A Decentralized Climate Club Model of Global CO2 Mitigation

by

Shyam Nath and Yeti N Madhoo

Amrita Center for Economics & Governance, Amrita Vishwa Vidyapeetham University, PO Clappana, Kerala, India

Abstract:

This paper examines the feasibility of sub-global climate governance to replace global governance for mitigating CO2 emissions. Regional climate clubs become an argument having separate bundle of emission targets and incentive mechanisms in the form of opportunities of climate finance and technology sharing among the club members. While facilities would constitute incentives to join the club, a carbon entry tax can serve as a fiscal instrument to discourage imports from non-member countries. The paper also attempts to incorporate some lessons from the emergence and impacts of COVID-19. This tax would go a long way in reducing CO2 emissions while maintaining the pace of global climate governance through CO2 emissions strategies by non-member countries.

Key Words: Climate change, CO2 emissions, international climate diplomacy, free riding, COVID-19

I. Introduction

This paper focuses on the changing perspective of global climate change governance with reference to climate clubs. Global warming has been the major concern for the atmospheric pollution and ozone layer depletion attracting international attention for collective action. CO2 emissions are responsible for most of the climate change that has occurred (Huntingford and Mercado, 2016). Recent outbreak of corona pandemic has however changed the existing perspective on climate change with drastic reduction in global CO2 pollution resulting in massive improvement in environmental quality. From some sources, for instance, CO2 emissions in the UK have gone down by about 33 percent. According to one estimate, global output could fall by more than 5% in 2020 as compared with a reduction of 1.4% after the financial crisis of 2008. This however has happened globally at a phenomenal cost of economic deceleration. It is however not easy to disentangle the effects of planetary changes from the effects of economic slowdown on environmental quality. Nevertheless, worldwide economic slowdown accompanied by improved global atmospheric environment would have implications for international cooperation on climate governance issues. It has brought to the notice a stark reality that while addressing climate change, economic slowdown was never on the global agenda. Nevertheless, it has provided an opportunity to take lessons for conducting business as usual from the current episode in the context of climate governance.

The natural and human sources of CO2 emissions are reported in Table 1. The largest natural source of CO_2 emissions is from ocean-atmosphere exchange (42.84 percent). The process works in a way that the oceans contain dissolved carbon dioxide, which is released into the air at the sea surface. Moreover, as regards human sources of CO_2 emissions, use of fossil fuels tops the list. The interactions between human activity, climate change and CO_2 emissions are again a complex phenomenon. But CO2 emissions are major contributor to climate change and controlling CO2 emissions is a challenging task om the global environmental agenda.

Table 1: Sources of Carbon Dioxide globally

Natural Sources of CO_2	Percent	Human Sources of CO_2	Percent
Ocean-atmosphere exchange	42.84	Fossil fuel use	87.00
Plant and animal respiration	28.56	Land use	9.00
Soil respiration and decomposition	28.56	Industrial processes	4.00

Source: Adapted from Le Quéré et al. (2013).

The structure of the present discussion is as follows. Section one highlights the difficulties in measuring the contribution of visible and invisible environmental resources in GDP growth. It is argued that CO2 emissions can be used as a proxy for resource use in terms of environmental degradation and loss of environmental quality. Section two examines the pros and cons of various strategies to combat CO2 emissions. Section three focusses the limitations of international agreements to deal with global climate as a public good and the stark possibility of free riding on the part of nations and governments. Section four analyses the feasibility and working of governance of global climate by climate clubs as the second best alternative. Section five discusses the decentralized governance of climate clubs incorporating subnational governments and the corporate sector. Section six concludes with a summary.

II. CO2 emissions and productivity of environment as an economic input

Environment and natural resources are important ingredients in conjunction with labour and capital in the growth process. While the growth of GDP (Gross Domestic Product) necessitates use of these resources, which get degraded in the process, the concern here is what happens to environmental quality. What is worthy to note is that the earth planet, as part of the eco balance system, uses photosynthesis (the process for converting carbon dioxide into oxygen, using sunlight) to produce an environmental (invisible) output (called photosynthetic product of the planet, PPP), which is one of the inputs in further production process. If GDP growth degrades environment and there are no remedial measures, the decline in PPP would affect the GDP growth rate in the future. In other words, the GDP growth rate can be sustained only when the policy on protecting the quality of environment is in order and effective. The pertinent question however is how to capture the hidden environmental costs and benefits in economic models? In data-based empirical models, total factor productivity (known as Solow Residuals after isolating the contribution of factors such as labour and capital), is expected to capture the contribution of missing factors including environmental resources. Environmentalists argue that GDP growth overstates the true improvement in economic growth and welfare, because it fails to capture the degradation of environmental resources and the negative spillover externalities associated with rapid GDP growth (Gore, 1992; Repetto et al. 1996). What is equally important is that the contribution of the photosynthetic product of the planet and other positive externalities emanating from the natural capital are not taken into consideration. These are equally important constituents of total factor productivity.

Economic and environmental modeling would have to be concurrently employed to filter these factors from the black box. Following Hulten (2001), TFP growth is estimated as a residual factor, it is thus a measure of our ignorance, giving with ample scope for measurement error. Another source of controversy arises from sins of omission, rather than commission. A new economy critique of productivity would point to unmeasured gains in product quality, while an environmental critique points to the unmeasured environmental costs of growth. Moreover, measuring economic damages from climate change is a stupendous task (Auffhammer, 2018). It is also important to note that a decomposition of TFP using market data on values and prices is bristled with vicissitudes of environmental valuation of visible and invisible goods and services. Keeping this in mind, most environmental proposals, including the system of integrated environmental and economic accounts, suggest that environmental degradation should be measured by obtaining estimates of restoration costs rather than by attempting to quantify and put a monetary value on damages (Harrison, 1993; Feather et al., 1995).

Given that there are enormous difficulties in measuring the contribution of environmental resources in income generation, the differences in geographical location is one of the most important reason of economic variety among the world. Nordhaus (1993) studied the role of climate (latitude and average temperature) on income but its effects may be swapped by other variables. He reports that income per square kilometer vary from a low of $31 in China to high of about $36,000 in Hong Kong, and from $37 in Indonesia to $62,000 in Japan. In fact, latitude explains less than one percent of the variance in income per capita and per area. *This would imply that average temperature emerges as a dominant factor in productivity outcomes* *(emphasis added).* According to computations by Gallup et al. (1999), average GDP per capita in high temperature tropical countries in 1995 was $3,326 as against $9,027 for non-tropical countries with low temperature. Thus, the growth of CO2 emissions having consequences for spatial temperature variation and global warming and thereby productivity growth presents a global concern for climate governance.

III. Climate mitigation and control mechanisms for CO2 emissions

This section examines various methods to abate CO2 emissions, namely reducing carbon intensity of economic output by using alternative energy sources, cap-on-trade and carbon taxation and restructuring the economy by assigning greater emphasis on less polluting sectors. These channels would have two implications: increasing cost and diminishing total output. Countries investing in green technology development may witness cost escalations reducing their international competitiveness and countries restructuring the economy would have implications for standard of living and dampening prospects for future growth. In this situation, there will be no incentive to undertake costly technology improvement by individual countries as the benefits will be shared by all countries. So, the asymmetries in cost and benefit sharing would be detrimental to any collective action to reduce CO2 emissions. The objective of lowering down the CO_2 emissions can be achieved either by moving away to production and consumption activities that either minimize the growth of CO_2 emissions or displace growing CO_2 emissions or by doing both (see Nath and Madhoo, 2020 for a summary). With this background, some important mitigation strategies that have potential to regulate CO_2 emissions are described in this section.

Green technology and renewable energy driven growth

Strikingly, conventional global energy use is outpacing decarbonization world-wide (Jackson et al., 2018) that necessitates development of alternative energy sources. A major channel of CO_2 reduction can be via big investments in green technology and renewable resources, which seem to be practical and more feasible alternatives. In the absence of data, however, it is difficult to calculate and compare the gains from this switchover as the economic costs comprise static and dynamic costs and period varies from short to long run. Moreover, exploratory initial investments may not be cost effective and may necessitate subsidies and concessional loans to attract investments in the renewable energy sector. It is worthy to note that financial costs and some economic costs are easy to identify but environmental costs and benefits may remain difficult to measure and capture. Thus, in the absence of any state-of-the art cost and benefit analysis, policy support would become mandatory.

There is urgent need to institutionalize investment in alternative clean technology and energy sources at the global level. Such green investments can be encouraged by alternative funding mechanisms and through multilateral cooperative ventures to share the risks. Participatory arrangements such as the Clean Development Mechanism (CDM) and Joint Implementation (JI) coming from Kyoto Protocol may assume greater significance in attempts to reduce CO_2 emissions. These mechanisms allow polluters in developed countries to buy pollution rights by investing in clean energy and afforestation projects in developing and developed countries, respectively. It is important to note that CDM and JI provide mechanism to offset the enhanced CO_2 emissions in developed countries, which have hit their quota of pollution rights.

Minimizing the impact of sun rays on the Earth's surface: Geoengineering

One way in which cloud science may become important to economists is in the rapidly growing research field of "geoengineering" or "climate engineering," which considers various proposals to intentionally alter the climate so as to counteract some effects of GHG emissions (Caldeira et al., 2013). The most widely proposed intervention is "solar radiation management," which involves increasing the reflectivity of the atmosphere in order to shade and cool the surface. One proposed mechanism for increasing reflectivity is to spray aerosol precursors into the upper atmosphere, mimicking the mechanism through which historical volcanic eruptions have cooled the surface. Another proposal, with more localized and shorter lasting effects, is "cloud brightening," achieved by manipulating cloud droplet size by spraying particles into lower portions of the atmosphere.

A theoretically appealing feature of cloud brightening proposals is that cloud brightening might be used to temporarily cool a city or ecosystem during particularly damaging heat waves, although the various economic costs and unintended effects of such policies remain poorly studied (Proctor et al., 2018). Volcanic eruptions are considered to be large enough to affect the earth's climate by injecting large amount of sulphur dioxide (SO_2) into the stratosphere. This is due to the optical properties of SO_2 and sulfate aerosols, which strongly absorb or scatter solar radiation, creating a global layer of sulfuric acid haze. Although volcanoes are technically part of the lithosphere, which itself is part of the climate system, the IPCC explicitly defines volcanism as an external forcing agent.

Wagner and Weitzman (2015) provide an illuminating discussion of the dilemmas of geoengineering. The whitening process is roughly close to what occurs after large volcanic eruptions to offset the CO_2-induced warming. The process entails making the earth "whiter" or more reflective, so that less sunlight is absorbed by the surface of the earth. This cooling effect aims to offset the warming that comes from the accumulation of CO_2 in the atmosphere.

A variety of techniques have been proposed to do this such as using naval guns, aircraft, or rockets. Recent studies indicate that such geoengineering can lower global temperatures at very low-cost relative to other approaches, such as reducing carbon emissions. It has been discussed in the literature that even though the costs are low and the average impacts on temperature are clear, the dangers are frightening, as is emphasized by Wagner and Weitzman (2015). Moreover, such experiments would necessitate cooperation and consent of countries likely to be affected.

Increasing the efficiency of carbon sinks and carbon capture

Carbon sinks can be a natural process using forests, rivers, ocean, and clouds. With technological development, CO_2 can be captured out of air, industrial source or power plant using a variety of techniques such as absorption, adsorption, chemical looping, membrane gas separation and Amines. While they have the capacity to capture sizeable amount (70/80 percent), the use of the energy would marginally add to the operating cost and pollution level. The latter would depend on the kind of energy used, derived from fossil or green sources.

The technologies of capture from industries, and recapture from the atmosphere are proven to work across the globe. CO_2 can be stored in chemically reactive basalt, where growth of new minerals can lock up CO_2 at very low cost. It is documented that there are 17 operating carbon capture projects in the world, capturing 31.5Mt of CO_2 emissions per year, of which 3.7 is stored either in deep geological formations, or in the form of mineral carbonates and abundant basalts in central India could be investigated for their suitability (Haszeldine, 2019). What is vital is that natural processes of carbon sinks are facilitated by afforestation and reducing ocean pollution. Deep ocean storage is not used as it could acidify the ocean. According to Jacobson (2019), however, carbon capture technologies are inefficient and increase air pollution. Given this analysis, he argues that the best solution is to instead focus on renewable options, such as wind or solar, replacing fossil fuels.

Defensive expenditure vs carbon tax

The fiscal measures, namely defensive expenditure and carbon tax are derived from the basic tenets of sustainable development, that is, resource utilization in the present should not preclude its availability in the future. In other words, there should be a defensive approach to preserve the productive capacity of the environmental resource for the future use. This can be achieved in two ways. One, while production takes place, a part of income should be spent on rejuvenation of environmental resource so that the growth of CO_2 emissions declines. We call it defensive or restoration expenditure. Two, a part of income generated designated as carbon tax depending on the magnitude of carbon footprint of the activity. The proceeds of the carbon tax should be spent to restore the quality of environment.

It is however worthy to note that for the success of carbon tax, the determination of tax base, that is, CO_2 emissions by countries is crucial. There is a growing realization based on evidence that the current production based GHG accounting framework does not give a true picture of a country's responsibilities towards global emissions (Gupta et al., 2018). It is indicated that production-based CO2 emissions of developed countries have gone down, which can be attributed to shifting of energy-based industries to developing countries. However, their consumption emissions have increased, which is supported by imports from these countries. Attempts have been made to quantify the carbon leakage from developed to developing countries with some evidence in support from the trade flows data (Zhang and Fang, 2019). This mechanism would increase the responsibility of major CO_2 producing and exporting countries in terms of carbon tax. It is important to mention that in the first method, the responsibility can be decentralized at the points of production and income generation, that is, industry or firm level. In the second method, the role of government assumes special significance. A global carbon tax however may be administered by a super national government such as the United Nations.

International cooperation and climate diplomacy

International cooperation seems to be the most promising step to deal with the problem of global warming and CO_2 emissions and why cooperation is not optional. Sandler (2010) provides a list of factors that can improve the likelihood that nations will undertake policies to correct for the problems of global public goods. At or near the top of his list is the expectation of benefits, net of the costs of those policies. Linked to the net benefit issue are several others. According to Sandler it's desirable for policies lead to mutual net gains for all countries as opposed to some gaining and others loosing. Closely linked is the hypothesis that outcomes be equitable and, as suggested above, that the expected net benefits be realized in the fairly near term as opposed to far in the future.

It is however well documented that important international agreements under the United Nations Framework Convention on Climate Change, such as Kyoto Protocol, Montreal Treaty and Paris 21 to deal with rapidly growing global CO_2 emissions have been largely unsuccessful. It is interesting to note that two different versions of international agreements on fixing quotas on CO2 emissions have been experimented, that is, involuntary (Kyoto) and voluntary quota regimes (Paris 21). In the latter, the system of fixed quota has been modified to incorporate credible intentions of participating governments in terms of national determined targets. What is vital however is that the global climate governance is based on the mechanism of enforceable agreements in terms of fixed quota of CO2 emissions with no penal action against non-adherence and free riding.

The primary reason is that since CO_2 emission is a global public bad, each country wants to free ride and enjoy the benefits of actions taken by other countries. This behaviour can be observed on the part of countries while investing in technology development and renewable energy projects. If one country invests and others do not, investment cost will be borne by the investing country, but its benefits will be shared by others as well. On the other hand, if this country does not invest, it saves the investment cost and shares the benefits of actions taken by others. If others are also not taking such initiatives, this country is still better off and loses only the benefits that do not exist. So, the dominant strategy will be to stay put and allow the environmental degradation from the use of technology and fuel that are not environmental-friendly. As against dominant strategy, in this scenario, the strategy is 'If you do this, I will do the same' so the chance of free riding and cheating can be avoided. We can term it a reciprocal strategy equivalent to Nash strategy for climate governance.

Olson's famous dictum that "the larger the group, the farther it will fall short of providing an optimal amount of a collective good" sums up the limitation of global governance of climate protection. The upshot is that global attempts to reduce in CO2 emissions is hampered because of its global public good nature and global governance nature. Thus, the success of these attempts would entirely depend on how to introduce private good nature in the global CO2 management strategy. In other words, there is need to redefine climate protection as a quasi-public good. Moreover, in order to introduce an element of private good, it would be important to develop a market of different packages. These packages would need to be optional (rival) and not available to non-participants (excludable). This condition for the success of management of a global public good would bring us to formation of groups like club goods (quasi-public goods) that benefits only the members.

IV. Climate clubs as sub-global climate governance institutions

A club is established in order to provide benefits to its members and, by excluding non-members, ensure that they do not free ride and obtain the benefits of the club's service (Buchanan, 1965; Cornes and Sandler, 1986). The paper by Nordhaus (2015) takes this approach (see Schroeder and Nath, 2020 for a good discussion on climate clubs). He argues that an effective way to combat climate change would be for a climate club to be formed that includes nations willing to implement policies designed to diminish the production of greenhouse gases (GHG) that constitute the primary causal factor associated with climate change. If the member countries succeed in lowering GHG emissions, not only do they benefit (along with future generations) *but* so do the non-members of the club. That is, the non-member nations become free-riders and do not have to bear the costs of imposing policies that lower GHG emissions locally. The question then is how to create incentives in the system to overcome such free riding.

Nordhaus proposes the use of sanctions against non-member nations of the club. Specifically, he recommends imposing tariffs on imports from non-member nations into club member nations. Since exports can be substantial income-generators for many countries, it is anticipated that this form of sanction would encourage an exporting country to join the club. Nordhaus goes on to consider whether the tariffs should be linked to the amounts of carbon contained in the imported product or more simply be a uniform tariff imposed on all imports from the non-club member country. He opts for the latter given the administrative costs of implementing a carbon-based duty. What is not discussed by Nordhaus (as he admits) are the political and legal issues associated with creation of a climate club in this form, particularly through tariffs as the sanctioning mechanism. For example, regional and bilateral trade treaties could preclude the use of tariffs as a sanctioning device.

One issue that is considered by Nordhaus and which is more relevant here is how such a climate club would be established. His conclusion is that a “top-down” approach will be necessary; that is, either an international organization, perhaps the United Nations, or a group of particularly powerful countries would need to take the lead and form the initial club. His paper provides an argument against the “bottom-up” formulation of coalitions. The argument is that “…theoretical and empirical studies indicate that bottom-up coalitions for cartels and global public goods tend to be small, fragile, and unstable.” (p. 1344).

The top-down approach runs counter to the arguments made by a variety of other scholars who also advocate for the formation of climate clubs but argue they should be voluntary and non-hierarchical. For example Keohane and Victor (2011) argue that (i) different states have different interests related to climate change, (ii) there is considerable uncertainty around the complex forces associated with climate change and (iii) there are different linkages among different states with these three forces “…create incentives for governments and non-state actors to invest in a wide array of institutions rather than a single hierarchy” (p.8). Their call for a “regime complex” runs counter to the single integrated regime that attempts to create a comprehensive package of reforms to be followed by all.

Hovi, et al. (2016) define a climate club as "…any international actor group that (1) starts with fewer members than the UNFCCC [United Nations Framework Convention on Climate Change] has and (2) aims to cooperate on one or more climate-change related activities, notably mitigation, adaptation, climate engineering or climate compensation." (p. 2). While these are clubs, they differ in their intent from the clubs envisioned by Buchanan (and Nordhaus) where a club is formed to minimize the problem of free riders who obtain benefits from a service without bearing the costs. Under the definition stated above, the voluntary nature of states joining a club that creates benefits for club members and non-members alike requires that at least the member states anticipate benefits to themselves that exceed the costs. But just as a Buchanan type club allows for lower costs per member as more members are invited to join up to the point where congestion occurs, a climate club with additional members that comply with the club's anti-climate change policies will provide additional benefits for all.

Victor (2015) considers the types of tasks that voluntary climate clubs could perform and similarly argues that, as suggested above, one of their important efforts is to "entice reluctant countries" (p. 2) to join. He suggests that the clubs might even try to impose Nordhaus-like trade penalties on the non-joiners. Victor also argues that club members might impose policies related to international trade to recognize that imports from other countries (in or outside a club) may contain embodied carbon and that border adjustments should be made to reflect those external costs that the exporting country is imposing on the rest of the world. Unfortunately, as Nordhaus indicates, the administrative costs of such measures can make implementation extremely difficult. Other tasks a carbon club might undertake would be to design and demonstrate technological methods to decrease airborne pollutants, assisting other countries either with technical assistance or monetary compensation to adapt new technologies and, most economically, tackle easier, less costly problems first.

There have been some attempts to understand how climate clubs (the voluntary type) can help in the fight against climate change. Weischer, et al. (2012) analyze 17 clubs with much of the article focused on a description of what those clubs attempt to do, how they are organized and funded, as well as a review of what motivated their formation. They conclude that the analyzed clubs have made contributions to overcoming global warming but that a "transformational club" is still needed if more significant results can be obtained. They argue that in order for a climate club to be transformational, it must satisfy four criteria. These include that the benefits have to be significant (since there will be costs associated with joining), all members of the club derive benefits, that the benefits derived conform to existing international law and, finally and perhaps most difficult to obtain, that benefits accrue *only* to club members and not to others.

There is another strand of literature that relates at least indirectly to climate clubs and their organization. This literature is closely linked to the work on collective action by the late Elinor Ostrom, a Nobel Prize Winner in Economics. While effects on the climate can be viewed as a global public good (or 'bad'), another way of thinking about air and its pollution be greenhouse gases (GHG) pollute is that air is a common property resource not unlike unfenced pastures, communal forests or underground water aquifers. In her award-winning book on *Governing the Commons* (1990) Ostrom documents the ways self-governing organizations have been able to cope with collective action issues. Thus, the move to considering climate change within the framework of common property was a natural one for Ostrom. As stated in Ostrom (2014), generation of greenhouse gases is the result of millions of local micro-level decisions by households (e.g., what type of automobile, if any, to purchase and use) and firms (e.g., whether to adopt technologies that will reduce the CO2 pollutants emitted to the air). When considered this way, efforts for control of climate change can become a much more localized endeavor than commonly thought of in the international literature even though the consequences of those decisions affect both those in that same location as well as nations throughout the world. In other words, climate governance starts as a development from below.

This conceptualization of the climate change issue leads Ostrom and others (e.g., Dorsch and Flachsland, 2017 and Paavola, 2013) to argue that the appropriate organizational form to tackle climate change problems is a decentralized or "polycentric" one. It was, for example, used by V. Ostrom, Tiebout and Warren in their 1961 article regarding the organization of governments in a metropolitan area with overlapping jurisdictions taking on different roles depending on the nature and costs of producing the services being provided by those sub-national governments. Again, this suggests that a single hierarchical approach to climate policy is less likely to be successful than one with multiple, even small-scale efforts, to over the problems. As she states (2014, p.1115) "It is obviously much easier to craft solutions for collective action problems related to smaller-scale common-pool resources than for the global commons."

V. A market model of climate clubs with *carbon entry tax*

Why the proposal of climate clubs emerges as an alternative solution to counter the aggravating situation created by the imminent failure of international climate agreements deserves in-depth discussion (see Sandler, 2010; Mitchell, 2010 for impediments to collective action and international politics). In the absence of a supporting environment in favour of collective action at the global level, there is need to search for sub-global solutions like regional climate clubs of like-minded nations. Climate clubs may thus constitute a second-best climate governance regime. The challenge however is to understand how such climate clubs, besides fixing CO_2 quotas or carbon taxes to be adhered by the club members, would produce an incentive design to attract nations to join a climate club. One such method proposed by William Nordhaus (2015) is to build tariff structure that will be applicable to the imports from non-members. It can be uniform or different tariffs on CO_2 linked products with varying carbon intensities. Nordhaus however preferred a uniform 2% import tax on non-member countries. Besides preferential tariffs, the club based international cooperation can incorporate benefits in the form of access to technology and climate finance. It can be through grants and loans for investment in carbon reducing technologies; sharing low carbon technologies at reduced or zero cost, and implementation of joint mitigation projects. Different clubs would have a package of lower tariffs, cheaper carbon abatement technology and climate finance along with club level agreement on carbon emissions through quotas or carbon tax.

The flip side of this alternative is that multiplicity of tariff structures may jeopardize global trade patterns by creating regional trading blocks. This proposal may thus entail conflict with the objectives of WTO that aim at lowering the tariffs over the board. As an alternative, these tariffs may be converted into a carbon tax on imports from non-member countries. This can be done by creating a taxable base in the form of difference between CO_2 emissions by member and non-member countries. We can call it carbon entry tax, which goes a long way in fixing equivalent or higher carbon quota and at the same time providing an incentive to join the clubs that are destination of exports. The proposal carbon entry tax is administratively easy to implement as against the system of determining the carbon intensity of the imports.

What is vital is that besides climate finance and technology transfer, these clubs may like to incorporate some features emanating from the impact of COVID-19 on the environmental improvement through lockdowns, slowdown of economic activities and reduction in CO_2 emissions. For instance, lockdown and virtual offices can be considered as important arguments in the package of conditionalities underlying club membership. These features can be considered as an additionality for integration into the packages of climate clubs. Now the climate club package may consist of the following ingredients:

(i) A carbon reduction quota should be fixed for each member- country,

(ii) A carbon entry tax can be levied on the import from non-member countries in proportion to the difference between CO2 quotas in importing and exporting country,

(iii) A plan of restructuring the economic activities having consequences for environmental quality. The members with plan to reorganize their production and transportation activities to minimize the carbon footprint of the country;

(iv) Working from home online (full time and with weekly and monthly attendance) would save fuel cost, reduce road congestion and discourage concentration of built-in-environment/offices in city centers;

(v) Gig economy, that is, a labor market characterized by the prevalence of short-term contracts or freelance work as opposed to permanent jobs, should get a boost. This would encourage the practice of multiple jobs by an individual having a dampening effect on unemployment in the formal market,

(vi) More importantly, climate clubs would have to design methods of monitoring of default actions and following punishment outcomes. As has been discussed in the literature, this usually can take the form of exclusion from the club, withdrawal of certain membership rights, trade discrimination or financial penalties.

The attraction of this kind of multiple clubs is that it would provide avenues to selectively approach the issue of joining a climate club. It is like a Tiebout-type market analogue where different countries can shop around to select their preferred bundle of emission quota and financial and technological benefits.

VI. Discussion and conclusion

Climate and environmental resources contribute visibly and invisibly to global GDP growth leaving a trail of natural and environmental resource degradation. For simplicity, if such degradation is measured by CO2 emissions by different countries, global climate governance assumes tremendous significance eliciting cooperation of polluting countries. International co-operation and agreements have severely suffered from free riding and multiplicity of ad hoc decisions in regulating CO2 emissions. The primary reason of this failure of international climate diplomacy is that the climate governance is a global public good that provides ample opportunity for enjoying the benefits of any reduction in global CO2 emissions without participating in the mitigation activity, namely through defensive expenditure, carbon tax, green technology development and demonstration effect. This would bring us to a regime where CO_2 reduction responsibilities are defined along with financial obligations and provisions for penalty.

In the literature, formation of climate clubs has been advocated with great advantages attached to this design. First, global climate governance is made a regional responsibility thrown upon the participating governments. Two, climate governance is made a quasi-public good where benefits and costs are shared by participating governments. It is being proposed in this note that these climate clubs are designed as a bundle of climate governance services and financial obligations including penalty. This arrangement may look like a Tiebout type market solution where countries can shop for their preferred climate club. Once a country joins their preferred climate club, it would adhere to the CO_2 mitigation responsibility in order to enjoy the benefits of club membership.

This trajectory of multiple club-based CO_2 management can go a long way to yield better results than leaving the global climate management in the regime of insurmountable uncertainties in the hands of opportunistic countries. UNFCCC and WTO can work to coordinate the activities of different climate clubs in advising and fixing CO_2 emission quotas and harmonizing their tariff structures created by clubs to expand membership of clubs. It may be argued that competition between different clubs may work to harmonize the tariff structures through the institutional channels of WTO and GATT paving the way for other features of a climate club to dominate in decisions about joining a club. Given the complexity of tariff structures, alternatively, a carbon entry tax (CET) can be levied on the import from non-member countries in proportion to the difference between CO_2 quotas in importing and exporting countries. The real strength of climate clubs however should reflect in the variety of financial and technological advantages available to member countries.

The issue of the participation of subnational governments joining these climate clubs created by a group of countries (Martin, Nick and van den Bergh, 2019) would need further examination. This proposal has been designed keeping in view the states in the US. Given the level of development and state autonomy in the US and the EU, state-local level participation in the inter-country climate clubs may look feasible. However, the formalization of this arrangement would present political and constitutional roadblocks. This flexibility accorded to subnational governments may raise some co-ordinational issues. First, subnational preferences would have to avoid conflict with national priorities about nationally determined CO_2 quota. Second, these governments would have to fine tune their decisions with respect to national growth agenda and tariff regime. Nevertheless, the integration of subnational governments in regional climate clubs can be worked out in terms of financial and technological attractions, leaving aside differential tariff or carbon entry tax regimes.

References

Auffhammer, M. (2018). Quantifying Economic Damages from Climate Change. *The Journal of Economic Perspectives, 32*(4): 33-52

Barrett, Scott. 2007. *Why Cooperate? The Incentive to Supply Global Public Goods* Oxford: Oxford University Press

Buchanan, James M. 1965. "The Economic Theory of Clubs," *Economica* 32 (February):1-14. *Caldeira, K., Bala, G., and Cao, L. (2013). The Science of Geoengineering. *Annual Review of Earth and Planetary Sciences*, *41*(1): 231–56.

Cornes, Richard and Todd Sandler, 1986. *The Theory of Externalities, Public Goods and Club Goods*. London: Cambridge University Press

Dorsch, Marcel and Christian Flachsiand. 2017 "A Polycentric Approach to Global Climate Governance," *Global Environmental Politics* 17(2):45-64
Sciences Business Downloaded from https://www.nature.com/articles/palcomms201620.pdf

Feather, T. D., Russell, C. S., Harrington, K. W., & Capan, D. T. (1995). *Review of monetary and nonmonetary valuation of environmental investments*. IWR Report No. 95-R-2. Alexandria, V.A., Army Corps of Engineers.

Gallup, John L, Sachs, Jeffrey D., & Mellinger, Andrew D. (1999). Geography and economic development. In Pleskovic, B., & Stiglitz, J. E. (Eds.), *Annual World Bank Conference on Development Economics 1998*, World Bank, Washington DC, pp. 127-178.

Gore, A. (1992*). Earth in the Balance: Ecology and the Human Spirit*. Houghton Mifflin, Boston.

Gupta, Himangana, Rajani Ranjan Rashmi and J R Bhat. (2018). Estimating Greenhouse Gas Emissions: Does the Production Based Methodology Reflect Global Reality? *Economic & Political Weekly*, 53 (43): 38-45.

Harrison, K. (1993). Natural assets and national *accounting*. In E. Lutz (Ed.) *Towards improved accounting for the environment*. World Bank, Washington, DC.

Haszeldine, Stuart (2019). *Climate Emergency CoP 25: Carbon Capture essential to our future Down To Earth*. Available at: https://www.downtoearth.org.in/news/.

Hovi, Jon, Detief F Sprinz, Hakon Saelen and Arild Underdal (2016). "Climate Change Mitigation: A Role for Climate Clubs?" *Palgrave Communications: Humanities, Social*

Hulten, C. R. (2001). Total factor productivity: a short biography. In Charles R. Hulten, Edwin R. Dean and Michael J. Harper (eds), *New developments in productivity analysis*. University of Chicago Press, pp. 1-54.

Huntingford, C., Mercado, L. (2016). High chance that current atmospheric greenhouse concentrations commit to warmings greater than 1.5 °C over land. *Sci Rep* **6,** 30294. https://doi.org/10.1038/srep30294

Jackson, R B. et al. (2018). Global energy is outpacing decarbonization. *Environmental Research Letters*, 13(12):

Jacobson, M. Z. (2019). The Health and Climate Impacts of Carbon Capture and Direct Air Capture. *Energy and Environmental Science, 12*: 3567-3574

Keohane, Robert O and David G Victor. 2011. "The Regime Complex for Climate Change," *Perspectives on Politics* 9(1):7-23

Le Quéré, C. et al. (2013). The Global Carbon Budget 1959-2011. Available at: https://www.earth-syst-sci-data.net/6/235/2014/essd-6-235-2014.pdf *(Accessed on 6/1/2020).*

Mitchell, Ronald B. 2010. *International Politics and the Environment*. London: Sage.

Nath, S. & Madhoo, Y N (2020). Climate change, sea level dynamics and mitigation. In Roberts, et al. *Shaping the future of Small Island States: A Road Map for Sustainable Development, Singapore, Palgrave/Macmillan.*

Nick Martin et al. (2019). A multi-level climate club with national and sub-national members: theory and application to US states. *Environmental Research Letters* DOI: 10.1088/1748-9326/ab5045.

Nordhaus, William (2015). "Climate Clubs: Overcoming Free-riding in International Climate Policy," *American Economic Review* 105(4): 1339-1370

Nordhaus, W. D. (1993). Climate and economic development. In Summers, Lawrence H. and Shah, S. (eds.), *Proceedings of the World Bank Annual Conference on Development Economics 1992*. Washington, D.C.: World Bank. 55-376.

Olson, Mancur (1965). *The Logic of Collective Action: Public Goods and the Theory of Groups*. Cambridge MA: Cambridge University Press.

Ostrom, E. (1990). *Governing the commons: The evolution of institutions for collective action*. Cambridge University Press.

Ostrom, Elinor (2014). "A Polycentric Approach for Coping with Climate Change," *Annals of Economics and Finance* 15-1: 97-134

Ostrom, Vincent, Charles M Tiebout and R Warren (1961). "The Organization of Government in Metropolitan Areas: A Theoretical Inquiry," *American Political Science Review* 55:831-42.

Paavola, Jouni (2012). "Climate Change: The Ultimate Tragedy of the Common?" in *Property in Land and Other Resources*, eds Daniel H Cole and Elinor Ostrom, Cambridge: Lincoln Institute of Land Policy. pp. 417-433

Proctor, J., Hsiang, S., Burney, J., Burke, M., and Schlenker, W. (2018). Estimating global agricultural effects of geoengineering using volcanic eruptions. *Nature* 560(7719):480–83.

Repetto, R., Rothman, D., Faeth, P., & Austin, D. (1996). *Has environmental protection really reduced productivity growth?, we need unbiased measures,* World Resources Institute, Washington, D.C.

Sandler, Todd (2010). "Overcoming Global and Regional Collective Action Impediments," *Global Policy* 1(1): 40-50

Schroeder, L D, & Nath, S. (2020). International climate diplomacy: collective action and SIDS. In Roberts, et al. *Shaping the future of Small Island States: A Road Map for Sustainable Development*, Singapore, Palgrave/Macmillan.

Victor, David G. 2015 "The Case for Climate Clubs," *E15Initiative,* Geneva, International Centre for Trade and Sustainable Development (ICTSD) and World Economic Forum, 2015

Wagner, Gernot and Martin L. Weitzman. 2015. *Climate Shock*: *The Economic Consequences of a Hotter Planet*. Princeton, NJ: Princeton University Press.

Weischer, Lutz, Jennifer Morgan and Milap Patel, 2012 "Climate Clubs: Can Small Groups of Countries Make a Big Difference in Addressing Climate Change?" *Review of European Community & International Environmental Law* 21(3):177-192/

Zhang, Q., and Fang, K. (2019). Comment on "Consumption-based Versus Production-based Accounting of CO_2 Emissions: Is There Evidence for Carbon Leakage? *Environment Science & Policy,* 101: 94-06.