Journal of Business and Economics, ISSN 2155-7950, USA
December 2021, Volume 12, No. 12, pp. 1166-1177
Doi: 10.15341/jbe(2155-7950)/12.12.2021/002

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Climate Clubs: A Complementary Design to the UN Paris Agreement

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Abstract: Negotiations on climate policy have made only a little progress since the early 1990s. Economic theory offers various reasons for this unsatisfactory situation. Climate change is a global public good. Each country's emissions contribute to an increase in the overall concentration of greenhouse gases, and each country's mitigation policy generates higher costs than benefits. Hence, in a first step, this article focuses on game theory results that indicate free-riding incentives in the case of a public good. In the end, no one wins and all parties are worse off. A climate club would provide a supplementary approach and a solution to eliminate free-riding, externalities and lack of commitment by individual states. For such a club to be successful, some characteristics must be in place. Consequently, various options for a successful club are discussed. Finally, an analysis of the climate club approach between the European Union, United States and China suggests that, combining the international trade policy and domestic carbon pricing, could help to achieve the aim of keeping the global temperature rise below 2°C.

Key words: climate club, game theory, externalities, climate mitigation policy, carbon tax
JEL codes: Q5, Q58

1. Introduction

The Paris Agreement is a legally binding international treaty on climate change. It was adopted at United Nations Framework Convention on Climate Change, 21st Conference of the Parties "COP21" in Paris, on 12 December 2015 and entered into force on 4 November 2016. Its goal is to limit global warming to well below 2, preferably to 1.5 degrees Celsius, above pre-industrial levels. Today, 189 countries have joined the Paris Agreement. It includes commitments from all countries to reduce their carbon emissions (here referred to as greenhouse gas GHG emissions) and work together to adapt to the impacts of climate change, and to strengthen their commitments over time (United Nations, 2015).

According to a tracker by two German non-profit research organizations, Climate Analytics and New Climate Institute, current policy would result in a 2.9°C rise by 2100. Hence, the Paris Agreement is not enough to avoid this development. The Agreement needs common commitments to reduce carbon emissions and not just individual efforts by different countries. How can individual countries be encouraged to show more commitment and reciprocity? The greatest obstacle to answering this question lies in the prisoner's dilemma. To reach the common global goals, the Paris Agreement invites countries to make national contributions. Each country specifies the

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effort required by each nation to reduce emissions. Besides the global goal to limit the average temperature increase to well below 2°C, countries have agreed to review their efforts every five years, to install robust transparency and accountability rules that will provide confidence in their actions, and to support developing countries financially, technologically and through capacity building.

There are many ways to reduce GHG emissions. This article focuses on the instrument of carbon pricing. According to the World Bank (2021), most carbon prices are below the levels needed to drive significant decarbonization. Global emissions have continued to rise and the current climate policies of governments and the private sector also continue to fall short of what is needed to reach the goals of the Paris Agreement. Climate change is trapped in a collective action dilemma. To solve this problem, more and more experts are relying on the club solution.

2. Literature Review

2.1 Carbon Pricing

Carbon pricing is a cost-effective policy tool that governments and companies can use as a part of their broader climate strategy. It creates a financial incentive to mitigate emissions through price signals. Furthermore, it helps to encourage changes in production and consumption patterns (The World Bank, 2021). An important element of carbon pricing is the "polluter pays" principle. For the application of this principle different instruments are available. A *carbon tax* puts a price on GHG emissions. This sends clear and compelling signals to consumers to conserve fuel, to major carbon emitters to find cleaner alternatives, and to alternative energy developers to expand operations (Rabe, 2018). The second instrument is an ETS emission trading system, or a cap-and-trade system. The government sets a limit (cap) on total GHG emissions in specific sectors. A market is created in which emission rights are traded, with the market determining the carbon price. This approach enables polluters to meet emissions reductions targets flexibly and at the lowest costs.

The proponents of a carbon tax are convinced that the biggest advantage of their approach is the ability to transmit clear price signals. Unlike the cap-and-trade approach, this makes costs transparent. A carbon tax pegs a tax rate to the social cost, thus directly reflecting the marginal damage caused by a specific amount of carbon emitted into the atmosphere. Cap-and-trade would produce compliance costs but would be less likely to provide this direct link between cost and actual environmental damage. What is more, a tax-based policy would also promise a simple design and straightforward implementation. The time from enactment to operation is quite brief in comparison to the trading system (Rabe, 2018). Finally, the application of a carbon tax is likely to be relatively easy given existing cooperation across subnational and national borders. Hence, the focus in this article is on the carbon tax.

2.2 Climate Change as a Market Failure

Climate change is a global issue. An agreement like the Paris Agreement aims to reduce emissions worldwide. But it does not seem that the agreement will bring the desired results. Therefore, the question is what prevents the individual nations from complying with the agreement?

2.2.1 Market Failure

Neoclassical theory is based on the assumption that markets produce efficient outcomes (Samuelson & Nordhaus, 2009). In the standard model economic agents act in their self-interest: either firms maximize their profits or households their utility. Markets are in equilibrium if the sum of quantities of commodities that households want to buy at current prices equals the quantities of commodities that firms want to produce at current prices. This is a competitive equilibrium with optimal resource allocation (Varian, 2010). This economic concept is associated with Pareto efficiency and is defined as an economic situation in which the circumstances of one individual cannot be made better without making the situation worse for another individual. In this case, the allocation of resources is said to be Pareto-optimal. While the Pareto-efficiency criterion is useful as a benchmark for evaluating whether or not an allocation is efficient, it has its limits. It makes no statement about justice and equality. It also implies that, if agents are acting in their own self-interest, a social optimum from which nobody can improve their position without harming someone else, will be achieved. According to Perman et al. (2011), the following conditions must be met in order to sustain an efficient allocation of resources: markets exist for all goods and services; all markets are perfectly competitive; all transactors have perfect information; private property rights are fully assigned for all resources and commodities; no externalities exist; all goods and services are private goods; all utility and production functions are "well behaved". In fact, two of these conditions are often not fulfilled: not all goods are private goods and there are externalities.

Two criteria are used to classify private and public goods respectively: rivalry in consumption and excludability. Rivalry exists if only one person can consume a specific good. This specific consumption is at the expense of the consumption of someone else. Excludability occurs when a good or service can be limited to only paying customers, which can prohibit another person from consuming the good. If both conditions are fulfilled, one speaks of a private good. On the contrary, if a good is non-rival and non-excludable, it is a public good. Between private and public goods, there are also so-called club goods and common-pool resources. The latter are rival, but not excludable. Private goods, public goods and common-pool resources require different economic approaches. Common-pool resources include open-access resources such as ocean fisheries, or the atmosphere as a carbon sink. They can be exploited without restrictions. In that sense, the atmosphere as an open-access resource is not a private good. Hence, one of the above-mentioned conditions for a competitive market — all goods have to be private goods — is not fulfilled and the allocation of resources is not Pareto-efficient. A second condition that is violated is the requirement of no externalities: GHG emissions are an example of an externality. Cementeri (2009) explains that the concept of externality is used to define situations in which the activities of one or more economic agents have consequences on the economic well-being of other agents, without any kind of exchange or transaction occurring between them. If there is an increase in well-being, they are classified as positive externalities, otherwise they are qualified as negative externalities. Thus, pollution is an example of a negative externality. According to Perman et al. (2011), it is important to consider that no compensation/payment is made by the generator of the impact to the affected party. Policy solutions to externality problems always involve introducing some kind of compensation/payment to remove this unintended effect.

Anybody can exploit the atmosphere by using it as a sink for GHG emissions since there is free and unrestricted access. The use of the atmosphere cannot be prevented and causes overuse and negative environmental consequences. In that sense, the benefits of using the atmosphere as a GHG repository are rival. As a consequence, the atmosphere cannot be exploited as an open-access resource in an efficient way. The outcomes are not socially optimal because market economies cannot efficiently manage open-access resources. Hence, markets fail. In the case of negative externalities, markets produce too much of the products because agents cannot be prevented from generating them. Greenhouse gases impose costs on present and future generations. The result is not Pareto-efficient from society's point of view. The costs of emitting greenhouse gases (i.e., the costs of climate change) are not borne by the emitting agent, but by the rest of the society (Unctad, 2016). The marginal social costs of producing a good are higher than the agent's marginal private costs. The difference between marginal private and social costs are marginal external costs. As a consequence, markets emit enormous amounts of GHG emissions into the atmosphere. Nicolas Stern (2007) identified this development as the biggest market failure in the history of mankind.

2.2.2 Prisoner's Dilemma

Climate change mitigation is conceptualized by economists as a good that can be consumed and supplied. Supply includes the reduction of GHG emissions; consumption is passive. According to IPCC (2014): "everybody can reap the benefits of climate change mitigation by living in a world that is not affected by the potentially catastrophic effects of a changing climate." In other words, it is non-excludable and non-rival. In that context, climate change mitigation is a public good that cannot be sufficiently supplied in a market. Therefore, intervention by the government is required. But single nations also struggle to supply public goods. No single nation can by itself change the composition of the world's atmosphere and mitigate climate change (IPCC, 2001). They have to collaborate, because the costs and benefits of one country not only depend on that country's actions, but also on the actions — or lack thereof — of other countries (Unctad, 2011). Sandler (2004) defines it as a "collective action problem". In a collective action, the efforts of two or more agents are required to accomplish an outcome.

The following section uses game theory to discuss strategic interactions between countries to mitigate climate change. To show why countries struggle to coordinate measures to combat climate change, the noncooperative game of the prisoner's dilemma will be introduced. There are three characteristics of a noncooperative game: the set of players, their strategy sets, and the resulting payoffs of their strategic choices (Sandler, 2004).

In order to discuss behavior with regard to climate change mitigation policy, a game with two agents is presented (Sandler, 2004). Agents A and B must each choose between two alternatives: contribute one unit or no units of the public good. It is further assumed that the cost of each contributed unit is 8 and a unit of the public good yields 6 in benefits to each player. In Table 1 the matrix indicates the payoffs for the four possible strategy combinations. No contribution, A alone contributes a unit, B alone contributes a unit, both players contribute a unit for a total of two units.

Table 1

		B	
		Do Not Contribute	Contribute
A	Do Not Contribute	0, 0	6, -2
	Contribute	-2, 6	4, 4

Source: Sandler, 2004.

The left-hand payoff in each cell stands for the player A, the right-hand payoff in each cell stands for the player B. If no one contributes, there are no costs and no benefits. In the upper left-hand cell each player receives 0. If B contributes and A does not contribute, A is a free-rider: B receives -2 and A receives 6 from the free-ride. The result is shown in the upper right-hand cell. If both contribute, each of them receives 4 (= 2 × 6 -8). Each player has the incentive to produce nothing, because the payoff is always higher than the contribution option. This is termed a *dominant strategy.* For both players the dominant strategy would be not to contribute. Since neither player has an incentive to change their strategy, this is also a *Nash equilibrium*; because if one player changed their strategy, the payoff would be smaller. Thus, the Nash equilibrium is the best response for each player to the responses of the other players. In this case, neither player would regret their reaction *alone,* but both players would be better off, if they both changed their strategy. If they could agree to cooperate and contribute, all players would be better off with the result of 4. The "temptation" of 6 exceeds the reward of 4 from cooperating (Sandler, 2004).

Sandler (2014) then turns to a n-player Prisoner' Dilemma (n = 8). Table 2 shows the result of a GHG reduction of 10% by each nation. The reduction cost for each country is 8, while the benefit for the actor and each other country is 6. The benefits are non-rival. All eight nations are identical.

Table 2

Number of GHGs-reducing nations other than nation i								
	0	1	2	3	4	5	6	7
Nation/does not cut GHGs by 10%	0	6	12	18	24	30	36	42
Nation/does cut GHGs by 10%	-2	4	10	16	22	28	34	40

Source: Sandler, 2004.

The top row in Table 2 represents the free-rider nations. If nation i reduces emissions by 10% alone, it receives a net payoff of -2 (benefit of 6 minus costs of 8). If, however, another nation also reduces emissions, nation i receives 4. The other net payoffs in the bottom row are computed in a similar way, with the net payoff equaling 6 times the number of reducers (including nation i) less 8 in costs. The dominant strategy for all nations would be not to cut GHGs. The Nash equilibrium results when no one cuts emissions. The social optimum would be when all nations decrease GHG emissions by 10%. This example shows that free-riding is the main problem related to the supply of a public good.

If the net gain of the reduction is positive, then the payoffs in the bottom row would be higher than those in the upper row. The dominant strategy would be to reduce pollution. And, in that case, the Nash equilibrium would correspond with the social optimum (Sandler, 2004). It is necessary to reduce the payoff of the free-riders. At this point the idea comes into play that a penalty for the free-riders is worth considering. In the game above, a penalty of 2 would be enough to make the free-riders to change their strategy.

What would happen in a cooperative game involving the negotiation of an agreement? Going back to the game with two players, they could agree to actively mitigate climate change. In Figure 1 the result would be 4 for each player. The reward is higher than it would be with free-riding on both sides. But how long would this last? Each player, or nation, has an incentive not to keep the deal. If country A has chosen to implement environmental policy, B could have an advantage by not contributing, resulting in a payoff of 6. If country A also decides not to honor the contract, the cooperative solution is, at best, an unstable solution (Perman, 2011).

To secure the best collective outcome and to ensure that revenues exceed costs, a new political design is needed. In the following section a new approach will be discussed: the club solution.

2.3 A Climate Club for Carbon Pricing

The literature on clubs dates back to Pigou (1920), Knight (1924), Olson (1965) and Buchanan (1965). Buchanan is generally seen as the founder of club theory (The World Bank 2021). He defined clubs as "consumption ownership-membership arrangements". He states that between the purely private and purely public goods, there is a missing link: the theory of clubs (Buchanan 1965). Only members paying a fee have access to the club good. That could be access to Satellite TV or a private park. The size of the membership plays an important role in his theory.

The failure of international climate policy under the UNFCCC has led to a discussion about climate clubs. In contrast to the Buchanan Club, in which a public good is produced and offered, a climate club offers a public good that produces a positive external effect. Greenhouse gases such as carbon dioxide are global pollutants. If a country opts for active climate policies and companies move to regions that pursue more liberal policies, this creates carbon leakage. In that case, a carbon tax decreases carbon emissions in one country but, at the same time, emissions abroad increase. According to Forslid (2020), one way of handling these problems is the creation of climate clubs.

2.3.1 The Features of a Club

As already explained in section 2.1, the focus of this article is on pricing carbon emissions, in particular using a carbon tax. In 2015 William Nordhaus proposed the idea of a climate club to price CO_2 emissions in an international context. Nordhaus (2015) based his thesis on a fundamental reason for the failure of international agreements: the free-riding. It is difficult to overcome free-riding for global public goods. Countries have an incentive to rely on the emissions reductions of others without taking proportionate domestic abatement. In addition, there is also an intergenerational conflict in which the current generation benefits from the consumption of high CO_2 emissions paid for by future generations in lower consumption or a degraded environment. As a solution, Nordhaus (2015) advocates a climate club, which is an agreement by participating countries to undertake harmonized emissions reductions. He focuses on an “international targeted carbon price” that should be a key point in the international agreement. He sees the following conditions as a good basis for a climate club: (i) there is a public good type that can be shared; (ii) the cooperative arrangement, including the dues, is beneficial for each of the members; (iii) non-members can be excluded or penalized at relatively low costs to members; (iv) the membership is stable in the sense that no one wants to leave.

According to Pihl (2020), rather than following the traditions of environmental diplomacy, the design of international climate policy could have learnt from how international institutions, like the WTO, were created. The WTO is a good example of an emergent institution in a world of diverging interests. This institution was based on a selected group of nations sharing a strong common interest. Phil (2020) states: “The WTO’s solution did not focus on voluntary UN negotiations among all nations but started in a club of nations with similar high ambitions to reduce trade barriers. The club provided members with the benefit of access to a market with low barriers, noncompliance was sanctioned and a decision to leave the club meant that the benefits were lost.” New members that accepted the same level of commitment and reciprocity allowed the club to increase to global coverage.

Is it possible that the club solution can be implemented to meet the goals of the Paris Agreement? Phil (2020) identifies a set of principles that allow this solution to be shown as an alternative to the Paris Agreement: 1) This design should start with a limited group of ambitious nations and have a mechanism that can lead to more global coverage in the future. 2) Measures should be implemented that provide reciprocity to low-ambition nations outside the sphere and encourage them to join the group of high-ambition nations. 3) There should be sanctions against noncompliance among the members. 4) Leakages of carbon-incentive activities from high-ambition members to low-ambition nations should be prevented. 5) The design should agree on efforts pursued by each nation individually. 6) It should be focused on activities with few dimensions to commit to. 7) The design should target activities that can be measured and that national leaders can be made accountable for. 8) Targets should be short-term activities that national leaders can control. 9) The design should target measures that coordinate reductions among all nations in a cost-efficient way and clarify conditions for innovations.

2.3.2 The Creation of Incentives and Club Benefits

For a climate agreement to be effective, it must engage the largest emitters and major trading partners. Victor (2015) calls countries that do not want to spend more resources to mitigate climate change “reluctant” countries. From his point of view, the first step should be to form a club with “enthusiastic” countries. Nordhaus (2015) elaborates two components for this step: members put a price on carbon domestically and, in order to enforce the rules and agreements, they impose international trade sanctions on non-members. The sanctions are also intended to be an incentive for reluctant countries to join the club. He concludes that the major potential instrument is sanctions on international trade. His empirical evaluation shows that the participation rate and the overall carbon price will rise with the trade tariff rate. With the lowest carbon price of $12.5 and $25 per ton, full participation and efficiency of the club members will be achieved with relatively low tariffs of 2 percent or more. But, if the carbon price rises, it will be very difficult to keep a cooperative equilibrium. For instance, a target price of $50 per ton will lead to an efficiency of 90 percent or more at a tariff rate of 5 percent. With a target price of $100 or more, however, the club will reach the noncooperative level of abatement. The reason lies in the gap between the cooperative and the noncooperative equilibrium, which rises sharply with an increasing carbon price.

Victor (2015) justifies the focus on commercial trade tariffs. When trading partners in Europe buy products from China, for example, they benefit from less expensive goods, but they do not pay for the cost of emissions generated during production. With international trade in goods, services and capital, emission embodied in these trade flows is called “embodied” carbon. According to the OECD (2019), the six largest producers and consumers of CO_2 emissions in 2015 were China, United States, European Union (EU28), India, Japan and the Russian Federation. While both the production and consumption of emissions have fallen in the United States and the European Union since 2005, there has been a significant increase in China and India. China has the highest absolute emissions from both a demand and a production perspective. However, even though China’s per capita demand for CO_2 emissions has increased by over 75% since 2005, US per capita demand is over three times higher. In this context, countries have an incentive to avoid the abatement cost at the expense of others. A small group of big countries can solve the problem by working on two fronts. First, the many different unilateral border measures need some discipline. And secondly, better accounting statistics on emissions in international trade are necessary. Hence, the inclusion of trade tariffs as an important sanction against non-members of climate clubs will spread throughout the trading system (Victor, 2015).

Besides tariffs for non-members, Nordhaus (2020) relies on an international target price for emissions rather than on the quantity of emissions. He argues that this approach leads to harmonized carbon prices. Hence, the marginal costs of climate policy would be the same in all countries. Negotiating a single carbon price would be easier than discussing different national policies to reach the goal of carbon neutrality. On the other hand, Hovi et al. (2017) concentrate on an emission reduction target as a percentage of GDP.

Another important aspect affecting clubs is club benefits. To ensure the attractiveness and growth of a club, it is necessary to provide net benefits. According to Hovi et al. (2017), a potential member must be offered at least one of the four following benefits. First, a benefit comes from the provision of the public good itself, in this case avoiding climate damage through enhanced mitigation measures. Instead of individual mitigation efforts, cooperation in the club can improve a country’s cost-benefits balance. The reason lies in the lower competitive disadvantage and simultaneous reciprocity of the club partners. Secondly, members are offered better trading conditions. Additionally, they can establish joint R&D programs for emission-reducing and low carbon technologies. Third, payments are offered to members. Examples could be grants or loans for emission-reducing technologies. Finally, advantages arise from indirect side effects. Through the mitigation efforts of club members, non-members also experience a reduction in indirect abatement costs, which is an unintended consequence of mitigation policy.

Club benefits can also be used to encourage members to become more compliant. In the case of non-compliance with the rules, clubs can impose sanctions like exclusion from the club, withdrawal from certain membership rights, trade discrimination or financial penalties.

2.3.3 The Formation of Clubs

Falkner (2015) concentrates on a minilateralist climate club solution. He sees three advantages of starting small. First, it facilitates dialogue and bargaining. In small groups, the bargaining process is conducted with informal discussions. It builds mutual trust, improves the provision of the collective good and it increases the efficiency of the bargaining process. Victor (2011) discusses the "k-group" approach: the smaller the group of countries, the easier it is to find an agreement than in large n-settings. With fewer country interests, there are fewer bilateral and plurilateral side-deals. In addition, a club solution only works if reluctant veto players can be excluded.

Furthermore, Forslid (2020) emphasizes that the size of the club would be crucial. If the club applies tariffs on non-members, it would be important for the member countries to have a large market so that the tariff would be expensive for the non-members. Size is not important for the costs joining the club. On the other hand, the benefit of membership depends a lot on the size of the club. And countries that trade a lot with the club members have strong incentives to join the club. If more countries enter the club, there could be a second-round effect that brings a further enlargement of the club.

In the view of Martin and van den Bergh (2019) smaller groups outside of the UNFCCC have the following key benefits: negotiations can be conducted more efficiently, and results can be achieved in a shorter time. Smaller groups of like-minded participants can tackle narrow but deep goals and achieve more focused and ambitious outcomes than large disparate groups. Climate clubs represent homogenous markets with fewer barriers. They are not only capable of providing a feasible reduction in emissions but can also offer immediate financial benefits to members in the form of club benefits. But what about the "likelihood-of-involvement"? Martin and van den Bergh (2019) developed four complementary criteria. The first criterion, carbon independence, quantifies the lack of dependence of carbon-intensive industries by comparing the member states' gross domestic product (GDP) earned per tonne of CO_2 emitted. The second criterion deals with public opinion on climate change. It captures the level of localized voter support for climate change action and thus the likelihood of government implementing more stringent climate policies. The third criterion considers the policy position of government bodies with respect to climate issues. The final criterion assesses the extent of local involvement in the growing number of climate-related coalition groups.

Martin and van den Bergh (2019) calculated the likelihood-of-involvement scores for the 15 countries with the highest carbon emission rates. The result of the calculation suggests that there exist two distinct groups of countries: A group of seven "likely" club members, including the EU, Japan, South Korea, Canada, Brazil, Mexico and Australia. These countries represent approximately 20.5 percent of global carbon emissions. This group also includes all Group of Seven (G7) members, except the US. The second group consists of "non-likely" club members: China, US, Russia, India, Iran, Saudi Arabia, South Africa and Indonesia.

3. The EU Towards a Climate Club

In 2018, European carbon dioxide emissions amounted to 15 percent of global emissions (Ritchi & Roser, 2020). Even if great efforts are made on the part of the EU, these measures will not be sufficient to achieve the global climate targets. Additionally, there is the problem of leakage with this procedure. Leakage could occur in two variants. On the one hand, the European Union would produce less in high-emission sectors and move towards low- emission sectors. Emission-intensive production would shift abroad. At the same time, the demand for fossil fuels would decrease, resulting in a reduction in the price of these raw materials. This would make the production of emission-intensive products in non-EU countries more interesting.

These effects, together with the problem of free-riding, has led some economists to the idea of a climate club between the European Union, US and China (Mahlkow et al., 2021; Wolff, 2021). Mahlkow et al. (2021) carried out a simulation using a foreign trade model that can depict bilateral trade flows at the sectoral level along the entire international value chain. In this model, fossil fuels can be modeled simultaneously as internationally traded products and as production inputs whose combustion generates CO_2. Different scenarios are calculated: 1) the introduction of a global carbon tax; 2) a carbon tax introduced only in the EU; 3) a climate club between Europe and the US, and a climate club between Europe, the US and China.

This section mainly discusses the EU-US-China club variant with their impact on emissions and relative incomes. The starting point for this climate club is a carbon tax to the amount of US$ 50 per ton of carbon dioxide. The first version of the climate club would be to install this carbon tax without additional measures. Globally, carbon emissions would fall by 23% or 6.9 billion tons. China achieves the greatest reduction in carbon emissions at 55%. In this constellation, leakage can be reduced because China is the world's largest coal producer.

A next step would be to introduce additional carbon tariffs. These tariffs represent a form of carbon border adjustment. The idea is that every ton of carbon produced to either manufacture a product for consumption or for use as an intermediate good in the countries of the climate club, will be taxed at the same rate, regardless of where the product is manufactured. This makes outsourcing the production of emission-intensive products unattractive and reduces leakage. The reduction of national carbon emissions for the club members is clear: around 30% in the EU as a whole, around 36.5% in the USA and around 54.6% in China. Emissions outside of the club would increase slightly by around 1.2%.

When considering the national income effects of this scenario, there is a consistent picture: nearly all countries (88%) suffer a decrease in income. In the club, China will face the highest drop in income of around 0.74%. The United States will also be faced with losses of around 0.2%. The situation in Europe will not be uniform, with Eastern Europe facing bigger income losses of as much as 0.2 to 0.4%. The remaining European countries will have losses close to zero.

So far, the calculation of Mahlkow et al. (2021) has introduced a tax and imposed carbon tariffs. But these tariffs do not compensate for the fact that outside club members would be less competitive due to carbon taxation. In addition to these two measures of tax and tariff, export subsidies could be introduced. The level of subsidies would be chosen so that companies are reimbursed for the carbon taxation incurred in the production of an export good, if club members exported this good to markets outside the club. The result would be that companies from the club countries could offer their products at prices as if the carbon tax did not exist. This full border adjustment would reduce leakage. The introduction of subsidies puts pressure on non-member countries. At the same time, the club members stay competitive in emission-incentive industries and decrease emissions, albeit more weakly.

This analysis leads Mahlkow et al. (2021) to the following conclusions: 1) The larger the club, the higher the effectiveness of the climate policy. Hence, as many large CO_2 emitters as possible should be encouraged to participate in the climate club. 2) Both variants of the border adjustment examined increase the effectiveness of the carbon tax slightly. A full border adjustment can prevent CO_2 leakage more successfully than a pure carbon tariff. But the combination of a carbon tax with a carbon tariff has a greater effect on global emissions reduction than the addition of an export subsidy. The main focus should be on the size of the climate club. A combination of subsidies, along with tariffs, would be an incentive for other countries to become a club member.

What is he likelihood of the three countries mentioned forming a climate club? The EU aims to become "climate neutral" by 2050. It will tighten its carbon pricing system, strengthen environmental regulations and introduce carbon border adjustments. The US administration will target investment towards green projects and tighten regulations to drive decarbonization. Carbon border adjustment will be introduced. In China, the government is committed to carbon neutrality by 2060. All three participants together make up 61% of global gross domestic product and 43% of good imports. This would be a powerful incentive for other countries to join (Wolff, 2021).

Creating a powerful club is one of six tasks that clubs should perform, according to Victor (2015). The second task is to design smart border measures, which is demonstrated by carbon tariffs and export subsidies in the EU-US-China club example. The third task of crafting conditional commitments is a way to offset the free-ride incentive. Conditional commitments would link a country's own commitment to other countries' mitigation efforts. This goal is also connected with the offer of club goods. One main issue is the gain from technology strategies, which is task number four. Technological innovations come from grants or loans for emission-reducing technologies, a share in proprietary low-carbon technologies at low costs or below market rates and collective mitigation efforts. A climate club with three members is faced with the challenge of developing and demonstrating solutions to big goals, like those of the Paris Agreement. This is task number five. The final task deals with recognizing the fact that climate policy is not only about combatting climate change, but also about adapting.

To make the EU-US-China club effective and purposeful, efforts are needed on four fronts (Victor 2015): open the door, create some discipline for clubs, get expectations right and build strategic thinking about countries that are inclined to join the club.

4. Conclusion

International climate policy must overcome two basic problems. First, there is a need for coordination between individual countries and the avoidance of free-riding. Second, the costs of climate policy are incurred in the present, while the benefits will only become visible in decades. Hence, the incentive for a country to pursue climate policy is low. At the same time, the incentive for free-riding is high if other countries make an effort. To overcome the free-riding problem in particular, a climate club would be an interesting model. It is a promising complementary form to the previous UN climate agreements.

In a climate club, countries would undertake to pursue common climate mitigation goals. A club provides incentives for members to stick to agreements. In other words, the club structure encourages compliance and participation. There would be a shift in cost-benefit calculation from free-riding to joining the club. In the literature, different incentive options are discussed. Nordhaus (2015) favors trade barriers and carbon target pricing. Hovi et al. ((2017) build their argument on club goods and conditional commitments. Saelen (2016) elaborates that side-payments would be more effective. Large economies could induce large participation, especially if these economies were large club initiators. Hence, there is no consensus regarding the structure of a club, but it is unanimously stated that clubs could help to provide a forum for enthusiastic countries to "do the deals" that would encourage more reluctant countries to make bigger efforts (Victor, 2015). In this respect, the proposal of a climate club between the EU, the US and China would create an incentive for non-member countries to take part and to make the club a catalyst for tougher climate mitigation policy worldwide.

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