffs for nonparticipants—as long as the tariff rate is not too high. This powerful result indicates that a regime with sanctions should be attractive to most regions.

The analysis shows how an international climate treaty that combines target carbon pricing and trade sanctions can induce substantial abatement. The modeling results indicate that modest trade penalties on

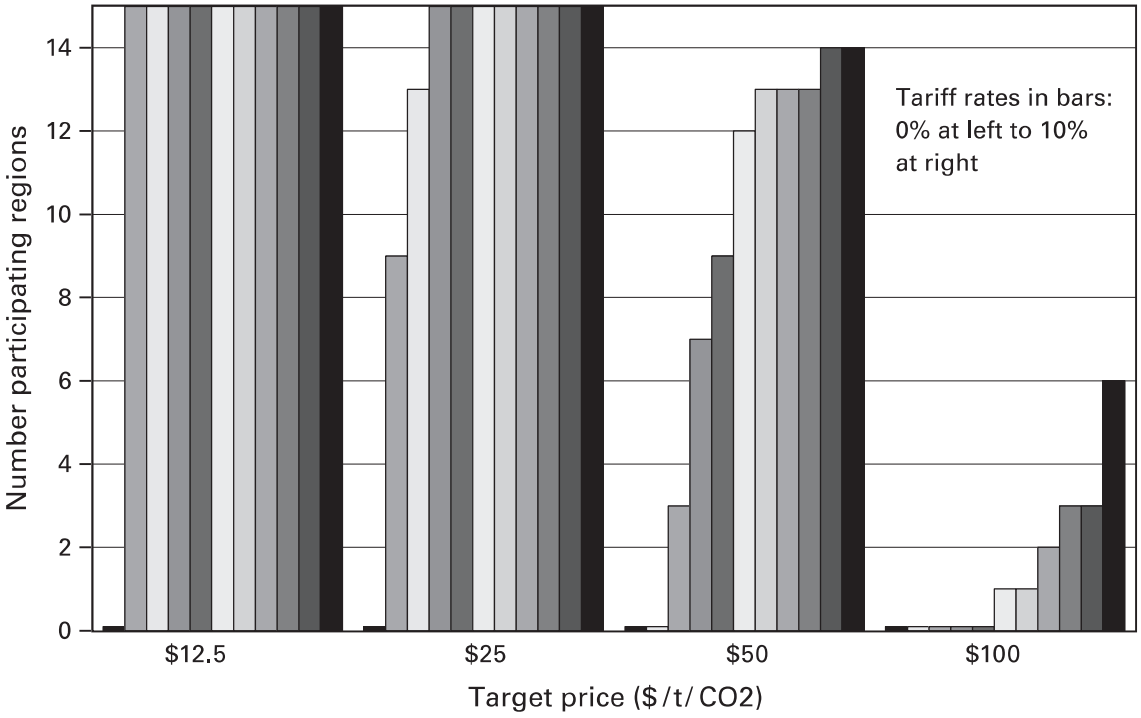

Figure 7.1
Number of participating regions by international target carbon price and tariff rate: The four sets of bars are the model results for four different international target carbon prices, running from left to right as shown at the bottom. The 11 bars within each set are the penalty tariff rates, running from 0% to 10%. Note that each set has zero participants for a 0% tariff. The vertical scale shows the number of participants. These results are based on the author's C-DICE model. For the source, see Nordhaus, "Climate Clubs," in the references.

nonparticipants can induce a coalition that approaches the optimal level of abatement as long as the target carbon prices are not too high. The attractiveness of a Climate Club must be judged relative to the current approaches, where international climate treaties are essentially voluntary and have little prospect of forging agreements that can effectively slow climate change.

References and Historical Notes

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