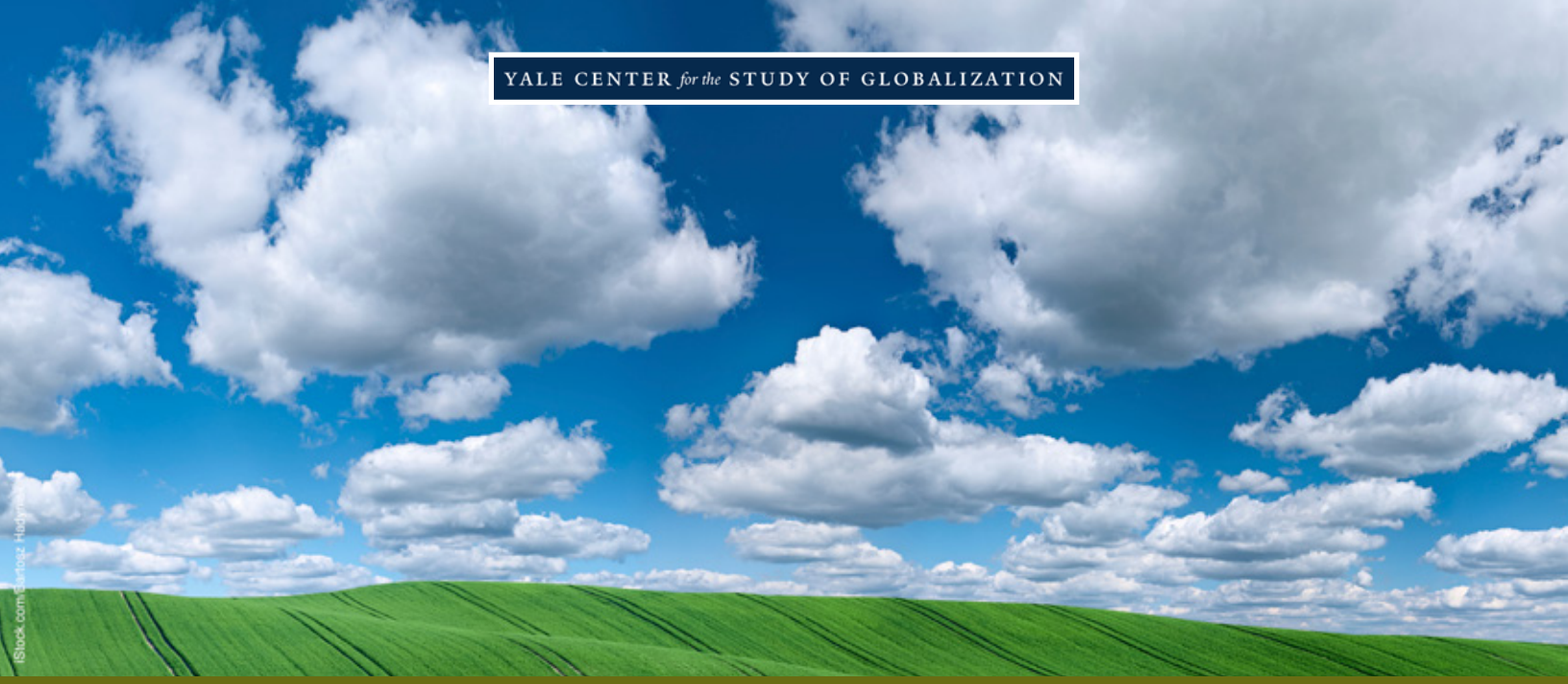

Global Harmonized Carbon Pricing: Looking Beyond Paris

Yale Center for the Study of Globalization, International Conference, May 27 and 28, 2015

Session Four:

The challenge of achieving participation and compliance

Presentations and Discussion

PARTICIPANTS

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Session Four — The challenge of achieving participation and compliance

This session will discuss the alternative instruments for promoting participation (including the modality of a "club"), procedures for monitoring, mechanisms for enforcement, and in particular address the question of whether trade policy should be entertained at all, or under which circumstances, as the instrument for achieving participation and enforcement of such international agreement. Some of the thorny issues that need to be addressed are inconsistencies with existing international trade law, potential damage to the multilateral trading system, and the role of the dispute settlement understanding of the WTO.

Presentations

Samuel Kortum

Okay, let's begin. It's great to be here. I'm a trade economist and not an expert in these issues. But it's a very exciting set of issues for a trade economist and I dabbled a little bit in them when I was at Chicago. One of the things that sort or jumped out at me is the importance of the free rider problem, even aside from the issue of carbon leakage. And I think that this panel coming at things from very different angles is going to emphasize that issue. We have economists, lawyers, all sorts of people contributing here. Our first speaker will be Bill Nordhaus.

William Nordhaus

I would begin by saying how grateful I am personally, but also institutionally, at having someone like Ernesto Zedillo here. Conferences such as this have enriched our university, not just

areas like this, but on nuclear non-proliferation, meetings on trade, drug policy, and many other areas. So, we are very grateful to him more generally, but also for this meeting.

My talk is about Climate Clubs. Here is the background: 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, it has up to now proven 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. 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.

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.

My suggestion is that the Kyoto Protocol ran aground, and 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.

So, in talking about free riding in climate agreements, I want to emphasize that it is a positive theory, not a normative theory. It is a theory about how countries will behave assuming countries behave in their self-interest. Without international agreements, countries will end up in a non-cooperative equilibrium with very low abatement.

With international cooperation, it's actually a little more complicated, but the result differs very little. Without sanctions on non-participants, you end up with what I call the small coalition paradox. You may end up with a few small, bottom-up treaties, such as China and the U.S. joining together. But under the small treaty paradox, the only stable treaties are ones with a very small number of countries. Because of the free riding, as you get larger and larger coalitions, they're unstable.

So the bottom line is that the current approach will lead (as it has led) to minimal abatement.

One approach that I would like to consider is to have a Climate Club. So what is a club? While 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 in order to gain the benefits of membership.

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) that 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) that the cooperative arrangement, including the dues, is beneficial for each of the members; (3) that non-members can be excluded or penalized at relatively low cost to members; and (4) that the membership is stable in the sense that no one wants to leave.

Here is a brief description of the proposed Climate Club: The club is 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 CO2. Countries could meet the international target price requirement using whatever mechanism they choose — carbon tax, cap-and-trade, or a hybrid. But the harmonizing mechanism is a carbon price.

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

In order 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 presentation is based, I describe an integrated-assessment model (the Coalition-DICE or 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 you to the original source for an extended discussion.

The C-DICE model is designed to find whether or not countries join a Climate Club, 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 rate. The assumed target prices are $12.5, $25, $50, and $100 per ton CO2, 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 CO2 emissions) to be around $35 per ton of CO2.

In most models, a carbon tax of this magnitude would lead to emissions reduced 15–20% 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.

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 (the Kyoto model) will dissipate to the low-abatement, non-cooperative 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 CO2), full participation and efficient abatement are achieved with relatively low penalty 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 plus percent 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 non-cooperative level of abatement.

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 an ineffective regime with no penalties. This is the case even 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 non-participants — 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.

To summarize: The analysis shows how an international climate treaty that combines target carbon pricing and trade sanctions can induce substantial abatement. 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.

I will wrap up here. Let me emphasize there are many issues raised by the idea of a Climate Club. How do we get started? How does it fit in with international law? How can we get people to move from the Kyoto model to the club model? What is the right price?

But before we talk about those, I just want to plant this seed and see if it grows.

Samuel Kortum

Thank you. Now we have Carolyn Fischer.

Carolyn Fischer

This is a session on participation and compliance. I'm going to talk about border carbon adjustments and why they're not just for participation and compliance.

I think fundamentally, the big reason we're here is the problem of carbon leakage. When countries take actions unilaterally or sell globally it's like squeezing on a balloon. If you price carbon when not everyone else is, you may be sending emissions elsewhere.

There are several channels for carbon leakage. I think the one that pops up in most people's minds, especially politicians' minds, is the competitiveness angle: the concerns that economic activity manufacturing in energy intensive industries is going to shift abroad where it's cheaper because they don't have to pay the carbon penalty. But actually, modeling shows the bigger effect is through global energy markets. If some countries, the U.S., Europe, would draw our demand for fossil fuels and we run down that supply curve, the prices fall, and that just makes it cheaper for India to pay for oil and consume more, even without moving any manufacturing plants.

There are a couple of other channels. People have looked at income effects — they're pretty second order. And some folks have also looked at technology spillover. Theoretically you could get some negative leakage if the carbon policy produces a lot of innovation and clean technologies, brings down their cost and they spill over to other countries. So, theoretically there's a possibility for negative leakage. But the fossil energy and competitiveness issues are important.

What are the main options for coping with carbon leakage? Well, the first one is the best one:

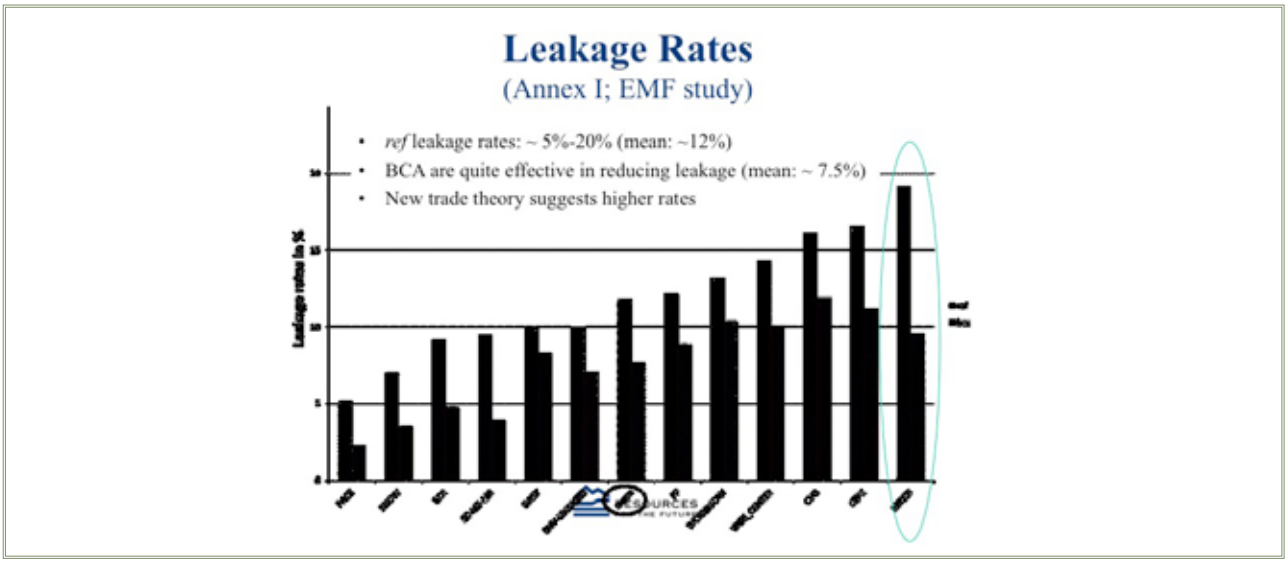
it's a global price on carbon. I think that's what we're all here trying to get. That would be the ideal because that's the only mechanism that really addresses all of the channels of carbon leakage.

Barring that, what are you left with? Not such great options. You can weaken your policies, then you get less leakage. That doesn't really get us to where we need to go in terms of emissions reductions. There's kind of a neat idea: instead of withdrawing demand for fossil fuels, withdraw supply. So, if we could convince Canada and Venezuela to stop drilling for oil and Australia to stop extracting coal, that would be great. But that's highly unlikely. We could give away our clean technologies and deal with the spillover channel, but that still doesn't get at competitiveness and that's what we're left with in terms of dealing with carbon leakage.

This does set up some of the tensions with the trade regime because competitiveness is not a reason — there is no Article XX exception for competitiveness. It's the same reason as protectionism. Reducing carbon leakage and obtaining your environmental goal is, so it's a little hairy because in this case they're linked because this is the one channel we can get at.

There are some different options for dealing with competitiveness. The popular one is exempting the trade exposed sectors. This is done a lot with energy taxes in Europe. There are a lot of energy exceptions. This isn't great because you lose a lot of cost effective opportunities in these sectors to get them to reduce their emissions. There is output based rebating, which I'm happy to expand upon later. Benchmarking, maybe using emissions allocations preferentially to trade exposed industries, is not bad. It can improve the efficiency overall taking into account for leakage, but it's not great because then you're not really sending the right signals to consumers that these energy intensive products have carbon embodied in them that we should be thinking about and trying to find alternatives to them.

There are sectoral agreements Scott has worked on, some of these issues. At least you can target the competitiveness sensitive sectors and get all the big players regulating carbon in them so you're a little more comfortable trading. And then there's border carbon adjustment. This is the idea that you would place a charge on imports, on products from energy intensive sectors based on some measure of their carbon content, and that way try to have more of a destination based carbon tax where consumers are facing consistent prices regardless of the origin of the product.



This is from a, this was from an EMF study, so a cross model study we did on border carbon adjustments with a bunch of different models. This is looking at leakage rates. So, the bar on the left, this is by model, leakage rates without border carbon estimates, so just with a carbon price. We see that border carbon adjustments do reduce leakage, but they don't totally get rid of it and that's because they can't get out of that energy market channel. You still have it. But they reduce it by maybe about a third on average.

And I'll just point out that the range is from 10 to 20% for most of them. But this model here (circled in green), this is the Colorado School of Mines Model that's based on new trade theory. This is the only model that does that, places it in a world with heterogeneous firms and monopolistic competition. Modeling this new trade theory, you get much bigger leakage rates and much more effectiveness of border carbon adjustments, just to throw out some of the things that are driving this range. Leakage rates, if you're looking at them in terms of particular sectors, can also go much higher.

A couple of years ago I was involved with a group of mostly NGO people, economists, trade lawyers, development specialists, to think through the following: seeing that border carbon adjustment proposals are coming down the pike, what do we think might be a reasonable elaboration of this policy that would be somewhat disciplined? It would be prone to abuse and more likely to achieve the environmental outcomes and thus conform to a variety of international agreements — kind of a golden rule. How do we think we might do this? It forced us to go through a lot of the details.

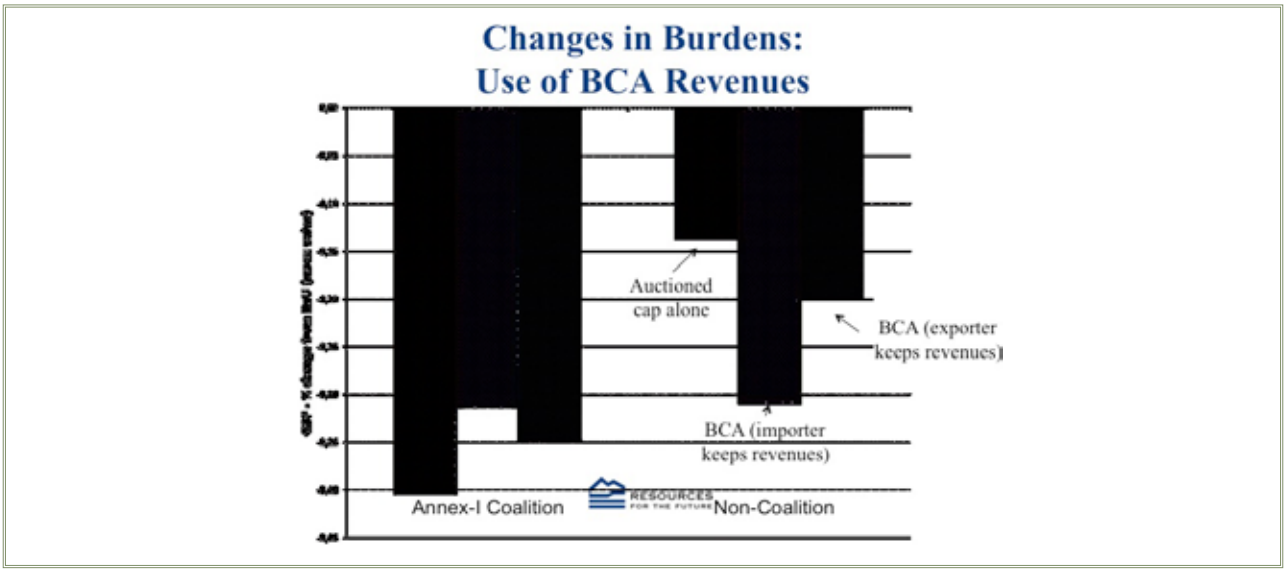
The main international obligations you have to worry about a previous speaker already told us about the WTO non-discrimination principles, but there is this Article XX exception in that. Of course, it doesn't apply to subsidies. But in addition to that, we have the principle of common but differentiated responsibilities that Richard [Cooper] wants to throw out but has been agreed to formally in several international agreements. So, we needed to be sensitive to that.

We thought through what are the potential motivations for using border carbon adjustments? First and foremost, we identified preventing carbon leakage. This is the one that conforms with the GATT Article XX goal. If you think that you're going to need to rely on the Article XX exception to make this policy WTO compatible, then you're going to have to show this is primarily for preventing carbon leakage.

Politically, competitiveness concerns are very popular, but this isn't a legitimate motivation. Although, if you don't address the competitive concerns, you're not going to get a significant carbon price. But I think that's a harder argument to make. In practice, it is important for facilitating agreements.

With regard to the potential for leverage, this is creating an incentive for your trade partners to take on more ambitious policies. This is viewed as potentially a serious violation of common but differentiated responsibilities. If we're not supposed to have the same expectations for developing countries in order to take on the same kinds of policies or carbon prices, having as your main motivation for border carbon adjustment, this kind of leverage may be an issue.

Then finally, enforcement for this session. My understanding is that if you're party to an agreement, you can agree to whatever you want. You can agree to border adjustments as an enforcement measure for not complying or for agreeing to a lower carbon price than the other guys in the club. That's fine. But the question is, can you use this as an enforcement measure for non-club members? This is one of the issues that Bill raised, because if you're outside the club, you're not agreeing to the rules.



What we have here is getting to this question, and Massimo brought it up yesterday about the distributional effects. This is a 20% emissions reduction for members of the Annex One Coalition. And this is the change in welfare as a consumption based metric of welfare. So, we see the cost of the coalition with just the carbon price. The next one is their cost with border adjustments. So, it lowers their cost. And then the third bar is border carbon adjustment where the exporting countries get to keep the revenues.

This is an idea and one way to increase your compatibility both with Article XX and with common but differentiated responsibilities is to show that you're not doing this for protection. Don't keep the revenues. We'll return it to the developing countries potentially in a mitigation adaptation fund or just directly to the exporters.

So you see here for the non-coalition parties, the first point is, they don't benefit from the coalition regulating carbon. They suffer welfare losses. So, it's not that they're running away to the bank while we take over the world economy. A lot of their trade partners now are reducing their demand.

Border adjustments really shift the burden further. There are big changes in terms of trade and they suffer much bigger welfare losses and these are developing countries. So, that may be a concern. If, however, they keep the revenues, this mitigates a lot of that additional burden shifting.

You can see the tension here that if you don't give them back the revenues, then their welfare in and out of the club is pretty much the same. So, it's a much bigger incentive to join the club. But if that's in conflict with common but differentiated responsibilities, you know, you don't want to punish them. But then the difference between being in and being out of the club is much bigger.

I just want to point out there are tensions between what we're trying to achieve with encouraging people to be more ambitious and take on carbon prices versus respecting some of our other international obligations. I'm happy to talk more about other details but I'll stop there.

Samuel Kortum

Okay, next we have Santiago Rubio.

Santiago Rubio

First of all I would like to thank Mr. Zedillo for the invitation to participate in this conference on carbon taxation and international environmental agreements. I would like also to thank the Center for the Study of Globalization for giving me the opportunity to visit Yale University.

The title of my presentation is: "What kind of climate club?" Recently, Professor Nordhaus has launched the idea of a Climate Club to face climate change. According to his proposal, the aim of the agreement would be to implement an "international target carbon price" with signatories using whatever mechanism they choose — carbon tax, cap-and-trade, or a hybrid — to meet the target instead of an agreement as the Kyoto Protocol on emissions. To stabilize such kind of agreement, non-signatories should be penalized. The penalty proposed is uniform percentage tariffs on the non-signatories' imports. Other scholars, among whom I am one, have moved in the last years in a different direction proposing a technology agreement leading to increased R&D in clean technologies to reduce abatement costs as an alternative to international cooperation on emissions reductions. In my presentation I would like to talk briefly about the proposal I'm working on: an international research joint venture to develop breakthrough technologies to control climate change, a different idea than that proposed by Professor Nordhaus; and to conclude, I would like to compare it with Professor Nordhaus' proposal.

I want to begin by mentioning a paper I published last year in *Resource and Energy Economics* entitled "Sharing R&D Investments in Cleaner Technologies to Mitigate Climate Change" where we examine the stability of an international cooperation on technological development. The focus of the paper is on mitigation and the result is pessimistic: the technology agreement does not lead to a substantial increase in participation. The focus of the present research is on "breakthrough" technologies that eliminate emissions, i.e. we focus on a zero-emissions technology treaty. A first analysis of climate treaties and "breakthrough" technologies was developed by Scott Barrett (2006) who also published in the *Journal of Economic Perspectives* in 2009 a survey of the possibilities of developing these technologies. The aim of our investigation is to analyze which could be the level of participation in a zero-emissions technology treaty.

So, let me present briefly what I have done up to now. The work done consists of the definition and solution of an R&D agreement formation game. It is a game that has a lot of features in common with the exercise that Professor Nordhaus has presented in this conference. Firstly, I'm going to present the payoffs of the players (countries), second, the timing of the game, and third, the main results.

The payoffs of the countries are given by the net benefits associated to the energy consumption. The national net benefits have three components. The benefits that depend of the country level of energy, the environmental damages that depend on global emissions — a global public bad — and finally the investment costs. National emissions are the product of the level of energy and the emission intensity of the energy system, which can be reduced by investing in cleaner technologies. In this way we take into account that there are two ways to reduce emissions. One is to reduce energy production and consumption. In this way, the country pays a cost in term of lesser benefits. The other is to invest more.

A key assumption of our model is that there exists a threshold for investment that, once reached, allows the economy to implement a "breakthrough" technology. Above that threshold, the emission intensity is zero and the country is free of GHG emissions.

So, what I have done is to solve this standard model but focusing on corner solutions. I have investigated which are the conditions that support a corner solution, and then I have analyzed the stability

of the technology agreement for these conditions. In order to derive explicit solutions for the different variables of the model, I have used a linear-quadratic specification of the net benefit function, assuming a linear-quadratic specification for benefits, a linear specification for damages and quadratic investment costs.

In the model it is assumed too that the effective investment in a country depends on the amount invested in that country in addition to the investments in R&D undertaken in all other countries. In other words, in the model are taken into account the effects of spillovers in R&D from one country to another. However, technological diffusion is not perfect; only part of the R&D investments undertaken in other countries is beneficial for a specific country. This beneficial effect is measured by the degree of spillovers that could take values between zero and one.

Moreover, countries can achieve larger technological spillovers by means of appropriate instruments such as technological cooperation. Cooperating countries can allow for patent agreements that provide the other countries in the coalition with a large share of their own innovative technology or they can sign agreements on technology transfers and/or joint R&D projects that increase the degree of innovation spillovers inside the coalition. Following the approach proposed by Kamien et al (1992), it is assumed that when countries cooperate they pool their R&D efforts so as to fully internalize spillover effects, which implies that in this case the degree of spillovers is the unity for signatories' investments and positive, but less than the unity for non-signatories' investments.

Thus, three cases can be distinguished depending of the value of the degree of spillovers for non-signatories. If the degree of spillovers is equal to one, then the effective investment is a (pure) public good. All countries benefit from the investment undertaken in all other countries. When the degree of spillovers is between zero and one, we have an *international research joint venture (IRJV)*; and finally, if the degree of spillovers for non-signatories is zero, then we have a *club good* because in this case the signatories can exclude the non-signatories from the benefit coming from their investment.

For the case of a public good, we are going to have problems to get a high level of participation. What would happen if a technology agreement comes to substitute for an emission agreement is that an agreement for cooperating in the provision of a public bad, the global emissions, is substituted by an agreement for cooperating in the provision of a public good, global effective capital; but for both types of agreements, the free-riding problem prevents the efficient provision of the global public good or bad. In the case of an IRJV an asymmetry appears between signatories and non-signatories. The effective investment of the signatories is equal to the total investment of signatories of the international research joint venture plus the spillover effects coming from the non-signatories' investment. However, the effective investment of the non-signatories is equal only to their national investment plus the spillover effects of the rest of the countries. So there is an asymmetry here. This asymmetry promotes participation in a technology agreement as El-Sayed and Rubio (2014) have shown, but not significantly if the focus is on mitigation. Finally, if it is possible to form a climate club, the signatories can exclude the non-signatories from the benefits of the club good and then participation is larger than in an IRJV but not very large.

Next, let me explain quickly the timing of the game. The R&D agreement formation game has three stages. The first stage is the membership game. In this stage, countries play a simultaneous open membership game with a single binding agreement that guarantees compliance with the agreed investment in the second stage. The level of participation is given by the internal and external stability conditions. The internal stability condition requires that any signatory country is at least as well-off staying in the agreement as withdrawing from it, assuming that all other countries do not change their membership status. The external stability condition similarly requires any non-signatory to be at least as well-off remaining a non-signatory as joining the agreement, assuming once again, that all other countries do not change their membership status.

At the second stage, the R&D investment game, signatory countries pool their R&D investments so as to fully internalize spillover effects between signatories and coordinate their R&D activities so as to maximize the aggregate net benefit of the agreement taking as given the R&D investments of non-signatories. On the other hand, non-signatories choose their investment in R&D acting non-cooperatively and taking the investment of all other countries as given in order to maximize their national benefits. Signatories and non-signatories choose their R&D investment simultaneously. Thus, R&D investments are provided by the *partial agreement Nash equilibrium* with respect to a coalition. Finally, given the level of participation and the investment in R&D of all countries, at the third stage, the emission

game, each country simultaneously selects its own emissions acting *non-cooperatively* and taking the emissions of all other countries as given. The game finishes when the emission sub-game is over.

The solution to the game shows that there exist two threshold values for marginal damages, such that if marginal damages are larger than the lowest threshold value, the grand coalition implements a "breakthrough" technology and emissions are eliminated, and if marginal damages are larger than the highest threshold value the fully non-cooperative equilibrium also implements a "breakthrough" technology, in other words, with large enough marginal damages cooperation is not necessary to eliminate emissions although they would be eliminated in an inefficient way. Moreover, we find that there exists another threshold value between those defined above such that if the marginal damages are larger than this third threshold value, the grand coalition is stable.

There is no time to explain these results in detail but it is clear that they solve what is known in the literature on international environmental agreements as the *small coalition paradox*. The small coalition paradox was establishes in the early nineties and although there are different versions, the most popular version says that the larger the gains from cooperation, the lower the level of participation. Our analysis show on one hand that the larger the marginal damages, the larger the gains coming from full cooperation and, on the other hand, that the larger the marginal damages, the larger the membership. Combining these two results, we get that the larger the gains from cooperation, the larger the participation — just the contrary of what is established by the small coalition paradox. Moreover, we find that only when marginal damages are large enough to justify the implementation of a "breakthrough" technology, the grand coalition is stable. In other words, participation increases with marginal damages but the grand coalition cannot be stable if the marginal damages are not larger than the threshold value that justifies an investment level big enough to completely eliminate emissions.

Finally, I would like to devote two minutes to compare these results with those derived by Nordhaus (2015). Professor Nordhaus, using the C-DICE model (Coalition Dynamic Integrated model of Climate and the Economy), solves numerically a coalition formation game with 15 regions very similar to the one I have just presented, and he finds that the grand coalition is stable with small tariff rates provided that the marginal damages are not very large ($12.5 or $25 per ton of CO2) but that participation falls drastically when the marginal damages are large. For a target price of $100 per ton of CO2, the maximum membership is 6 regions for a 10% tariff rate, the maximum tariff rate considered in the analysis, and participation decreases to 3 regions with a decrease of 1 point in the tariff rate. Thus, the Climate Club proposed by Nordhaus could not achieve a lot of the potential gains when these are large, i.e. when marginal damages are important. For a target price of $100 per ton of CO2, the club consisting of 6 regions only could achieve the 40% of the potential gains coming from full cooperation, and this percentage drops to a percentage below 10% with a decrease of 1 point in the tariff rate. Contrary to our results, Nordhaus's conclusions are consistent with the small coalition paradox.

To conclude, let me answer the question with which I opened this presentation: What kind of climate club? The answer is clear, it depends on how large is the social cost of carbon (marginal damages). For low and medium values, an international target carbon price with trade sanctions could promote a lot of participation but for large values we should look for other alternatives. One of these alternatives could be a technology agreement to promote the adoption of "breakthrough" technologies.[1]

Samuel Kortum

Now we have Scott Shelton.

Scott Shelton

I think I'm the lone administrator in the room. My presentation is not going to be modeling or economic theory. I have listened to a number of very thoughtful presentations and my presentation will take the approach that you have convinced me in a very decisive manner that carbon tax is the appropriate way to go and I will focus on how do you successfully implement that policy. I will look at the design of the taxing instrument from two bases; one being a country's ability to manage and implement that tax and two, the ability of the targeted tax base to understand the policy intent and comply with the law. If either of those two are frustrated by the design of the policy, they will frustrate or impede the successful implementation of the policy intent of the tax.

It's important in both developing and developed economies to take into account the institutional capacity to administer a new tax, but it's especially an important consideration in developing econ-

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omies where institutional capacity is generally weak. Another consideration is that institutional capacity where it does exist is normally concentrated. A tax policy that focuses on a specific economic sector which involves a number of regulatory agencies that have limited and/or concentrated experience and expertise emphasizes the need to consider the institutional capacity of agencies/departments within a government to monitor and manage the tax.

It's not my intent to say from an administration point of view that the number one aim should be eliminating the administrative complexity in designing law. Obviously, policy intent is paramount.

The first point, I would make is that an effective administration of a carbon tax or any other tax requires that you have a considered and well-defined tax base with a clear underlying policy objective. The larger the tax base that you identify, the harder and more complex it will be to manage. The more sophisticated that tax base is in complying with similar tax laws, the fewer compliance issues you're likely to encounter.

Defining your tax base is dependent on the methodology you choose to tax. So, you're going to have to select not only what you're going to tax (consumption vs. emissions), but at what point you are going to tax. As I take you through a number of options, I will discuss what I see as the complexities that might frustrate a successful implementation of a carbon tax. Ultimately, the message that I would deliver is to keep it simple so taxpayers can understand and comply and governments have the capacity to administer it.

So, let's talk about what you tax. You either tax emissions or you tax consumption. The first option, you tax all emissions. It has a clear, straightforward policy objective. People would see that as fair as everybody is effected by the law. It's comprehensive. It minimizes leakage. The only constraint is that there are some administrative practicalities. One of the pluses that comes from this is that you can use an upstream tax base to tax emissions indirectly as you would design it in relation to the carbon content of the combustible product. As you would be applying a tax to a product defined by its carbon content, the tax would be similar to an excise tax.

An upstream tax was talked about in an earlier presentation and I want to clearly define what I mean by upstream, which is different from the earlier presentation. Upstream is not production from a well or a mine face. The upstream process is taking carbon fossil fuels to a stage where they can be put into a process where they're combusted. So, you're talking about the outlet of a refinery or possibly the mouth of a coal mine, if the coal does not have to be processed further.

Audience

You're talking about taxing the production stage of a combustible product, how is that different from Robert's [Schmidt] proposed upstream tax?

Scott Shelton

I don't want to speak for Robert, about his proposal to tax at the upstream stage. My understanding

of Robert's proposal was that you're talking about taxing production, production from an oil well, for instance. In my scenario I'm not talking about that. I'm talking about the taxation point being at a finished product stage as it leaves the refinery.

The next scenario realizes that there are a number of pressures that have been talked about for governments to exempt parts of the economy that are going to be negatively affected by the implementation of the tax. There is a policy case to be considered for protecting any disadvantaged domestic business. A tax on emissions with some business exemptions included obviously increases administrative complexity. The negatives of introducing exemptions are they could cause leakage, probably will cause leakage, maybe frustrate the policy intent and increase global emissions. It has a less clear policy objective. The taxpayer base may not understand the policy objectives. It's not comprehensive. And it may require not utilizing an upstream but a downstream tax base. If you use an upstream tax base, you can't adjust, or it is more difficult to adjust for negatively affected domestic taxpayers who are further down the value chain. So, you may have to abandon the upstream tax base and go to one further down that value chain, which will increase the number of taxpayers that are going to be included in your tax base.

The last option I will consider, and there are probably others, falls under the concept of the polluter pays. This is a tax on consumption. The concept is that the tax would apply to all domestic activity at the point where the end user (polluter) acquires the product for use, which would also include a tax on emissions produced in the upstream process to produce the product. In this scenario there is a concern that you may miss the carbon content of imported goods that are consumed within the domestic economy. Therefore, there is a need to put a tax on imported carbon intensive goods coming into the country. Exporting countries would exempt carbon intensive goods and services being exported, as they would presumably be taxed in the destination country. This would be the case, unless the country is part of a carbon pricing club, as has been discussed in other presentations. The policy case for this option is clear: that it's to tax emissions produced to meet domestic consumer demand, if they're not taxed elsewhere.

Under this last option, what are the complexities you would need to consider before implementing a consumption tax? One, the complexity of measuring the carbon content of imported goods, is a difficult, if not impossible task to resolve. More than likely you would have to utilize an approximation of carbon content. Second, the WTO as you've heard in other presentations is a possible issue. The rules for taxing international flows will have to be within the WTO rules. Thirdly, the complexity around the administration of a carbon pricing club, from my perspective and I'm relatively new to the game is, who's in the club? You've set parameters for entry into the club. You have to monitor to make sure that members continue to meet those parameters. Otherwise, you would obviously want to remove those people from the club and there will be countries, once they see the value of being in the club, that will want to join. There has to be a due diligence process around entry into the pricing club and the maintenance of that membership. Again, something that increases the complexity.

In the interest of time, I will go to my conclusion on a carbon tax based on administrative simplicity. The process of implementing a carbon tax should first of all be an emissions tax starting with the fossil fuels. Other sources of emissions, as they would be more difficult to tax (if considered), should be at a later date. The point at which a country should establish liability for the tax should be at the upstream level. This establishes a tax base that is small in number and is easily identifiable. As an example, in the U.S., you're down to probably in the neighborhood of 1,500 sophisticated taxpayers to be administered.

The upstream outputs of this tax base are already subject to an excise tax in most countries. This means there is already a process in place to identify the outputs and it should be relatively simple to attach a carbon content to those outputs. It will also catch CO2 from non-energy use such as asphalt. So that is why you have a small, sophisticated tax base and you have easily identifiable outputs that you can tax. There may be synergies at some point for taxing methane emissions. An upstream tax will be a comprehensive tax on fossil fuel combustion and with no, or limited, exemptions, there's limited scope for avoidance.

Other practical concerns to consider and address:
A) You're going to have a number of different regimes worldwide that are going to be in place and continue to be in place. (1) You have a carbon comprehensive carbon tax model in a number of countries. (2) You have carbon tax models with exemption thresholds. (3) You have, what I would call, targeted carbon tax, a carbon tax for a limited number of sectors and/or activities. (4) You have emission trading schemes. (5) You have different CT rates. (6) And some regimes allow payment for the tax in carbon credits. These different regimes will need to be reconciled in order to establish a fully integrated international tax system for carbon tax. This will introduce monitoring issues for tax administrations. For example, how do emission trading schemes and carbon tax work together? As we see in Sweden, it is treated as a double taxation issue. In Europe, you have an ETS and Sweden domestically introduced a carbon tax. Sweden exempted those institutions from a carbon tax that were also subject to the ETS. This introduces a concern for the revenue administration about their ability to monitor whether the companies that claim to be under the ETS trading schemes are actually registered and complying with the ETS scheme.

B) Administratively you're going to have Ministries of Mines, Ministries of Petroleum and the Revenue Ministries involved in the process in defining carbon content and administering the fiscal framework. Especially in developing countries where you have limited and concentrated expertise, a cooperative and coordinated regulatory process is required and simplicity is mandated.

C) I think one of the most important considerations is that most countries have an excise tax regime in place and carbon taxes currently implemented in the world mirror an excise tax regime. Therefore, most tax administrations will have relevant experience and processes in place to administer a like tax.

So, what are my recommendations? (1) Apply carbon tax on fossil fuel CO2 emissions initially at an upstream level. (2) I'm Canadian, so I have to refer to one of our provinces, British Columbia, who implemented a carbon tax on a graduated basis. I think that has a couple of positive aspects. It allows you initially to address the policy or administrative glitches while minimizing their economic effects. As you move up the level of tax, which has a larger effect on the economy, you have hopefully worked out those bugs. (3) Utilize a self-assessment system in order to minimize the cost of administration and the compliance burden. (4) Design should be similar to an excise tax regime, which for a tax administration is one of the simplest taxes to administer. (But this is not a panacea, the importance and concern about excise taxes has diminished as the more important taxes, corporate tax, the VAT, have taken the attention of institutional administrations. Relevant administrative experience may have been lost which may need to considered)

Discussion

Samuel Kortum

I thought I'd break the ice by asking a question first. I was puzzling over the Nordhaus proposal and why he didn't like the carbon duties. And here's my explanation, but I want to see if he agrees and I think I'd like Carolyn to reflect on it as well.

Say that there was no trade at all in the world. You'd still have the free rider problem. And I feel like Bill's proposal is really about that and then it happens to be that if you think of the world, well what penalty can we impose? Trade is the one thing we have going as a club in the world. And so that's where the penalty can be applied. It really has nothing to do with anything about carbon. I think that's the reason he's pushing that because it's really detaching the penalty from any kind of carbon tax adjustment issue. And then you can make it as strong as you want.

My feeling is that maybe the kind of tax he's talking about of say about a two, four percent tariff would probably rule out all the carbon leakage anyway. The kind of carbon tax we're talking about would be — what were people saying — like 25 cents. So 10% of the value, but then mostly we're not importing gasoline. Most of the things don't have such a high carbon content. So, it seemed like that would solve that problem as well.

I guess a question is, if we think about it this way, maybe that would take some of the emphasis off thinking about tax adjustments for carbon leakage. And just try and get a big group of countries to comply and then those who don't, there's not going to be leakage from them because of the tariff imposed on all goods.

William Nordhaus

Part of the reason I went with this route when earlier studies have focused on leakage, which is a problem when you have differentiated or lack of participation. I think the real problem is participation. Leakage is trying to shift the ballast around on a sinking boat and try to get the boat so it doesn't tilt in one direction or the other. But I think the problem is to keep the boat from sinking and that means we have to have high participation. That's the first reason.

Secondly, if we didn't have existing WTO rules and we weren't try to shoe horn an agreement into WTO rules, but if we just said there are no rules. We're just setting up an agreement, but we want

to harmonize, we want to have a system that will actually make this effective, and at the same time we're setting up WTO, then we might say, well, okay. We don't have a whole history of WTO law that we have to conform with and we might just use the Uniform Tariff.

There are really two reasons to go with the uniform tariff. One is that the border tax adjustment has been shown by modeling not to work. I've done an earlier modeling that shows it's not going to induce participation because it's only on a small fraction of a country's production. And the second thing, it's really complex. When you think of how to impose these tariffs it becomes very difficult. We just know it's going to be really complex. It was raised a couple of times today in the discussion.

I realize that it is not the way trade lawyers and trade economists think about sanctions of the trade system. I realize that, but what you have to think is that we need to find a way to design sanctions that is going to do what we want, which is induce participation. The things that are clearly conformed with WTO law, according to the current modeling, back of the envelope calculations won't do it. I think that's the logic of going this route, a different route for the trade sanctions.

Discussion Participant

Two small things. You mentioned that there are agreements, environmental agreements with sanctions and I understood you as saying that it would not be WTO consistent. I think they could probably all be WTO consistent. It all depends on how they're implemented. But there are at least 25 of them at the moment. None has ever been challenged. Of course, I'm not entitled to say whether or not, but you can draw your own conclusion.

I think that it falls directly under WTO first rule that at the border, whatever you do should be MFN, whether it's a tariff, administrative paper, or license — all countries should be treated the same. Now if you make distinctions, discrimination, those outside are punished. The issue is not discrimination. The issue, and it's now 60% of all the disputes, is whether the discrimination can be justified. The whole debate and the whole case, if there is one would be justification.

If you can demonstrate that this is necessary to ensure participation, I don't know how it would be assessed, but I would not reach the conclusion that it's necessarily clashing with WTO rules. It clashes with the basic MFN, non-discrimination, yes. Whether this is justified, still depends on how it works in practice.

Carolyn Fischer

What's nice about your modeling exercise and the *ad valorem* tariff is that it's very simple and you get a clear sense of the dimension of the punishment necessary to induce participation. I was coming from a perspective of thinking, well what could really be implemented and be compatible? So, that's very interesting to hear that there might be a way to use a non-carbon based metric that would be compatible with the justification being participation and not leakage. And the proposal that our group sent would be necessary to qualify for an Article XX exemption.

Some of the other things that came up in our exercise, we were not overwhelmed by the complexity, although there are a lot of decisions to make. Part of the recommendations were not to go too far down the value chain and really focus on the key commodities that are energy intensive and highly traded and find simpler metrics.

But then there are also these issues of what countries to exempt. And there is a standard exemption for the least developed countries. So, maybe that's part of what could be done to enhance compatibility.

In terms of the leakage aspect, if the *ad valorem* tariff induces full participation then, yes, you've solved the leakage problem. In the case where we need a high social cost of carbon, a high tax, and you're not getting full participation, then the *ad valorem* tariff is not going to differentiate among the higher and lower emissions intensity products. So, it's not going to be as targeted towards dealing with leakage as a border carbon adjustment would be. But some interesting questions.

William Nordhaus

I've talked to a number of trade lawyers and what I've learned from them is the kind of trade sanction that is in the proposed club is not clearly outside existing law. It's not clearly inside existing law either. There's some ambiguity.

My thought on that is I don't think you want to put in place a mechanism that is not clearly justified by existing law. You don't want to put in all the effort, negotiate a treaty, go on for years and years and then have the 1st Circuit throw it out because it doesn't conform with U.S. law. I think it's clear you need, in part of the treaty, to have what I call climate amendments that make it clear that the mechanism that you're introducing, and particularly a regime of non-retaliation, is conforming with existing international law and domestic law as well.

Samuel Kortum

Thank you. Okay, now we have lots of questions. I'm going to work from the back. Richard Cooper?

Richard Cooper

I want to make a general point on Bill's proposal. He happens to choose trade, but trade is actually unrelated to the problem at hand. It's just a way to punish countries that don't comply with what you want them to do. That is a very general problem. It is not limited to climate change. We have many, many examples of treaties we'd like countries to sign on to, including, in some cases, the United States is the outlier. And I want to make the point that if trade were literally to be used in this context, it would set a precedent for using it in many, many contexts. The non-proliferation treaty and the ICC and so forth, countries that say well, we really want Country X in. Country X is a free rider or whatever you want to call it and, therefore, we're going to impose trade sanctions.

I think we need to think about, as I said yesterday, the system as a whole, not just climate change or the trading system. We have to think about the system as a whole and the precedents that this sets. We have many ways to make countries comply with what we want them to do. Going to war is one

extreme. I haven't heard anyone suggest that we should go to war over climate change. But we could deny them some of the benefits of the WHO. You can make an imaginative list of things, and the point I want to make is that Bill has chosen trade. His use of trade is unrelated to the issue on the table. It is a way to make another country comply with what you want to do. It's a long list of possibilities on the one hand and it creates a precedent for many, many areas on the other hand and we have to think about both of those.

William Nordhaus

I think there are a number of points and their implications that Dick raises. But I'll not get to all of them. Is it really true that there are other sets of sanctions that are as fine tuned as trade sanctions and can be used in the same way with the same affect? I actually think not. If you go back and read about the history of sanctions such as in Hufbauer and Schott, they're actually a very limited number of tools that can be used.

Secondly, one of the things I didn't talk about, but one of the questions you can ask is, how finely tuned is this to get at the transnational externality? It's an interesting question and within the confines of the Ossa Model and the other economic models, the Uniform Tariff is reasonably closely tuned to the transnational externality — not 100% but it actually captures the transnational externality of carbon emissions reasonably well.

Third, on your central point, I think it's a very important point and I completely agree that we need to think very carefully about whether we want to make exceptions and whether this is one we want to make. Is climate change a sufficiently important problem that we want to run the risk of changing the trade system in this way? And again, that comes back to your first point about are there alternative instruments that we can use that are also effective in inducing participation and that have the same incentive compatibility that the trade system has?

And finally, another reason that I didn't mention the climate amendments is that that sets up a threshold that says, okay, this has to be a sufficiently important problem. Are you actually willing to amend the fundamental principles of the agreement, international and domestic law, to change them to include this as a kind of generic exception? An explicit one, not just one that you can shoehorn into existing articles.

So, I think you raised a number of really important points, but I think the fundamental question is, is this an important enough issue? I think it is. Are we making progress? Absolutely not. Can we think of another instrument that will have the same effect in inducing high levels of participation, at least as Professor Rubio said, at relatively modest levels of social cost of carbon? I don't know of any.

Samuel Kortum

Adele?

Adele Morris

Everybody keeps talking about free riding and I just want to challenge the notion from the U.S. perspective. I would argue that the U.S. is not free riding. Let me explain what I mean by that. I think the Obama administration is offering everything in its power under existing law and maybe, arguably, then some. So the U.S. administration has nothing else to offer and it's participating to the extent it can. What's holding it back is Congress, and the absence of a comprehensive, economy-wide price on carbon or other comprehensive new authority. And what's holding that back? It's not that the U.S. is sitting around saying, hey we're going to benefit from everybody else's mitigation and that's why we're not taking action. It's a whole set of other reasons, a gross under estimate of the benefits of litigation, a gross over estimate of the cost of action, a concern around the distributional outcomes of the action.

I don't think the joint announcement with China, the U.S. part of that, was in any way contingent on China's action. I think it was a joint announcement, not an agreement. It was like we're doing everything we can and I think we would have made exactly the same announcement irrespective of what China did.

So, the question that comes to my mind is, would trade sanctions potentially imposed against the United States overcome all the barriers I just described with the U.S. Congress? And it's hard for me to see a scenario where the threat of trade sanctions — first of all, I don't think the U.S. would ever agree to make itself subject to trade sanctions in any kind of a priority agreement about clubs — it's unfathomable to me that the U.S. would agree to do that. And even if we were at some point subject to trade sanctions, it's hard for me to see how that does anything to meliorate all the barriers I just described with regard to new legislation.

So, as sympathetic as I am to this basic idea of free ridership, when I look at the U.S. at least, that's not the dynamic that I'm observing within the political and economic climate in the U.S. So, I'll just throw that out there as my observation. It's not to say that this model of free riding doesn't apply to other countries or maybe just kind of broadly conceptually, but within the U.S., I just don't see that as the right name for the dynamic we're experiencing.

Samuel Kortum

Jason Bordoff?

Jason Bordoff

I'll talk about this in my presentation in a minute. But the clean power plan from the EPA in terms of what it gets you from power sector reductions is probably on the order of a $10 a time carbon tax or something equivalent. If you look at the EIA modeling, there's not a ton of countries out there with a higher carbon price the last time I checked.

But really I was going to make the point that Dick Cooper made of why I think the idea, as intriguing as it is, actually strikes me as quite dangerous. There are ways in which sanctions, I think, are not

as blunt an instrument as some of the older literature suggests. Some of the recent experience with Iran and Russia has shown a lot of creative and innovative uses of sanctions targeted at very specific sectors of the energy sector, of the banking economy. And when we think about the potential — first, it wouldn't be like one policy mechanism. You'd think about a carbon price, but you'd have to account for the fact that other people are going to use other tools and regulatory approaches and whatever else. Then you need to draw those lines that Adele said yesterday are really hard to draw for the guy sitting at the Treasury Department, and it's easy to see how political considerations and interest groups come into play. That this ends up being used to the point about the chapeau who is not in the right spirit and from a protectionist standpoint, not necessarily an environmental exception justification.

Then more broadly what I worry about is I look at where the global economy is headed and Ernesto or others may have thoughts on this. As we see sanctions being applied against Iran and against Russia, the Asian Infrastructure Bank, there are a number of efforts underway to actually disentangle what had become a more integrated global economy. These sorts of tools create an extra risk that actually the response would not be to join the club, but to try to pull further away and expose yourself less to the threat of sanctions from any small group of countries. Or that retaliatory tariffs could be applied in response to something else. So I think that danger is one that is very real and should not be underestimated.

Samuel Kortum

Thanks. Grzegorz Peszko

Grzegorz Peszko

This is a fascinating discussion and I have a lot of comments that have been said here already, although, I'm kind of sympathetic because I think what Professor Nordhaus suggested is that we are stuck a little bit in this kind of small coalition corner. And we need to find other out-of-the-box ways to induce the incentives to form the coalition. Certainly every choice will be risky and have side effects.

But I'd like to switch the gear a little bit and focus on the consumption-based charges that Scott has mentioned. He said that carbon taxes are based on the carbon content on the goods and services. It has to be squared with WTO. There's literature that suggests that actually if you impose them in a non-discriminatory way in the national jurisdiction and they equally apply to the carbon content in the goods and services produced in the country as well as imported, then they are WTO irrelevant, because they are not discriminatory. Could you comment on that aspect? But the point is taken that it's extremely complex. That can be a killer, but from the point of view of the kind of WTO compliance, I'd like to hear the comments.

Zhongxiang Zhang

I have two questions. The first is for Carolyn on leakage. I reviewed the literature on this and it basically covers two priority channels — the leakage competitiveness channel and the international energy fossil fuels price channel. The common finding is that most of the leakage actually comes from

the international fossil fuels channel. That basically means if the U.S. and the EU cut emissions, the more fossil fuel prices go down, the more China and India might use them. Did you service a model in your work to see whether this is still the case, that the port adjustment now is still the leakage channel, and mid-channel it is still fossil fuels?

My second question is about the U.S carbon tariff proposal and the implication in China. We argue from the WTO based on a few cases that are, like yours, imagined that as long as you have comparative effectiveness, in the end it is okay. In the climate field, that might look a little bit different. You still have to look at the comparable effectiveness, which are more focused on the results compared to the efforts. So, as long as the U.S. in the proposal says that if you don't take the comparable efforts, then the products that come to us have a carbon tariff. So you have to decide what the carbon contents are. But suppose you didn't do it. If you look at the cases, you mentioned like U.S. and Mexico and others, you basically said you can use this Article XX, but the primary purpose has to be to protect the environment. That has to be the primary purpose. So, suppose that the U.S. is arguing that it is trying to comply with WTO law; so China and India could come and they have to buy the allowance from a designated program from the U.S. That case is very questionable because if you are really considering the environment too, and primary effectiveness, why can I not buy some other carbon certified things, which maybe can achieve similar effectiveness, but we don't necessarily have to buy yours.

Samuel Kortum

Thank you. I'm going to take two more questions and then I'll let everybody respond, starting with Scott Barrett.

Scott Barrett

Thanks very much. What a great five presentations and a great discussion. I've really enjoyed this. I was going to ask two questions but before I do that I may start off with a brief comment on what Adele said.

I think the central problem with climate change is free riding. But there are two aspects to free riding. One is greed and that's how we often think about it. But the other is fear. The greed is obviously just about self-interests. The fear is the fear that you'll act and others won't and the job won't get done. One of the key things that you want an agreement to do is to give an assurance to all the parties that if each one makes a sacrifice, all would make sacrifices and all, together, will be better off.

I think the United States would support this because the first paragraph of that 1,400 Waxman-Markey bill was not about the United States. It was all about China and India. And, as you know, from the previous senate non-binding resolution just before Kyoto was negotiated, it was also about the rest of the world.

I think the United States cares as much about that as any country. I completely agree with Dick Cooper's point. This problem is completely unprecedented and the institutions that we have available are

not equipped to deal with it. And I think what Bill is doing is throwing something out that I think is provocative in many ways. But I think it should be stimulating people into thinking, how are we going to deal with this unprecedented problem with institutions we have that were never designed to deal with it?

I have two questions. One is for Bill, which is that his analysis assumes that the non-members of the new climate coalition are really rather docile. So the members of the coalition adopt the tariff, but the others all abide by the trade agreement and they're really quite docile. I'm curious as to whether he has investigated how these countries may want to respond. He did mention that some of the countries are actually quite happy to face the tariff because the agreement that has the tariff also is reducing global emissions and they benefit from that. But I am wondering if he has looked more deeply into this question of retaliation. It does seem to me that there's a risk to the entire trade system of using a measure like this that would be worse than anything because you not only aren't dealing with climate, but now you're also dismantling the success we've had on the trade side.

And my other question is for Santiago. He's pointed to the importance of these so-called corner solutions, which I think are hugely important. It's a radically different way of thinking about cooperation. And I'm just curious about what is actually going on in the corner? There's zero abatement, but why is it that that would be stable. If one party deviates from that, does everything fall apart? There must be some mechanism like that at work. I couldn't understand what it was.

Samuel Kortum

I'm acknowledging the other questions, but I want to start hearing responses. So, could we start with Scott Shelton. I think there are questions for everybody, so you can pick and choose.

Scott Shelton

The only comment that I have in relation to one aspect of my presentation that I didn't get to was, there's been lots of talk about how do you deal with the revenues that are generated from the tax. That's very important in my mind to the tax base and the public in general as to whether they see the tax as fair and adhering to its policy objectives. And I wanted to refer to the ETI transparency initiative as a possible aspect that you might want to consider from an administrative point of view, so that the public, the tax paying public, is well aware of what funds are collected and how those funds are being utilized.

Samuel Kortum

Thank you. Santiago?

Santiago Rubio

I would like just to make a general comment on all this debate about trade sanctions. If one looks at Nordhaus' (2015) paper and examines his stability exercise, the debate we are having on trade sanctions only makes sense if the international carbon price is in an interval between $25 and $50 per ton

of CO2. If the carbon price is higher, it doesn't matter whether trade sanctions can be implemented or not. Why? Because for instance for a carbon price of $100 per ton of CO2, trade sanctions are not going to be useful to promote cooperation. The costs of controlling emissions are so high that even taking into account trade sanctions, what you get is a very low level of participation.

So, it means that although all the debate about legal and political feasibility of trade sanctions is really interesting, it makes sense only if we expect a not very high carbon price. If it is not the case and the target carbon price we expect is above $50 per ton of CO2. We should begin to think on another proposal, maybe, on a technology agreement.

So about Barrett's question on stability, what's explaining the result is something really simple. Although the signatories' investment is larger than the non-signatories' investment for any level of participation, this difference is decreasing with the number of signatories. The diminution in this difference is explained because the necessary level of effective investment to develop "breakthrough" technology operates as an upper bound on the effective investment of the countries. Thus, the signatories' investment decreases with the participation once they have implemented a "breakthrough" technology, and this causes the difference between the investments of signatories and non-signatories to decrease with the participation.

On the other hand, the energy production of signatories is larger than the energy production of non-signatories because the emission intensity is lower for signatories than for non-signatories. In fact, once signatories have eliminated the emissions, the energy marginal damages, which are equal to the marginal damages of emissions times the emission intensity, are zero because the emission intensity is zero, and then the energy production is the same for the different levels of participation that support the implementation of a "breakthrough" technology. Thus, if we compare the net benefits of a signatory belonging to the grand coalition with the net benefits of a coalition structure with a unique non-signatory to check the internal stability condition of the gran coalition, the result is that the non-signatory supports lower investment costs but that the level of energy production and consumption it enjoys is lower and the damages are larger because the non-signatory uses a polluting technology. With low differences in investments, the reduction in investment costs are more than compensated by the reduction of benefits coming from the consumption of energy and the increase in environmental damages, and the final result is that the grand coalition is stable. Briefly, this is the argument explaining the stability of the grand coalition when emissions are completely eliminated.

Samuel Kortum

Thank you. Carolyn?

Carolyn Fischer

Okay, quickly, again Greg's question and then Zhongxiang Zhang too. In terms of the consumption tax compliance, I think the growing consensus I'm hearing in the international community is that border

carbon adjustments can be designed in a way that's WTO compatible. If it's well done, there's less concern about that.

But I think you're right on your intuition that something that's designed more explicitly as a consumption tax avoids getting into that debate at all. I'm actually working with some colleagues in Europe thinking about using a consumption tax on energy intensive goods as a way of undoing the bad features of the free allocation to get the prices right for consumers. And they feel that that would have an even easier time with the WTO compliance.

In terms of the effectiveness of border carbon adjustments, you're right, it seems that more of the leakage is through this global energy channel. And you just can't get at that without a really, nearly global carbon price. But they do have a substantial effect. So, with border adjustments just on the major energy intensive exposed sectors, we were getting a reduction of about a third of the leakage. So, that's, that is significant. And the other way to maybe try to get at the other stuff would be a bigger push on clean technology. So, making the rest of the world that's not regulating carbon pricing make cleaner technologies more competitive for them. So, that might be a way to go.

An overall comment, as an economist we're used to thinking in very specific ways and thinking very clearly about what is in our self interests and assuming that countries are primarily behaving in their own self-interests. And I would certainly argue that self-interest is an important component of decisions, but not the only one. As Adele was saying the administration is putting out everything that it can in its power. It thinks this is an important issue. So there is will to act, but there are constraints. I don't see it as a pure free riding problem, but competitiveness is a big issue that came up over and over again. It still comes up in discussions about a carbon tax on The Hill and carbon leakage.

So being able to deal with that will actually induce participation in more significant levels on players, although I don't expect anything with this Congress. But I think it is an important aspect.

I have two research questions that I would love to collaborate with folks here. One is with Ion, that you've done all of this work estimating the co-benefits of carbon pricing, I would like to bring that back into some of the border adjustment studies and see — because, you know, Bill is right. Border adjustments alone, at least these kind of limited border adjusts, for a lot of countries, aren't enough. In China in particular they aren't enough to get them in a self-interested way to want to participate in the coalition. But I'm wondering, if we add in the co-benefits that they would experience anyway in terms of reduced conventional pollutants and other things, how many more countries is it really in their interest? And would border adjustments be enough of a nudge to put them over?

The other question is for Bill. From your study, you see that when you get up to the very high social cost of carbon, like $100 a ton, the trade sanctions aren't that effective. I'm wondering, how much more effective are border carbon adjustments at that point because then they would get very high and targeted towards energy intensive industries and have possibly different effects, both certainly

for leakage, but also potentially for compliance and looking for the kinds of countries that you definitely want to get into the coalition. I would love to collaborate with you on that. Thanks.

Samuel Kortum

Bill?

William Nordhaus

Well there have been a number of very interesting comments and I'll just give one line responses to them given the time.

Just standing back, I think we have to recognize that we're not actually making much progress on reducing, or taming, the climate beast and reducing climate change. Given all the modeling — Massimo is here and you can just shake your head if you think I'm wrong — we're not heading toward any of these aspirational goals like a 2% limit or even a 3% limit. We're basically on the path now of unrestrained climate change. And for whatever we're talking about, whatever the motivations, whatever you want to call it — free riding, obstructionists, right wing governments, whatever you want to call it — we're just not making any progress.

So, that's part of what my thought is just standing back, not as an economist necessarily, but as someone who has thought about this and looked at different mechanisms and looked at what different people are doing. We're just not anywhere and you can look at that in terms of decarbonization rates in the United States. You can look at decarbonization rates within the world and different countries. We are just not getting anywhere yet.

On the food rioting thing, in a way I've already answered that. Politics is the art of doing what you want and throwing up a smoke screen so people don't really know what you're doing. Are the senators really interested in the interests of the United States? Probably not. Wyoming? Probably not either. Ideology versus opportunism? Who knows? It's a very complicated mechanism.

The Obama administration is not going to be very effective. Why doesn't the Obama administration say what it actually knows, that we need to raise carbon prices? I've asked that of many people and they say, well, the administration is not over quite yet. Maybe just hold your breath and it will happen.

I think whether it is free riding, it looks like free riding--let's put it this way. The Congress is not acting in the interests of Indonesia. Whatever it's doing or whatever it thinks its interests are, it's not in the interests of Indonesia, Bangladesh, India and other countries when it sets climate policy.

On the question of other sanctions, which was raised earlier, I was very surprised to hear that. The idea to bring other countries in while for this country we use banking sanctions and in this country we're going to use energy sanctions, for that country we're going to use steel sanctions and for this country we're going to use shrimp sanctions or whatever. If you just look at what's going on with the EU and their sanctions with respect to Russia, that is exactly what you don't want to do, aside from

the fact it's probably going to hurt Europe. You don't want a sanctions regime that's going to take forever and everybody's going to be arguing. You want something simple, clear, that analytically you know the impact of.

On Scott's point about docility and then there was another point over here about stressing the WTO. Are we stressing the trade system by imposing all these rocks on it? It's already a strained system. We'll put the non-proliferation rock on it. We'll just keep loading rocks on it. The point that I think was being made is that you have to make sure you have enough surplus in the trade system so you can load some other obligations on it. And I think one question is, are we really sure that all these countries will actually decide to continue to participate in the trade system when you start loading on these emissions obligations? I think that's something we need to worry about.

The point you made about the system not being able to support high prices I found to be a very troubling one. This is with today's economy, today's technology, today's emissions — those are the prices. Few people are saying we should have $100 a ton prices today. Almost all models have $100 a ton of CO2 sometime in the middle of the century to get any reasonable climate outcomes. So, I do worry at lot about that. But I actually haven't looked to see what the 2050 economy, 2050 emissions, 2050 technology, whether that could support the high carbon prices. That's just an open question.

What I do think is capturing is a really important point, is that the stresses of free riding, the strains of free riding, the strains of countries acting in their self-interest — and this would be either not participating in an agreement or cheating or lying or finding false emissions or submitting all kinds of reports or subsidizing things at the same time they're taxing them — all the kinds of stresses and strains that would come from a very high carbon tax has shown up here. But they're going to be real world strains. If you think of some of the models that have $200, $300, $500 a ton carbon taxes, if you just think of what that does to the petrochemical industry or any other carbon intensive industry. The idea that we actually know the emissions, the CO2 content, from a ton of coal, that's not correct. We know from CH4, but we don't actually know from coal and are varied by a factor of five or ten percent, depending on the source of the call.

One of the things either as economists working in this area or as practitioners we haven't really coped with is the fact that when you get into these high prices, you not only have the stresses and strains of free riding, but you're going to have the stresses and strains on the fiscal system of having a tax on something that's actually not that well measured and where there's all kinds of tax arbitrage considerations.

Discussion Participant

I think that maybe I was not understood properly. My point is that thanks to the U.S., under the WTO if a measure affects trade, even if it's not actually affecting it, then the WTO is arguably exclusively responsible for deciding whether it's right or wrong if there's a challenge. So, with all due respect, I think that your club, to the extent that you would use a tariff at the border, if there's a challenge it

would be decided in the WTO. That's why the whole debate would then shift. Is it consistent with the flexibilities that exist?

Now, the other question by Jason is the tariff imposed on everyone and then environmental measures? I'm ignorant of the details of the program. It depends, but usually, yes, you have to prove that it's environment from the beginning and the example that we use as a non-environmental exception would be a government that imposes a border measure, let's say a tax, saying they are doing it for the environment and then they give the money to the country's own industry instead of investing it in environmental programs or CDM in the case of climate change.

So, it's quite demanding to comply and satisfy the requirements of Article XX, but it has introduced flexibilities that could be useful. You talked about a CO2 content tax and there's no discrimination. Well, some countries would still argue there's discrimination because two products that look identical, one polluting, the other one not polluting, are alike. So if you tax them differently, you shift again to Article XX. The benefit of XX is that it would allow you to work with averages, to the extent they make sense.

So the whole assessment now is on this justification, whether it's rational and how far you could get. The legitimacy issue is why is it that it would be WTO who would decide in a particular dispute?

Whatever trade is used for, if the United States tells another government "you violate human rights," under international law you can use counter-measures to punish. You violate a treaty, I'll violate another one. I'll violate trade and trade has always been historically the best counter-measure because it hurts in the short term. But thanks to the U.S., as I mentioned, there's a clear provision that says, if trade is affected for whatever reason, it comes to the WTO and unilateral measures cannot be accepted unless they're justified. So, we're back to justification.

Samuel Kortum
Thank you.