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Cooperation in International Environmental Agreements: a theoretical and ethical analysis

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Abstract

One of the main challenges facing the future is implementing a successful climate policy. Climate change is economically defined as a global public good, resulting in one of the biggest social dilemmas of the latest years. This thesis aims to provide a comprehensive analysis of the limits to cooperation in climate policy starting from the examination of the antecedent models of environmental agreements – Earth Summit, Kyoto Protocol, Paris Agreement - and the intrinsic obstacles of climate change to international cooperative results. It contains a selective review of experimental literature and contributions from non-cooperative game theory. The objective is to identify significant variables and political conditions responsible for insufficient progress on climate change mitigation. A potential solution analysed is the Climate Club approach proposed by the economist and Nobel Prize winner William Nordhaus. The work concludes with an ethical reflection on the climate change social dilemma and the critical lack of responsibility proved by countries in absence of economic and political incentives

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Introduction

Climate change is a growing urgency; nonetheless, to date, the implementation of an adequate climate policy remains a challenge. According to the World Economic Forum, “Climate action failure” represents one of the main global risks of the latest years (World Economic Forum, 2021) and despite several attempts have been made to foster international cooperation, the limitations of the implemented models, as well as the inherent complexity of climate change, have limited the ability of these negotiations to effectively reduce emissions and ensure the full participation of nations. Specifically, previous international environmental agreements employed a voluntary approach and since climate change is economically classified as a global public good, a similar structure provided strong incentives to free-ride. The implementation of an effective mitigation mechanism for greenhouse gas emissions requires the identification of the factors that drive individuals to not participate in public good provision. Numerous studies have been conducted over the years and experimental theory, supported by a multitude of accurate theoretical research, provided countless insights on the main causes of insufficient progress on climate change mitigation. Although applying the results obtained on selected variables may help foster cooperation, achieved results demonstrate that there is no way to fully avoid free-riding incentives and in 2022 climate change is still perceived as the “gravest threat to humanity” (World Economic Forum, 2022). A potential solution was proposed by professor Nordhaus (Nordhaus, 2015a). His idea relies on the introduction of an alternative approach based on a club mechanism, therefore moving from a voluntary agreement to an incentive system based on monetary sanctions. Theoretical studies confirmed the great potential of his proposal however, its implementation is jeopardized by multiple limitations associated with the absence of political legitimacy and consent. Considering the economic feasibility of the model, it is evident that the limitations to cooperative solutions are beyond the sphere of the traditional economic analysis and reveal a persistent lack of responsibility in countries’ decisions, which usually prioritizes their self-interest ignoring the long-term consequences of their actions.

Starting from the investigation of the previous international environmental agreements, this study aims at revealing the limitation of a purely economic approach to climate mitigation and

provides the identification of major variables affecting the performance of international climate policies. In particular, it contributes to the introduction of a potential field of investigation based on the inclusion of unexplored variables and a more comprehensive inquiry according to various disciplines of analysis.

The first chapter of this study aims to provide a historical excursus of the main international environmental agreements, focusing in particular on the Rio Convention, the Kyoto Protocol and the Paris Agreement. Following a detailed description of the main negotiations, a critical analysis reveals intrinsic obstacles of climate change to international cooperation and structural limitations in the regulatory approach. The second chapter continues with further theoretical insights on intrinsic obstructions of climate change to a cooperative solution; assessing it as a global public good, the chapter proceeds with the examination of empirical studies and the identification of relevant variables in selected public good games and a review of the main results. In light of the outlined limitations of the previous international environmental agreements, the third chapter introduces the climate club approach, the alternative model of international cooperation proposed by the Nobel Prize winner W. Nordhaus, starting from a theoretical definition and then proceeding by explaining the limits to practical application. Finally, chapter four concludes with an ethical and epistemological analysis relative to several limitations in international cooperation on climate change mitigation.

1. The Difficulty of Cooperation in The History of Climate Policy

1.1. The Evolution of Cooperation in International Climate Policy

The Global Risks Report 2021 published by the World Economic Forum, classifies the “Climate action failure” as the second most impactful and most likely global risk (World Economic Forum, 2021), second only to “extreme weather”, which may be considered a consequence of it and it is the top likelihood concern from 2017. Nearly three decades have passed since 197 nations signed the first commitment to “prevent dangerous man-made interference with the global climate system” (United Nations, 1992b). Despite it, scientific evidence indicates that greenhouse emissions are rising and each international effort to mitigate them was ineffective. The first chapter of this thesis introduces an overview of the history of international environmental agreements and in particular, it describes the three main agreements signed by the Member States: the Rio Convention in 1992, the Kyoto Protocol in 1997, and the Paris Agreement in 2015. After a detailed description of the main negotiations achieved by the mentioned and well-known agreements, the chapter continues with a critical analysis of the implementation of these treaties and the insurmountable limits in cooperation resulting from a global public good, as climate change is economically classified.

1.1.1. Rio de Janeiro Earth Summit - 1992

The first publication quantifying the influence of CO₂ on the greenhouse effect goes back to 1896 when the Swedish scientist and Nobel Prize winner Svante Arrhenius suggested that human action from burning fossil fuel could have raised the global temperature (Arrhenius, 1896). Yet, the scientific credibility of climate change was not recognized until 1988 when the World Meteorological Organization (WMO) and the United Nations Environment Programme (UNEP) established the Intergovernmental Panel on Climate Change (IPCC). The IPCC was specifically constituted to inform policymakers with regular scientific estimations on climate-related issues. The First Assessment Report of the IPCC was published in 1990

and it constitutes the theory at the basis of the first political environmental debate, the United Nations Conference on Environment and Development (UNCED) which serves as the foundation of the whole climate policies on climate change (Union of Concerned Scientists, 2008).

The United Nations Conference on Environment and Development (UNCED), also known as Earth Summit, was a crucial step towards climate change prevention. It was an unprecedented event that took place in Rio de Janeiro from 3-14 June 1992 and it was extremely relevant because for the first time the world community gathered together to discuss measures for sustainable development and environmental protection establishing a consensus on the urgency of climate warming in the political scenario and the necessity of collective action. To quote the agreement, the conference aimed at the “stabilization of greenhouse gas concentration in the atmosphere at a level that would prevent dangerous anthropogenic interference with climate system” (United Nations, 1992b). It was the largest conference in the history of the United Nations attended by representatives of 172 nations, 116 of them being represented by their Heads of State or Government, and it was the primary form of climate policy implementation (Boon, 1992). The subjects discussed were centred on environmental concerns and, in particular, it urged the redaction of a series of documents laying the foundation for worldwide commitments on ecological rights and duties of the States and individuals (Sustainable Development Foundation, 2006). Among many documents, three major documents were established at the Earth Summit 1992: the Rio de Janeiro Declaration on Environment and Development (Rio Declaration), Agenda 21 and the Statement of Principles on Forests. They represent the foundations on which all climate policies are based.

The Rio Declaration is a short and concise document representing a code of ethical environmental conduct for the Member States advocating cooperation among them to protect the environment and the developmental system. It proclaims 27 principles that summarize the basic efforts required by the States to prevent damage to the environment and, for the first time, it explicitly recognized the difference between developed and developing countries. In detail, some principles to be emphasized are: men are at the centre of sustainable development

(Principle 1); States have sovereignty over their resources and must not damage neighbouring countries (Principle 2); eradication of poverty is a primary prerequisite for sustainable development (Principle 5); a global partnership must be established in the common effort to safeguard the environment and states have a common but differentiated responsibility on environmental protection (Principle 7); information on environmental concerns should be made available to encourage awareness and participation of citizens (Principle 10) (United Nations, 1993). The Rio Declaration, as the majority of documents agreed on the international meeting, was a soft law agreement lacking any legal obligations for participants and explicit examples on how to adopt sustainable development policies. As a result, Member States were not required to do anything specific and they still had the opportunity to focus on their self-interests as their priority and not care about the scientific evidence proving the necessity of collective action (Palmer, 1992).

The second decisive document stipulated on the UNCED is Agenda 21. It is a pragmatic text which exposes a complete plan of actions to be implemented by organizations of the United Nations, Governments, and other Major Groups at a global, national and local level to pursue sustainable development and protect the environment. It contains forty chapters divided into four sections: social and economic dimensions, conservation and management of resources for development, strengthening the role of major groups, and means of implementation (United Nations, 1993). Agenda 21 is founded on democratic participation, scientific basis and, as explicated also in the Rio Declaration, it requires international cooperation. As the Rio Declaration, the implementation of the action plan by the Member States is voluntary and non-binding and it requires local involvement and worldwide cooperation to be able to prevent environmental damage. Yet, as reported on the official document agreed at Rio de Janeiro, the plan requires huge fundings to cover the costs of implementation, estimated around \$600 billion annually, among which approximately \$125 billion from the international community (grant or concessional terms); notwithstanding new financial commitments were reached at Rio, the amount collected was not even close to the necessary sum (Palmer, 1992).

Statement of Principles on Forests is a less known document, but still determinant in climate policy because it provides an overall understanding of the difficulties related to global

cooperation on public goods. During the Rio Convention, there was hope for the adoption of a binding agreement to regulate the use of forests to avoid irrevocable damage to the environment, especially as regard biodiversity and climate change. Nonetheless, developing countries refused to negotiate binding commitments on these natural resources because they were considered indispensable for the country's development and economic growth. As a result, the hoped hard-law convention failed and it was substituted by a declaration titled "Forest Principles: Non-legally Binding Authoritative Statement of Principles for a Global Consensus on the Management, Conservation and Sustainable Development of All Types of Forests", which simply represents an introductory consensus on forests with no specific commitment on limiting deforestation. The disappointing outcome of this declaration is the definition of forest as a resource to be consumed, where its intrinsic value is not perceived and moreover, it recognizes the sovereign right of States over their resources. To be specific, the Declaration affirms that "States have, in accordance with the Charter of the United Nations and the principles of international law, the sovereign right to exploit their own resources pursuant to their own environmental policies" (Principle 1a) and that forests serve to satisfy men's needs which "relate to forest products and services, such as wood and wood products, water, food, fodder, medicine, fuel, shelter, employment, recreation, habitats for wildlife, landscape diversity, carbon sinks and reservoirs, and for other forest products" (Principle 2b). (Sustainable Development Foundation, 2006).

By the end of 1992, the United Nations Framework Convention on Climate Change (UNFCCC) which is the first legal document on climate prevention redacted on the Earth Summit, was signed by 158 States and, after a ratification process, it entered into force in 1994. Even though the document did not provide concrete quantitative targets of greenhouse gas emissions, the convention was essential to generate worldwide consensus on the necessity of cooperation and it urged industrial countries to take action (United Nations, 1992a). As the Conference Secretary-General Maurice Strong defined it, the Rio Convention was a historical moment for humanity and it influenced all the subsequent international agreements on climate change (Palmer, 1992). Furthermore, and foremost, on this occasion, participants committed to meet on an annual basis at the so-called Conference of the Parties (COP), starting a series of international meetings to continue international cooperation on preventing climate change.

Since the first COP held in Berlin in 1995, the Member States reached two decisive International Environmental Agreements: the Kyoto Protocol and the Paris Agreement.

As exposed in the previous paragraph, the Rio Convention was the first concrete confrontation and political debate highlighting the issue of climate change and it represents the first worldwide consensus on the seriousness of the environmental problem and the critical consequences caused by anthropogenic global warming. Nonetheless, when it came to implementing the theory, the practical efforts to overcome this global risk were much weaker than what was agreed, so much to be defined as a “failure of political leadership, commitment and vision” (Palmer, 1992). Rio Summit was the first evidence of the insurmountable obstacles that a public good as climate change concerns, especially when reference is made to cooperation between the Parties. The analysis of the Convention is fundamental because the strategies adopted there are inevitably the main mechanisms subsequently applied to the whole international diplomacy. Precarious agreements taken on the Earth Summit have been reached exclusively because of soft law, meaning that impressive resolutions contained in the documents are far away from being legally binding obligations and there are concretely no specific requirements from participants. Even though the documents sounded accurate and specific, actions to prevent climate change and to support sustainable development were ambiguous or left unsolved and there was no guidance for nations on how to reduce emissions. Since participants were not obliged to comply with specific limitations, most of them preferred to protect their interests; economically and rationally thinking, it was the best solution for them in the short term, as demonstrated by Saudi Arabia, that, even recognizing the critical problem of climate change, decided to block the proposal on emission reduction for the fear of a drop in oil revenues, their main wealth. The choice to satisfy self-interests instead of cooperating represents the main critical dilemma of the whole climate policy also for future agreements. Another criticism regards the main tool used at Rio to agree on principles: consensus. It means that if 172 nations are negotiating a possible solution, all of them must agree to reach the final accord and if only one of them disagrees, the decision cannot be taken. As a consequence, international debates on climate change are exhausting and usually end up in little or no progress due to the complex process adopted (Palmer, 1992). Lastly, but equally important, the endless conflict between rich and poor countries on who has

to be considered responsible and therefore invest for the environmental protection, which ended with the establishment of annual global conventions (COPs) with the hope of solving the issue over time (Plumer, 2012).

1.1.2. Kyoto Protocol – 1997

"Rarely, if ever, has humanity made an attempt like this one: to exercise deliberate, collective foresight on a risk whose full impact is unclear and will not be felt for decades", wrote William Stevens in a 1997 New York Times report (William K. Stevens, 1997). The Kyoto Protocol was signed on the 11th December 1997 on the occasion of the COP 3, shortly after the publication of the Second Assessment report published by the IPCC and it is considered the first legally binding International Environmental Agreement. The Protocol plans to globally reduce the concentrations of polluting elements and it specifically appeals to developed countries to reduce their emission of six greenhouse gasses (carbon, dioxide, methane, nitrous oxide, HFC, SF₆ and PFCs) by 5.2% compared to 1990 in the period 2008-2012. Precisely, due to a process of internal bargaining among countries, different targets were agreed: the US negotiated on a -7% target, the European Union -8%, Canada, Japan, Hungary and Poland -6% while Australia, Norway and Iceland respectively adopted a +1%, +10% and +8% (Gupta, 2010). As a matter of fact, in addition to National Mechanism, the agreement introduced the possibility for member countries, to implement four flexible mechanisms: Joint Fulfillment, Joint Implementation (JI), Clean Development Mechanism (CDM) and International Emission Trading (IEM). The flexibility of these mechanisms results from the implementation of an accurate measuring system where each country was provided with a determined "Assigned Amount Unit" (AAU) which represents the threshold to the level of emissions they can individually produce. The following is a more accurate description of the mentioned mechanisms:

- Joint Fulfillment (Article 4). This mechanism allows countries to jointly set up a precise target as the overall required result. In the case of the European Union, the target agreed among the 15 countries which were part of the union was 8%. The amount of emission

reduction each country committed to achieve is not specified and it can be freely determined by the concerned group; (Oberthür and Ott, 1999)

- Joint Implementation (Article 6). Investors of developed countries could undertake emission reduction projects in any other country under the Protocol in return for Emission Reduction Unit (ERU), equivalent to one tonne of CO₂. For instance, if a country invested in another one with a project that led to a measurable reduction of GHG levels, those emission reductions could be transferred to the investing part;
- Clean Development Mechanism (Article 12). This solution encouraged sustainable development and emission reductions allowing investors to invest in developing countries realizing projects with certified and measurable GHG emission reduction in exchange for Certified Emission Reductions credits (CERs). The project had to be approved by CDM Executive Board and publicly registered;
- International Emission Trading (Article 17). It allowed the Member States to acquire unused emissions from each other in order to meet their Kyoto targets. Consider two countries, for instance, each of them is provided with 100 AAU. The first one only pollutes for 60 units, while the second country pollutes 120, exceeding the fixed AAU. Emission trading allowed the more polluting country to transfer the exceeding units to the other part paying a specific amount according to the ton of traded emission units. (UNFCCC, 2010)

The Kyoto Protocol represents the first concrete commitment in the history of climate policy because, as opposed to the Rio Convention and the first two Conferences of Parties, it explicitly imposed definite and precise efforts for each developed signatory country; moreover, the emission reduction target had to be achieved on a specific period (2008-2012). The Protocol is divided into two periods, the second one started on 2012 until 2020. Among others, the stringency of the negotiation was surely one of the causes why the Protocol was so difficult to be ratified by participants and it took eight years to finally enter into force in 2005. The conditions for entry into force were that at least 55 Parties of the UNFCCC, including industrialized countries representing at least 55% of the total CO₂ emissions level of 1990 ratified it. By appealing to Principle 7 of the Rio Declaration which affirmed that countries have common but differentiated responsibilities, the Kyoto Protocol divided the world into

developed (Annex I) and developing countries (Non-Annex I) and it only placed binding limitations on the first group since they were considered principally responsible for climate change. In Annex I (Annex B) there were 37 nations and the countries members of the EU (in 1997 there were 15 countries in the European Union). Non-Annex I nations (about 150 countries) were instead exempted from the Protocol limitations and they were only asked to comply voluntarily thus reflecting a concrete difference in responsibility between the parties involved. By 2004, the protocol was ratified by 126 countries. Among them, the industrialized countries (33 countries) accounted only for 44,2% of the total GHG emissions, leaving the second Protocol requirement unsatisfied. A relevant event was the withdrawal from the Protocol, in 2001, of the United States, responsible for 36,1% of the total GHG emissions (European Commission, 2004). The Protocol was initially signed by President Bill Clinton in 1998, but it was never ratified by the Senate, which expressed its total disagreement in a non-binding resolution called Byrd-Hagel Resolution declaring the rejection of any international agreement that did not provide equal mandatory limitations to developing countries and arguing the unfairness of a treaty that was potentially harmful to the economy of the United States (Byrd, 1997). Five were the countries of Annex I that did not ratify: Australia, Lichtenstein, Monaco, Russia, United States. It was only in 2005, when Russia, responsible for 17,4% of the emissions (European Commission, 2004), joined the Agreement that it finally reached the requirement and entered into force. The Kyoto Protocol was a fundamental international agreement to initiate cooperation on climate change prevention. Nevertheless, analysing the Protocol from a problem-solving effectiveness perspective, not only it did not reach the expected outcome, but it completely failed in its attempt to reduce GHG global emissions, which instead increased dramatically. From an output of carbon dioxide of 22,7 billion tons in 1990, the amount raised to 31,7 billion tons in 2008 and 36 billion in 2013, representing an increase in emissions of 59% between 1990 and 2013 and an increase of 14 per cent exclusively considering the Kyoto first commitment period (Rosen, 2015). The second commitment period of the Treaty was approved in 2012 via the Doha Amendment (COP18) which essentially extended it until the year 2020 providing a new round of commitments; during the defined period, Parties committed to reducing GHG emissions by at least 18% below 1990 levels, but the discrepancy among the two times is that the composition of Parties in the second commitment period radically changed (Poulopoulos, 2016). Canada,

the United States, Russia, New Zealand and Japan refused to join appealing to the unfairness of a treaty that was not binding for developing countries and that have never been controlled even after a progressive increase in GHG emissions, like in China for instance, which in 2001 was already the second-largest CO₂ emitter in the world (Woerdman, 2004). The negotiations for the period 2013-2020 started in Copenhagen during the Conference of the Parties 15, considered the biggest failure of climate policy and showing the evident adversity of Parties to international cooperation, notwithstanding the urgent subject discussed. The result, confirmed in Doha some years later, was a general mistrust in the Protocol with a progressive decrease in participation by the Parties: only 29 countries compared to the 37 of the first period, covering a total of 14-15% share of global emissions. (European Commission, 2013). The second commitment period of the Kyoto Protocol failed to enter into force due to a lack of ratification.

Research published in 2015 by professor Amanda M. Rosen from Webster University, defined the Kyoto Protocol as an “ineffective path-dependent model for solving climate change” and she added that it “is a case of institutional design failure, one with lasting and potentially catastrophic impact on the world” since many features of the protocol have persisted influencing consequent decisions on climate policy (Rosen, 2015).

The Kyoto Protocol was an ambitious attempt to reduce GHG emissions, but the institutional design of the agreement did not provide the right conditions to reach the desired output resulting insufficient to lower the total emissions in any significant way and producing no meaningful impact on global climate change. Moreover, the Kyoto targets didn't contain constraints on air and marine traffic, so even the modest results achieved were not as relevant as they might appear. As a result, after years of negotiations and climate efforts, emissions are however increasing beyond imagine. At least, it is undeniable that the Kyoto Protocol was a turning point because it provided the first international forum for dialogue and international cooperation on such a critical issue, but as illustrated below, the Kyoto approach presents several criticisms connected with international cooperation on emission reductions and comply with the requirements. First of all, the different efforts required by the parties involved. The majority attributes the failure of the Protocol to the substantial distinction

between the parties (developing and developed countries). In a letter on the 13th March 2001, President Bush wrote:

“As you know, I oppose the Kyoto Protocol because it exempts 80 percent of the world, including major population centers such as China and India, for compliance, and would cause serious harm to the U.S. economy. The Senate’s vote, 95-0, shows that there is a clear consensus that the Kyoto Protocol is unfair and ineffective means of addressing global climate change concerns.” (George W. Bush, 2001).

The United States blamed the Kyoto Protocol to be an unfair solution to the problem of greenhouse gas emission reduction because of its incomplete coverage and it was the first country to raise internationally the issue of non-meaningful participation to the agreement. At the time of the drafting of the Treaty, 60 per cent of the world’s emissions were caused by only 20 per cent of the world population (the Annex I countries), while the remaining part of the world, corresponding to the 80 per cent of the world’s population, was only responsible for 40 per cent of the emissions (Sari, 2005). However, the US position was not unfounded: in 2006, China, not legally bound by the Protocol because of its classification as a developing country, became the first emitter of CO₂ and in 2010 it reached the status of the second-largest economy (Maréchal, 2018). On the other hand, China refused to limit its emission appealing to the fact that it was still at a different stage of its development process compared to developed countries and claiming the fairness of the division between binding and voluntary contribution to climate change prevention. As a result, the climate policy was trapped into a prisoners’ dilemma where the two of the most polluting countries refused to participate and limit their emissions finding “good” reasons to justify their inaction (Maréchal, 2018). A second criticism of the Kyoto Protocol is the incorrect adoption of flexible mechanisms by developed countries. These instruments were conceived to encourage Annex I countries to undertake emissions reductions by exploiting opportunities in non-Annex countries promoting technology transfer or by exchanging emission units between developed countries to support and facilitate the effort of countries on emission limitation. (Napoli, 2012). On the contrary, the members of the Treaty, instead of reducing their emissions, used these means to move their most polluting productions somewhere else,

continuing to operate on a business-as-usual basis taking advantage of territories where emissions concentration were not controlled. Another relevant criticism is the freedom of the Parties to withdraw from the Protocol. Since no punishment is attached to the accord, each participant is legitimate to recede the deal with no consequences, as the United States did. In the end, the Kyoto Protocol was not able to solve the climate problem and it also caused a wrong perception of the structure that has now several negative path-dependency effects in subsequent climate policy agreements. What is relevant is that all of the countries had the incentive to free-ride. It means that they had the opportunity to not participate since it was voluntary and to benefit from the others.

1.1.3. Paris Agreement - 2015

The failure of the Kyoto Protocol confirmed the inadequacy of the top-down model used to induce international cooperation on the issue of climate change. A completely new agreement with legal force was needed but, at the same time, it was necessary to avoid the mistakes of the first international environmental agreement. Moreover, the division between developing and developed countries changed a lot during the years and made less sense as economies grew, so it was necessary to review the concept of “common but differentiated responsibilities” which can be found in the Rio Declaration. A differentiation was still needed but in a graduated system, not a radical single division. After a detailed analysis of the previous climate agreements criticisms, a new structure seemed necessary. (Derwent *et al.*, 2006). On 12 December 2015, after years of negotiations and debates, a new legally binding international treaty was adopted by 196 Parties (United Nations, 2020). The Paris Agreement is the second decisive international environmental agreement and it represents a revolutionary approach to the climate change risk. In contrast with traditional models of international law, it develops on a bottom-up approach where all countries are called to collaborate on greenhouse emission reductions dismissing the outdated division between developed and developing countries. To clarify, the Agreement is established on a key scientific-based necessity of “holding the increase in the global average temperature to well below 2°C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5°C above pre-industrial levels” (Article 2a), but in contrast with the previous attempt to mitigate climate

change, it provides policy formulation to individual state governments establishing domestic mitigation measures. Article 4 of the official Paris Agreement text (European Union, 2005) provides a more detailed explanation and also adds some binding clauses on national actions. Here are the main points:

- The key long-term policy goals have to be achieved “as soon as possible” and zero-net emissions are required to be reached in the second half of this century (Article 4.1);
- “Each Party shall prepare, communicate and maintain successive nationally determined contributions that it intends to achieve.” (Article 4.2);
- National contributions must “reflect its highest possible ambition, reflecting its common but differentiated responsibilities and respective capabilities, in the light of different national circumstances” (Article 4.3)
- “Each Party shall communicate a nationally determined contribution every five years in accordance with decision 1/CP21 and any relevant decisions of the Conference of the Parties...” (Article 4.9) and their contributions must be increasingly ambitious at each five-year cycle;

As seen, the Paris Agreement allowed countries to submit their own programs for climate action, called Nationally Determined Contributions (NDCs), where they specified actions that they agreed to take to reduce their GHGs emissions in the attempt to reach the main global target of keeping the temperature under 2° degrees Celsius. A fundamental aspect is that NDCs allow parties to establish their emission targets independently from the efforts of other parties (Warne, 2019). This revolutionary approach, implemented on a bottom-up structure, allowed obtaining a fairer perceived agreement which involved the participation of all the parties (developed and developing) into the common goal of preventing climate change resulting in the biggest collective action ever obtained thus instilling trust and a fictitious perception of cooperation (United Nations and China were also part of the Paris Agreement). As a matter of fact, results were much less optimistic than expected.

In light of recent data, by January 2019 the Paris Agreement was signed by 197 Parties, ratified by 184 countries among these and furthermore, 181, which correspond to the 90% of

the total GHG emissions, had submitted an NDC (Dimitrov *et al.*, 2019). These numbers prove that a bottom-up approach completely succeeded in enhancing countries' participation worldwide and for the first time it appears as the most appropriate solution to climate change mitigation: extremely high in participation, inclusive and fair in sharing responsibilities among the Parties and applicable beyond local sovereignty discord. Nonetheless, the Paris Agreement never reached the ambitious goals set at the COP 21 and the reasons for its disappointing results lie within its architecture design. The Agreement is founded on a typical voluntary basis with no specific limitations and overmuch freedom left to the Parties. A report published by the UNFCCC secretariat declared that already previously to the Conference of Parties in 2015 (COP 21) the submitted NDCs were insufficient to meet the Paris Agreement goals of limiting global warming to the 2 degrees Celsius needed to avoid a climate crisis. Considering policies already implemented, global emissions are assumed to stabilize by the second half of the century but the temperature will rise by 3.6 °C. Even assuming the total adoption of the submitted individual NDCs, scientific analysis expects the global temperature to rise by 2.7 °C by 2100 (Dimitrov *et al.*, 2019). Accordingly, the Agreement results in low effectiveness. In a paper by Keohane and Victor (2016), the strategy used in Paris is defined as a “decentralized policy coordination” where the NDCs are examples of “shallow coordination” and it explains why, unless several diplomatic decisions on climate change, little progress have been made on emissions-cutting (Keohane and Victor, 2016a). The Paris Agreement is the demonstration that the level of participation achieved with this innovative paradigm is extremely successful, however it lacks satisfactory outputs in terms of emission reductions level. As explicated above, the Paris Agreement is based on self-interest determination of targets and actions (NDCs) where countries are able to individually determine the level of effort in climate actions and targets. Even if this approach is extremely self-enforcing, the resulting outcomes are disappointing because it is possible for countries to avoid costly unilateral actions and focus only on their economic wealth and power, thus opting for a less incisive purpose. To conclude, the bottom-up strategy in the Paris Agreement where countries can independently determine their actions without coordination is basically a non-cooperative solution where the economic effectiveness of the agreement seems to overshadow the main intention of preserving the planet.

1.2. Definition and Limitation of a Global Public Good

The Stern Review, one of the most influential reports on climate change, defines this latter as “the greatest market failure the world has ever seen” (Stern, 2007). This assertion relies on the economic classification of climate change as a global public good. Public goods are commodities for which the consumption by one individual does not affect the consumption available for the others (MC of serving another consumer is 0) and for which it is not possible to exclude consumer from enjoying the consumption of it (in the case of climate change, it is not about the amount of public good that is consumed but about the number of countries that can pollute). In other words, public goods are characterized by two key properties: non-rivalry and non-excludability (Nordhaus, 2006). Furthermore, climate change is a peculiar example of public good, called global public good, because its impact is indivisibly spread around the world and its benefits expand across space and time, and for those goods “inefficiencies are the greatest” (W. D. Nordhaus, 2017). As a result, there are no workable market or governance mechanisms that are appropriate to solve the problem (W. D. Nordhaus, 2017) and, due to the externalities connected to it, it is also almost impossible to coordinate the cooperation between the parties involved. To understand the dynamics of human behaviour with public goods consider the following scenario, economists call it a public good game:

N is the number of people that take part in the experiment. Each of them is given 1 euro and is privately asked to choose how much to contribute to a public good pot, c_i is the individual contribution. Suppose that they know that the total amount P collected in the public pot will then be doubled and distributed among all the participants. How much will they contribute? If the individual contribution is c_i the final amount in the pot will be $P = 2 \sum_i c_i$ and each participant will receive $\frac{P}{N}$. Acting as an economic agent that has to decide how much to contribute, it is fundamental to evaluate the cost of contributing versus the benefit from the contribution:

$$c_i < \frac{2c_i}{N}$$

As a result, if $N > 2$, the individual participant will not contribute as the cost would result higher than the benefit. This is the theory behind the free-riding problem: in the presence of a non-excludable good, it is not convenient for the individual to contribute to the total amount, but to hope the other will contribute. This result demonstrates that uncoordinated behaviour is highly inefficient as if everybody contributed 1 euro, each of them would have ended up with 2.

The difficulty of cooperation in the public good game is well illustrated by the Prisoner’s dilemma. It is one of the most famous games in the history of game theory. The Prisoner’s Dilemma demonstrates that, if there are two prisoners apprehended for a crime and they are interviewed separately without the possibility to communicate, the social optimum for them would be to cooperate and get the minimum sentence; but since they cannot trust the action of the other and they are afraid to be betrayed, they prefer to act selfish and blame the other prisoner. The result shows that when individuals act in their self-interest, the outcome is much worse than if they had cooperated. This model can be applied to explain the difficulties in reducing greenhouse gas emissions. Figure 1 is a concrete example of this theory. It represents a two-player prisoner dilemma where each player can choose between two different strategies (Abate, Pollute): the choices of the first player are represented in the 2 rows while the choices of the second player are in the two columns of the matrix.

		Player 2	
		Abate	Pollute
Player 1	Abate	(10,10)	(0,11)
	Pollute	(11,0)	(1,1)

Figure 1. Prisoner’s Dilemma (Wood, 2011)

The numbers in the table represent the payoffs for each combined action of Player 1 and 2, where the payoff of Player 1 is the first listed (Wood, 2011). Just goes to show by the payoffs in the matrix, in a context where two countries have to decide if to cooperate on emissions abatement or to avoid cooperation and continue polluting in their self-interest, they will

choose the second, which is the only Nash Equilibrium. The reason for this result is explained in the following analysis of the 4 possible outcomes:

- (Abate, Abate) is recognized as the social optimum because the payoff (10,10) is maximised. The Oxford Reference describes the social optimum as “the point on the utility possibility frontier that maximizes social welfare”. It means that the cooperative action of reducing emissions is the desirable solution for the collective well-being. Despite it, players have no incentives to cooperate since, when one player abates, they are better off if they continue to pollute (individual payoff is 11 instead of 10). Under these circumstances, climate change is subjected to the tragedy of the common. It implies that, contrary to what assumed by Adam Smith in *The Wealth of Nations* where individual decisions are also the best solutions for the entire society, each country is locked into a system that incentivises them to increase their herd without limit in a world that is limited (Hardin, 1968a).
- (Abate, Pollute) is not a Nash Equilibrium. In this case, if Player 2 chooses to pollute, Player 1 is better off by choosing to pollute too. In the same way, (Pollute, Abate) is not an option, since Player 2 can obtain a higher payoff by choosing to pollute. Climate change is a global public good and, as such, neither the individual abatement of emissions by one country nor the choice of one country to continue to pollute, can be excluded from the others. As a consequence, both negative and positive effects are shared.
- (Pollute, Pollute) represents the only Nash Equilibrium of the matrix. Nash equilibrium is present when no player is able to improve their outcome by changing their strategy while the action of the other player is constant. In this case, if the strategy of the second player is polluting, the first one has a better payoff choosing to pollute as well. (Wood, 2011).

To conclude, International Environmental Agreements are founded on a non-cooperative game where there is no incentive for countries to cooperate since a better payoff is achievable by individually choosing to maximise the self-interest of participants. Moreover, as mentioned above, climate change is a global public good and, as such, neither the individual abatement of emissions by one country nor the choice of one country to continue to pollute, can be excluded from the others. As a consequence, both negative and positive effects are shared.

1.3. The Problem of Free-riding

From the first international conference on climate change, antipodal models have been adopted to reduce global emissions, but none of them have succeeded. Climate policy is a complex system where cooperation is fundamental for the functioning of the treaty but it is not a satisfactory choice for participants who have incentives to act selfishness. Moreover, there is a political obstacle in international decision-making defined as the Westphalian Dilemma: there is no supranational authority able to establish legal authority on national government; the latter have political sovereignty in their territory, meaning that international obligations on climate change are actuated only with the consent of the interested State and cannot be imposed. Citing the economist W. Nordhaus, it means that “there is no legal mechanism by which majorities can coerce reluctant free-riding countries into mechanisms that provide for global public goods” (Cramton *et al.*, 2017). Free-riding is considered the main reason for the current international environmental agreements' inadequacy. It is strongly connected with public goods and it describes a situation where a party benefits from the consumption of a non-excludable good without contributing to the cost of it. Applied to the context of international climate policy, since externalities are spread around the globe, it means that involved parties have incentives to avoid domestic abatement of pollution while benefitting from emissions reductions of other participants (Nordhaus, 2015a). The logic behind this situation is explicated in the prisoner's dilemma shown in the previous paragraph: individuals have incentives to non-cooperate in international environmental agreements in absence of individually appropriate inducements. Climate change, which represents a tragedy of the commons (Hardin, 1968a), is considered a classic example of free-riding. The challenge, as represented with the game theory matrix (Fig. 1), is to make the abate-abate strategy a Nash Equilibrium. That is the reason explaining the importance of introducing the government in climate change decisions (Wood, 2011).

2. Climate Change as a Global Public Good and the Free-Riding Problem

“...the global environment is a global public good—all benefit from a good environment, and all suffer from climate change” (Stiglitz, 2015)

International environmental agreements represent an extremely complex negotiation and action implementation. Previous attempts at cooperative solutions have revealed multiple underlying mistakes in the regulatory structure connected to the problematic nature of climate change. The ability to achieve effective joint action on climate change requires an understanding of both the structural aspects of the problem as well as national preferences in terms of policies towards solving the problem. (Keohane and Victor, 2016b). On this basis, the following analysis explores critical obstacles in international cooperation. In particular, the first part of the chapter is mainly dedicated to a theoretical explanation of the major obstructions encountered in the implementation of previous international environmental agreements. Additionally, it introduces a multidisciplinary approach to the complexity of international relations providing an innovative interpretative framework that expands from a purely economic model to a more comprehensive examination of climate policy decisions. The study then proceeds with a review of empirical experiments representing the standard levels of cooperation expected in general public good games with an emphasis on characteristics that have been held accountable for their limitations of past international environmental agreements and it concludes with further and more recent investigation specifically designed on international climate cooperation.

2.1. Definition of Public Good and the “Tragedy of the Commons”

One of the main challenges for international environmental agreements concerns the economic classification of global warming. Climate change represents an extreme economic phenomenon classified as a global public good (Nordhaus, 2015b). As introduced in the previous chapter, a public good is characterized by two fundamental characteristics: it is non-

rival and non-excludable. Non-rivalry refers to the condition where consumption of a good or service by one person does not reduce the amount of goods or services available to other members of the society (marginal cost of serving another consumer is zero). An example of non-rival good is the national defence created to protect citizens; explicitly, costs associated with protecting an additional citizen, such as a newborn or immigrant, are unaffected (Stiglitz and Rosengard, 2015). Other examples are broadcast TV and GPSs. In essence, by using them, individuals do not reduce the value of the good for others (TV signal is not reduced due to the usage of a consumer). The second characteristic of public goods is non-excludability. In other words, no one can be excluded from enjoying the benefits or from being affected by the good, including individuals who did not provide any contribution to it (Nordhaus, 2015b). A classic example is the lighthouse beam, which is visible to all the ships passing by and cannot be excluded to any of them, even if they did not contribute to the construction of the structure or they do not pay for the benefit received (Stiglitz and Rosengard, 2015). The atmosphere represents a pure public good. It implies that it is accessible by everyone and that the “consumption” by one individual does not prevent others from “consuming” it. Due to their nature, public goods may lead to market failures because private markets do not guarantee efficient production, and joint action is needed to overcome the negative externalities (Nordhaus, 2005). To clarify, negative externalities occur whenever an individual or collective subject conducts an activity that has adverse effects on other subjects or entities and for which these latter are not compensated. It implies that there are costs that are borne by someone other than the original producer or consumer. Air pollution is a typical case of this phenomenon and it is defined as a common resource problem. Markets affected by negative externalities usually results in overproduction of goods as illustrated in figure 2: the demand curve represents the marginal social benefit from the production of an extra unit of GHG emission while the supply curve represents the marginal private cost of producing an extra unit of it; in the absence of externalities Q_m is the market equilibrium. However, considering the total cost provided by pollution where even countries that do not contribute to the global risk suffer from it (or countries that invest in green technologies, sustaining major costs, still suffer from the pollution of countries that do not contribute), the marginal social cost is higher than the marginal private cost. The social optimum quantity of the good (Q_e where $MSC=MSB$) is lower than the private market equilibrium (Q_m where $MPC=MSB$) thus, it is

evident that too much is produced on the free market (Stiglitz and Rosengard, 2015).

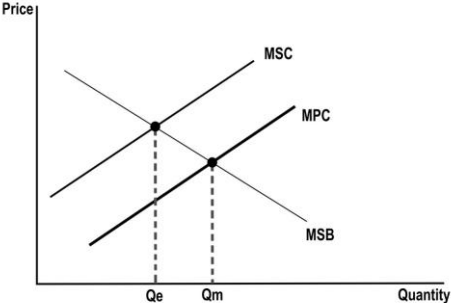


Figure 2. Negative externalities and overproduction

Further clarification can be provided by introducing another concept: “the tragedy of the commons” (Hardin, 1968b). This theory was introduced by the ecologist Hardin referring to problems that cannot be solved in a technical manner. He focused on the growth of human populations and the use of earth's natural resources, explaining that “we will greatly increase human misery if we do not, during immediate future, assume that the world available to the terrestrial human population is finite” (Hardin, 1968b). He explained it using the example of herds-man: to satisfy their personal interest each of them will try to keep as many cattle as possible and this situation may work for centuries since there are diseases, wars between tribes and other factors that keep the number of population and animals under the carrying capacity of the territory, but when social stability is finally reached, this scenario becomes a tragedy. The reason is that to maximize his private utility, each herdsman will rationally try to increase his resources with no limits in a limited world (Hardin, 1968b). Climate change has the same structure of a tragedy of the commons: in the absence of governmental regulations, each country will try to maximize its utility by over-consuming natural resources (in the case of climate change the issue is the unlimited incremental level of GHG emissions in the environment). Therefore, the global warming problem is a “common problem” in the sense that it is the result of overuse (or overexploitation) of a relatively scarce, shared resource and there is no unilateral obligation to reduce the emissions (Johnson, 2003). Based on this analysis, it is clear that an efficient climate policy is necessary. In particular, Johnson explains in detail why he believes that climate change should be recognized as a collective action problem, and concludes that, in the absence of a cooperative agreement that restricts

individual use of the commons, there is no reason to believe that individual voluntary actions will work (Hourdequin, 2010). The author claims that this logic is due to the structure of commons problems and he provides three assumptions of a Tragedy of the Commons Game which are quoted below in verbatim from his work (Johnson, 2003):

1. The only incentive players have is to maximise benefits from the use of the commons (All benefits and losses are internal to the game);
2. The only way players can communicate is by increasing or reducing use of the commons;
3. Use of the commons is shared, but individual herds are not
 - a. So costs (to the commons) of increased use are shared, but benefits from increased use accrue to the individual herder.
Benefits (to the commons) of reduced use are shared, but costs of reduced use are borne by the individual herder;
 - b. Resources saved by one individual are available for use by any other user.

Johnson emphasises the role of collective agreements as a means to “coordinate the behaviour of individuals to protect the commons” (Johnson, 2003).

2.1.1. The Global Nature of Climate Change

Another critical aspect of climate change is its global nature. Not only is climate change a public good, but it is a global public good, which means its impacts are indivisibly distributed across the globe and for many years to come (Nordhaus, 2005). In particular, to provide a more exhaustive explanation, for a public good to be classified as global, it must necessarily comply with the three universally recognized criteria established by the United Nations Development Programme at the end of the 1990s:

- *Geographical criterion.* It means that public good effects extend around the entire globe impacting whole countries worldwide. Considering global warming and air pollution, it is obvious that externalities produced in a specific territory have effects also on the other

- regions; there are no national boundaries preventing countries from the negative impact of climate disasters; even when suffering countries are not contributing to world pollution, they are subject to the negative consequences of others' polluting choices;
- *Socio-economic criterion.* Impacts of a public good are global if they involve nations belonging to different groups categorized on the basis of distinct factors including their income (poor and rich countries), access to knowledge and technology. In the case of climate change, negative externalities related to greenhouse gas emissions are equally spread between different classes of countries. Even assuming that the majority of pollution is caused by rich countries, the impact extends to all the countries, but benefits are usually gained by rich countries, highlighting strong inequalities;
 - *Generational criterion.* Global public goods are characterized by a long-term perspective, an aspect that undermines intergenerational equality. The effects resulting from these peculiar goods are not only spread around the globe but also affect several generations in the future. For instance, the risk of climate disaster is usually not perceived by the present generation but the consequences of current actions undermine the welfare of future generations; the same applies to benefits of reducing greenhouse gasses: the costs incurred in by present generations do not correspond to immediate benefits, which will instead be enjoyed by future generations.

According to the classification of global public good, it is evident that climate change mitigation represents a significant dilemma, that is not only characterized by the public good attributes, but also by political complexities determined by the international nature. All countries indistinctively contribute to global warming and the negative externalities generate worldwide consequences (Kaul, Grunberg and Stern, 1999). Environmental issues transcend national boundaries and this has led to interdependence among states as a matter of necessity. Due to their transboundary nature, global public goods cannot be preserved at a domestic level, but they require international environmental laws and an unprecedented degree of international cooperation and coordination (Weitzman, 2016).

In the light of this premise, one more relevant obstacle posed by climate change mitigation is a decision-making dilemma that may be identified as the Westphalian dilemma, generated by the Treaty of Westphalia in 1648. It is a formal statement recognizing the inalienable right of

national governments to administer their own territories enacting independent national laws and institutions within their territories. It is up to individual countries to decide how to govern their citizens. Rather, under international law, there is no legal mechanism by which disinterested majorities or supermajorities can coerce reluctant countries into mechanisms that provide for global public goods. Due to the evolution of sovereign states, international obligations can only be imposed on sovereign states with their consent in accordance with the current international law structure. The Westphalian system leads to severe problems for global public goods because nations attach great importance to their sovereignty, therefore it is extremely difficult to reach universal, binding, and effective international agreements and therefore global citizens are unable to provide solutions that overcome the voluntary contribution structure in international environmental agreements.

2.1.2. Fairness and Inequality

In relation to the global aspect of climate change, a further dimension of complexity can be found in the asymmetries defining various nations and their relationship to one another. Negotiators are faced with the major challenge of developing an agreement that will be generally accepted as fair and equal by all or at least the majority of governments. The issue in question has already been observed in 1997 under the Kyoto Protocol in which countries were divided into developed and developing countries on the basis of “common but differentiated responsibilities” (United Nations, 1998). This principle recognizes that climate change “affects and is affected by all nations in common, if not to the same degree, and that the resulting ‘responsibilities’ ought to be differentiated because not all nations should contribute equally to alleviate the problem” (Yamin and Depledge, 2004). However, some of the countries included in the non-Annex list have recently started major economic developments, such as China, which in 2006 became the world's largest emitter (Brown, 2021). Consequently, developed countries argued the presence of inequality in agreements that did not include limitations for these global economic powers. On the other hand, developing countries criticize the hypocrisy of rich countries which in the past polluted without restraint and now expect others not to do the same. China and other developing countries justify their emissions as survival emissions aimed at reducing the level of poverty.

Appealing to the previously attained level of pollution, which sees the US responsible for 25% of the world's historical emissions emitting 400 billion tons and the EU in the second place for 22%, China does not accept be constrained to environmental regulation on the next future. The historical level of responsibility provides a justification for China's behaviour concerning their level of pollution since historically, they only contributed to the 13%, which is about half of the recorded US level (Ritchie and Roser, 2020).

This is just one of the most relevant features increasing the complexity of conceiving an international environmental agreement that is perceived as a fair solution according to dissimilar participants. The design of a cooperative agreement on climate change requires the examination of multiple conditions which differentiate the countries involved. The Kyoto Protocol was the first attempt to study differentiated responsibilities and consequently to adapt the agreements to different levels of emission reductions. However, as previously outlined, it did not consider the rapid evolution of non-Annex countries and the dangerous effect of this policy decision on international results. The subsequent Paris Agreements tried to develop a fairer climate policy focusing more on the capabilities of nations rather than the responsibilities for emissions (Wang and Gao, 2018). This principle is based on Article 13 of the Paris Agreement which requires all Parties to regularly and transparently report on their emissions and on their implementation efforts to put forward their best contribution to the NDCs (UNFCCC, 2015). However, several distinctive aspects characterizing participant countries are still omitted due to the difficulties in controlling the multitude of variables. These differences between countries imply that costs and benefits of climate change have a different impact on nations and therefore, participation's incentives and fairness perception are often divergent.

An additional distinction has to be made concerning different situations of rich and poor countries. The latter suffer more from the damages caused by global warming and climate disaster. One of the reasons is that poor countries are usually located in territories with a higher average temperature than developed countries (Kverndokk, 2018) and between 70-75% of their inhabitant lives in rural areas highly depending on primary natural resources (Lee and Neves, 2009). As a consequence, rising temperature, drought and raw material scarcity have a

direct impact on their primary necessity, while the same climate damage may not even be perceived by the richest nations. Therefore, poor countries have usually strong incentives to fight climate change as the cost of taking action to reduce this global risk is undoubtedly lower than the benefits perceived, but at the same time, they are not willing to pay for the damage caused by other richer states. In contrast, rich countries generally consider the direct cost of taking action too high in respect to any direct gain associated with the reduction of global warming risk due to the benefits deriving from the fossil fuel assets they normally own. As a result, acting in their self-interest, polluters have incentives to continue polluting and not participate in any collective actions to mitigate global warming (Stiglitz, 2015) and, on the other hand, it is unlikely that poor countries will contribute to something they do not have responsibility for, often not even having the monetary opportunity to intervene.

Due to the different levels of impact, diverse responsibilities, and its global nature, climate change provides free-ride opportunities to the countries. The problem of free-rider arises from situations, such as those of non-excludable and non-rival public goods, in which individuals may obtain benefits of a good without contributing to its cost and it is usually referred to as the main cause of failure in the international climate-change policy. A free rider, as introduced in the previous chapter, is someone who receives a benefit from a specific action, or production in the case of general public goods, without contributing to it. Consequently, free-riders undermine the efficiency of the production of important collective goods or actions. They have incentives not to pay or act for such goods: considering climate change mitigation, the individual action of reducing pollution will not be sufficient; moreover, free-riding implies that some participants are receiving the benefits of others' individual actions without contributing. The theoretical analysis of this dilemma is described in "the logic of collective action" (Olson, 1965) which was defined in a homonymous book in 1965 by Mancur Olson and it is extremely relevant in climate change mitigation. In particular, the logic of the collective action clarifies the cause of the necessity to implement intergovernmental laws to regulate individual (also intended as a single country) behaviour, especially in a situation that requires the reduction of the level of pollution by under 50% by 2050, a threshold which is impossible for a single country to achieve (Milinski *et al.*, 2008).

2.1.3. Free-riding Incentives

Due both to their economic and societal importance, public goods are one of the most widely discussed topics in economics theory. As described in the previous paragraphs, peculiar characteristics of non-exclusivity and non-rivalry generally cause strong incentives to free-ride and therefore, they prevent the market from producing a socially efficient level of these goods. Concerning climate change mitigation, the problem relates to insufficient efforts to reduce greenhouse gas emissions. In order to be able to design a mechanism of proper mitigation of GHG emissions, it is essential to understand the driving forces that cause individuals not to voluntarily contribute to public goods.

Free-riding was initially and mainly studied as an economical problem. Classical economics assumes that each individual is completely rational and only guided to the maximization of his or his own profit, on a self-interest satisfaction basis. According to economic theory, the subject is not encouraged to contribute to the public good and is therefore not motivated to cooperate internationally. Notwithstanding, empirical evidence from a variety of disciplines contradicts these predictions. Multiple disciplines are concerned with the complexity of the free-rider problem and their different approaches highlight multiple behavioural responses and more optimistic results. Their investigation focus on particular factors that influence the level of contribution and the mechanism used to enhance cooperative actions. The main academic disciplines that have been involved in studying the free-ride problem are: social psychology, questioning the extent and the circumstances in which people are motivated to free-ride, and the negative incentives that motivate cooperation when free-riding is possible; game theory, focusing on strategic circumstances under which rational promotion of self-interest recommend free-riding; classic economics, asking which real-world mechanism approaches generate efficient production of public goods given the free-ride incentives; political science, questioning the existence of large-scale political participation when free-riding incentives are present; moral philosophy, investigation the morally wrong aspects of free-riding; normative political philosophy, wondering on the existence of satisfactory grounding for political obligation considering moral reasons (Hardin and Cullity, 2020).

The economist John O. Ledyard contributed to the provision of empirical evidence to these theories by reviewing some specific experiments on the different impacts of free-riding on cooperation revealing the presence of “a full range of behaviour from fully selfish to fully altruistic” (Ledyard, 1994). He focused on two main theories: economic and game-theoretic, which reveal a pessimistic level of contribution and a strong impact of the free-riding, and a sociologic-psychologic perspective, where it appears that subjects will rather contribute with something. In the majority of cases, experiments have resulted in discordant outcomes, keeping the question between cooperative and selfish behaviour open, but at least several variables have been recognized to affect the contribution rate. This also means that there is some form of control over it and there are variables that are more significant than others. From his investigation, it resulted that “sometimes subjects contribute and sometimes they do not” (Ledyard, 1994). At least, it is certain that cooperation is related to some specific variables. The paper considers six major experiments in the public good analysis: three results in selfishness even if the percentage is not so relevant as it was predicted (Bohm, 1972; Dawes, McTravish and Shaklee, 1977; Marwell and Ames, 1979), while the last three demonstrated the presence of temporal altruism (Isaac, McCue and Plott, 1985; Kim and Walker, 1984; Isaac, Walker and Thomas, 1984). More specifically, results show that the implementation of relevant communication (Dawes, McTravish and Shaklee) and increases in the marginal payoffs of contribution (Isaac, Walker and Thomas) enhance the level of cooperation between different subjects, while the repetition of the experiment have been found to be detrimental for cooperation (Isaac, McCue and Plott) and therefore the more repetitions, the less the cooperative behaviours. Furthermore, other factors were discovered to have a significant influence on the games; to provide a comprehensive overview of his main results and a clearer relation between contribution in connection to the environment and the mechanism implemented, Ledyard classified the main variables identified into three separate categories even if, as revealed from his review, effects are strongly interrelated: environments (numbers, marginal per capital return, repetition, common knowledge, gender, thresholds, homogeneity), systemic variables (beliefs, economic training, experience, friendship, learning, altruism/fairness, effort, risk aversion) and design variables (communication, moral suasion, rebates, unanimity). All the mentioned variables and experiments can be further in-depth on Ledyard’s publication called “Public Goods: A Survey of Experimental Research”

(Ledyard, 1994).

The experimental theory demonstrates the complexity of cooperative actions and the relative impact of free-riding. Ledyard's analysis demonstrated that several factors influence the rate of contribution in international cooperation and the classical economic theory assuming a completely rational subject is only an approximation of the complicated interactions arising in the actual international environment and it does not provide a comprehensive result about the international willingness of nations to take part in climate change cooperation. Public good experiments can be extremely useful to provide a cross-disciplinary evaluation of the level of cooperation. Moreover, they target the actual behaviour of participants rather than the merely stated preferences, since the outcomes of such experiments are dependent upon the decisions made by participants and they can include countless and divergent variables. According to research performed in November 2014 on the ISI Web of Science journal, the number of records associated with the field of economics and containing the key phrase "public good experiments" accounts for almost 1,864, while instead, environmental studies and environmental science together only account for the 13%, and political science is just a 5 per cent of the total works. As a consequence of this body of research, it is assumed that many of the findings, for example, the well-known evidence that players cooperate more if they can discuss the experiments, is generalized to all the cooperative decision-making, including policies on climate change and experiments form the classic public good cooperation are sometimes attributed to the climate-related decision-making (Jacquet, 2015). Fortunately, in the past decade, scientists have initiated the modification of cooperative experiments to specifically study cooperation in the laboratory specifically considering climate scenarios. Ledyard's review represents one of the first pieces of evidence of the influence of different disciplines on cooperative actions leading to several new research opportunities, especially in the field of climate change cooperation. The world is experiencing a period of unprecedented environmental awareness and new theories have been analysed providing a well-structured view of this complex issue. An important contribution comes from the consumer behaviour theory.

2.1.4. The Complexity of Human Behaviour: models from consumer behaviour theory

The complexity of cooperation in international environmental agreements proved the limitation of a purely economic approach based on the assumption of a rational subject. As introduced in the previous paragraph, agents are exposed to multiple variables connected to numerous disciplines. Consumer behavioural studies introduced innovative interpretative frameworks on human behaviour providing a well-structured view of this complex issue. New variables, as well as many new approaches including different drivers of action, have been examined to understand human conduct. (Lanzini, 2017). Consumer behaviour provides a conceptual theory of the complexity of human behaviour which might also be applied to climate change scenarios and countries' behaviour in international environmental agreements since countries are collective subjects acting as a single entity. In particular, as anticipated above, it reveals the existence of interdisciplinary approaches influencing decisions and the limitation of the pure classical economic approach in examining the real behavioural responses to global events. Human beings are much more complex than what is explained in economic theory and the utility they perceived by contributing to a public good could alter the economical assumption of rational non-cooperative behaviour on global public goods. Consumer behaviour theory suggests the adoption of models addressing a more comprehensive set of elements, which are not merely connected with rational consumption choices. One of these conceived models is the “theory of reasoned action” (Ajzen and Fishbein, 1980) suggesting that both attitudes (general predisposition toward a specific activity) and subjective norms (meaning the social pressure based on the expectation that other people have about us) represent the antecedents of behavioural intentions. This model was still insufficient to investigate all the possible behaviours, therefore, the introduction of other variables was required. An extension of this model is provided by the “theory of planned behaviour” (Ajzen, 1991) which adds a third element to the previous one: the perceived behavioural control, investigating the perception of how easy or difficult is to perform a specific behaviour. In addition to those, there are also other two models which could give further suggestions on impactful variables related to human behaviour. The first one is the norm-activation model (Schwartz, 1977). This model still suggests that the main antecedent of behaviour are the intentions, but it adds the personal norms as factors

influencing the latter. Personal norms are given by the feeling of moral obligation to act or not to act and they can be activated by two variables: the awareness of the consequences (about a specific action) and the ascription of responsibility (if the subject perceives himself as directly responsible or a consequence deriving from the specific action taken or not taken if he feels responsible personal norms are activated). Finally, the value-belief-norm theory is another model used in behaviour examination and it is relevant because it studies human behaviour on the basis of personal values and beliefs of the subjects analysed introducing further peculiar factors to human decisions. Moreover, in the real world, external actors can be highly effective in shaping behaviours as with the introduction of particular inducements, which can be divided into monetary inducement and non-monetary incentives (i.e., improve awareness about the global risk of climate change through messages to individuals). As it is evident from the model presented, human behaviour is influenced by a very large number of factors that very often are not connected to the idea of the classical economy in which humans are considered perfectly rational subjects and exclusively guided to the maximization of their profit, but very often their actions are merely the result of psychological and social factors and sometimes also of external incentives. The examples described have been studied and structured exclusively in relation to consumer behaviour. Nonetheless, the application of the presented theories and the newly introduced variables are perfectly applicable to the experimental research on the problem of free riding and the level of international cooperation on international climate change mitigation.

2.2. General assumptions and empirical results from standard public good games

The previous international climate agreements failed to provide desirable results in the presence of global public goods. Explanations of unsatisfactory results of the Kyoto Protocol and the Paris Agreements are based on the unfavorability of their structure and the unconsidered impact of significant variables. Classic experiments suggest evidence of the voluntary contribution's inefficiency and moreover, they provide an empirical demonstration of how peculiarities of public goods influence the level of contribution boycotting the preferable solution. Public good games are usually used as an empirical model to observe the

behaviour of a group of people attempting to achieve a common goal and to identify their level of contribution based on selected variables. They have the same structure as the prisoners' dilemma game but they describe the potential provision of a good from which all may benefit either through they contribute or not. In the previous section, obstacles connected to the cooperation in climate change scenario have been theoretically described to provide a general overview of the difficulties connected with the provision of this public good and therefore with the unsatisfactory level of greenhouse gas reduction which, if it is not prevented, it risks generating an irreversible global disaster. The theoretical description of public goods provides a pessimistic perspective where rational subjects are not incentivized to contribute to the non-excludable good. The purpose of this section is to describe the standard level of contribution expected in public good games and provide an overview of the general assumptions on public good contribution with related empirical evidence to verify these hypotheses. The analysis focuses on three characteristics of general public goods that are held responsible for the failure of the previous International Environmental Agreements and that are believed to have an important impact on the level of cooperation between the Parties. The main obstacles to cooperation are supposed to come from: the group size, meaning the number of individuals taking part in the collective action; the asymmetries characterizing the participants, which are connected to income level and differences between benefits and costs deriving from contributing to a public good; the lack of a punishment mechanism for participants to punish the non-participants.

2.2.1. Hypothesis 1

Hypothesis 1. "The larger the group is the larger is the possibility to have free-ride" (Olson, 1965)

From a classical perspective, cooperation is expected to be more difficult in larger groups. In particular, according to Olson, there are two main hypotheses regarding the effects of the group size on the public good provision. The first states that large groups will not be able to provide any public goods, and the second says that the difficulty in providing public goods increases with increasing group size (Olson, 1965). These hypotheses are connected to the potentially unequal distribution of benefits resulting from cooperation and the small

perception of individual defection in a larger group (if one does not cooperate, its impact is not even noticed in a large group) (Esteban and Ray, 2001). However, years of experimental research revealed discordant results on this hypothesis. In particular, some experiments revealed no effects by changing the group size, while others highlighted negative effects. Some of them however do not only consider a variation in group size but also modify benefits and costs making it difficult to isolate the impact of a large group on cooperation and the only one structured on constant benefits and costs is based on multiple rounds. (ibid).

One of the main experimental pieces of evidence to prove this assumption is provided by Isaac and Walker (Isaac and Walker, 1988). Their research attempts to analyse the relationship between group size and public good provision. They included the analysis of the actual number of participants in the group and the related individual marginal return from contributions to the public good. The result strongly supports the hypothesis that increasing the group size leads to a reduction in allocative efficiency when accompanied by a decrease in marginal return from the public good. The results show that larger groups have a more difficult time providing public goods than small groups. This is strongly supported when the decision in group size is driven by reductions in the marginal per capita return to an individual from contributing to the public good: groups with a lower MPCR had less success in providing optimal levels of the public good. Thus, to the extent that increasing group size decreases MPCR, these results are consistent with the hypothesis.

2.2.2. Hypothesis 2

Hypothesis 2. Due to their asymmetries, poor and rich countries have different incentives to contribute to a public good game, in particular, rich countries contribute more

In most cases, the literature contradicts this hypothesis. In particular, Mason (Mason, Phillips and Nowell, 1992) and Keser (Keser, 2000), analyzing situations of oligopoly, revealed the presence of greater cooperation in the presence of symmetry between the parts than in cases of asymmetry. In addition, further experiments related to the level of contribution with different endowments showed little altruism (Becker, 1974) and the lack of inequity aversion.

Milinski (Milinski, Röhl and Marotzke, 2011) provided an investigation on inequality in an experiment peculiarly conceived on climate cooperation. The described experiment provides specific information on more realistic scenarios which include inequality and interaction between “rich” and “poor” players in two different scenarios. His contribution involves the introduction of asymmetries not only in the capital participant received, as in Tavoni’s experiment from which it took inspiration (Tavoni *et al.*, 2011), but also in the potential gains from cooperation. In this experiment, participants are divided into 57 groups of six subjects each. The target of the public good was to collect at least €120 from each participating group in 10 rounds. In detail, if participants reached the threshold of 120€ by the end of 10 rounds, in addition to the prefixed gain (= operating fund – investment), additional funds were to be provided. In contrast, however, in case of failure in reaching the goal, they lost their sum with a 90 probability, receiving only their remaining operating fund (Milinski, Röhl and Marotzke, 2011). The experiment is divided into three different treatments:

- Treatment 1: six “rich” participants with a given amount of €40 operating fund and €60 potential revenue;
- Treatments 2: six “poor” participants given €20 as operating fund and €30 potential revenue;
- Treatments 3: three “rich” and three “poor” participants each with their respective funds and revenues based on the above description.

Each of the treatments was further examined in two different cases of climate targets (participants are informed):

- Case 1: the only requirement is that the total amount of €120 had to be collected at the conclusion of the tenth round, (participants knew the number of rounds in both treatments).
- Case 2: it requires that half of the total target (€60) is collected by the fifth round, in order to avoid climate-related disasters occurring with a probability of 20% in each of the following five rounds; these events are equivalent to a 10% loss of both the operating fund and the endowment.

After analysing the collected data, experimental results from Milinski’s experiment (Milinski,

Röhl and Marotzke, 2011) are reported in figure 1 and can be divided as follows:

- Without the intermediate target: groups of all “rich” players invested around or more than €12 per round, “poor” players invested progressively less; as visible, all the “rich” groups, none of the “poor” groups and the 60 per cent of mixed groups succeeded in avoiding climate change disasters (they reached the collective target)
- With intermediate target: high level of investments were made in round 5, thereafter, they dropped drastically and recovered in both mixed and “rich” groups, but in poor groups, they remained low; all the “rich” groups, 2/3 of the mixed groups and 3 out of 9 “poor” groups succeeded in reaching the €120 target and the remaining 1/3 of mixed groups were closer than without the intermediate target (respectively €113, n=5 and €97,2, n=4)

When the asymmetry is in the cost of global warming to each country, the country with lower costs substantially increases emissions. When a country is relatively more productive in generating benefits from emissions, then the more productive countries increase emission. (Manoussi and Xepapadeas, 2014) As a consequence, the assumption is false: rich countries do not contribute more, instead, it depends on the level of benefits against the cost and usually, the benefits generated from rich countries’ emissions are larger than the cost of reducing it, as a result, they do not have incentives to contribute.

2.2.3. Hypothesis 3

Hypothesis 3. “In the presence of punishment opportunities, there will be less free riding”
(Fehr and Gächter, 2000)

Empirical studies have demonstrated that providing agents with the opportunity to punish non-cooperative behaviour increases the level of cooperation in economic and social dilemmas like the one established by climate change. In particular, Fehr and Gächter (Fehr and Gächter, 2000) claim that both casual and daily experiences prove that many people face strong aversions toward being "suckers" in social dilemma situations and, consequently, those who cooperate could be willing to penalize free-riders despite being costly for them and

despite the fact that they will not be able to gain any benefit from their punishment. In order to verify this hypothesis, they conducted a public good experiment with opportunities to punish or not the non-cooperative parties. The study was divided into four treatment conditions: a “stranger” treatment with and without punishment possibilities and a “partner” treatment with and without punishment possibilities. Ten groups of $n=4$ people participated in the partner treatments. Here, the same group of 4 participants played a finitely repeated public good game with no variation in the group composition (the group does not change in any of the rounds). In the stranger treatment instead, the total number of participants is 24, they are randomly assigned to a smaller group of $n=4$ and the subjects in the group change at every round. Both the Partner-treatment and the Stranger-treatment are based on a 10 rounds interaction (10 rounds with punishment and 10 rounds with non-punishment). The scenario involving no punishment serves as a control. In sessions 1-3 researchers implemented the Stranger-treatments, while in sessions 4-5 they implemented the Partner-treatment. Moreover, in session 4 they started with the punishment condition while in session 5 they started with the non-punishment one. Here the focus is on session 3, where participants were strangers and they first played the treatment without punishment possibilities and then the one with punishment. Each participant started with an endowment of €20 and they decide on the amount they would like to donate to the public pool. Participants only know their punishment activities and the total punishments imposed on them by the other group members. Results show that without punishment opportunities the main contribution in the final period of session 3 was 2 while the number increased to 13,1 with punishment opportunities. This experiment suggested that in both stranger and partner treatments the existence of punishment opportunities largely increased the average contribution level: it converges to full cooperation in the presents of such opportunities. On contrary, when there are no punishment opportunities, the average contributions are close to full free riding for both treatments. Therefore, this study indicated that there is a widespread willingness of those who cooperate to punish the free riders. This finding has a profound influence on policy-making structures: introducing punishment opportunities in the structure can be helpful in increasing the cooperation level. This assumption can be used for further investigation and formulation of potential solutions in international climate policy. An alternative structure from international environmental agreements based on punishment and incentives is described in Chapter 3.

2.3. Multidisciplinary approach and further investigation on climate change

Subsequent analyses had tried to explore alternative approaches and different organizational arrangements including variables from the above-mentioned disciplines and models in the attempt of producing better outcomes in serving the public interest and discovering human behaviour. As described in the first chapter and confirmed in the previous paragraph, classic public good experiments such as the mentioned game investigating the collective level of contribution to a public pot (see Chapter 1), usually confirm the lack of altruistic behaviour, meaning that the collective benefit will generally not be reached, even if the collective contribution would have brought a better choice. Individual self-interest is in contrast with group interest. In the following section, the classic analysis on public good cooperation and the main obstacles to its achievements are integrated with more recent experiments which introduce novel evidence on climate change focusing on more specific variables that are peculiar to international cooperation on climate change mitigation and a multidisciplinary approach which departs from classical economic theory. Global warming and greenhouse gasses reduction are not just a simple public good game: they are intergenerational global public goods and their complexity requires further analysis to determine the actual level of contribution based on those additional characteristics. The main peculiarity about climate change is related to the fact that this latter involves dynamic externalities, therefore, decisions made by the Parties during the current period may affect the welfare of their inhabitants in the future. Not only do national climate-related decisions generate consequences for external nations, but furthermore, those current decisions have a strong impact on the well-being of future generations through changes in the atmospheric concentration of GHG increase, water availability, or biodiversity (Sherstyuk *et al.*, 2016). An efficient allocation of resources in the context of global dynamic externalities requires cooperation between sovereign states over a long period of time, including the potential participation of multiple generations. Researchers and policymakers have grown increasingly interested in institutional arrangements in the attempt to facilitate cooperation in such situations (Sherstyuk *et al.*, 2016). To provide empirical proves on the complexity of climate change scenarios, it is interesting to investigate cooperation on specific climate change scenarios. In particular, the focus is on the level of risk perceived by the current generation in comparison to the future generations about potential

climate change disaster: the intra- and inter-generational approach connected with the time gap between current actions and future benefits or consequences and therefore a more accurate analysis on the cooperation level considering the persistence of greenhouse gasses in the atmosphere. To conclude, related to the multidisciplinary approach mentioned in the first paragraph, the thesis provides an experiment based on the level of awareness of the consequences and the impact of reputation.

2.3.1. The perception of risk

The professor and experimental economist Manfred Milinski was the first to adapt a public goods experiment to the critical context of climate change. His main question was on the ability of a group of people to reach a collective target through individual contribution even if everyone suffers individually when the target is not achieved, which is essentially what happens in international environmental negotiations on climate mitigation, where reaching a collective target implies individual sacrifice with benefit for the group but with no assurance that others will contribute too. Nevertheless, public good investments conclude with the realization of a gain while, in climate change scenario, it results in a loss avoidance, therefore strategies pursued by participants should be risk-averse. For this purpose, Milinski introduced the “collective-risk social dilemma” and he studied it in an experimental approach. (Milinski *et al.*, 2008). The experiment involved thirty groups of six students. Students were provided with €40 each to invest in 10 rounds. They have three options to invest the given endowment: they could choose to invest €0, €2, or €4 in a “climate account”, all of them on condition of anonymity. If the full amount of the group reached or exceed €120 at the end of the 10 rounds, all the group members would receive the amount they had not invested (e.i. they received €20 if they had invested €2 each round). In the case of failure in achieving the collective target, a computer randomly assigned the 90%, 50%, or 10% risk of losing the whole endowment. All this information was available to the students. Results are represented in the following table (Figure 3).

Loss probability, %	Free rider, €	Fair sharer, €	Altruist, €
90	4	20	0
50	20	20	0
10	36	20	0

Figure 3. Expected values by the three strategies with different loss probability (Milinski *et al.*, 2008)

In each round, free riders contribute zero euros, fair sharers two euros, and altruists four euros. With a 90% probability of losing the monetary amount, the best strategy would be to commit €2 each round as part of the collective. In the case of a 10% probability of loss, the Free Rider strategy is rational, and in the case of a 50% probability of loss, both strategies have the same expected gains. To provide a better explanation: a probability of 90% implies that if nobody invests anything, any subject will receive the saved €40 only in one out of ten instances, which is an average of €4; in the case of 50% treatment, the groups would gain on average €20 per individual, either by investing the fair share or nothing, which is considerably more than in the first scenario; lastly, in the 10% treatment, on average participants made the most money investing nothing because if no one invested, all subjects would receive 36 euros on average, (since they would lose the saved 40 euros only once in ten cases). According to the results, only five of ten groups succeeded in achieving the target amount considering a 90% probability of loss, only one group succeeded with a risk of 50% and, as expected, in the 10% loss risk treatment none of the groups succeeded. (Milinski *et al.*, 2008). In this experiment, the failure in reaching the €120 target sum symbolized the inability to prevent climate change disasters. The collected data proved a strong limit in cooperative efforts even though the presence of a high level of risk.

2.3.2. Intergenerational games with dynamic externalities

Experiments have proven extremely useful for alleviating environmental problems and providing valuable advice to policymakers when it comes to finding solutions to environmental problems (Bohm, 2003). There is, however, a severely inhibiting factor represented by the fact that the majority of the experiments do not take intergenerational interaction into account, which is one of the main characteristics of the climate change

dilemma. In other words, it is fundamental to consider that the sacrifices made today are rarely rewarded by immediate benefits, but rather by benefits that are enjoyed by future generations beyond what one generation could reasonably expect today (Schelling, 1995). In this experiment, the researchers bring to the forefront the intergenerational nature of the problem. One of the research questions of interest investigated by Sherstyuk is: “does raising awareness about future effects of own actions through access to information, history, and advice from the followers make people (somewhat) future-regarding, even if they are not directly motivated to care about the future?” (Sherstyuk *et al.*, 2016). Their findings indicate that dynamic efficiency becomes more challenging when there are several generations of decision-makers in the system as well as a more myopic approach to the action path (Sherstyuk *et al.*, 2016). Two important issues referred to climate change mitigation are raised by this study: problems arising from decision makers' lack of concern for the future and problems associated with the intergenerational decision-making process due to a higher level of strategic uncertainty (not related to direct motivation but to the uncertainty about whether his policy decisions will be followed in the future.

According to the researchers, long-lived and intergenerational scenarios lead to different game evolutions: intergenerational players are more myopic than long-lived players. As a conclusion, they found that, even without direct financial incentives, emphasizing the dynamic externality aspects of the problem made the participant more future-oriented. they found that emphasizing the dynamic externality aspects of the problem to the decision-makers makes their actions somewhat future-regarding even in the absence of direct financial incentives to care about the future. It suggests the need to introduce long-term motivation for real-world decision-makers and to ensure that climate policies are consistent even if they are implemented at different times by different individuals.

Intergenerational scenarios reveal a well-established noncooperative behaviour that evolves across generations. Noncooperative emission levels are chosen by participants and recommended by them to the followers resulting in increasingly non-cooperative outcomes. Consequently, International Environmental Agreements are required to reduce greenhouse gas emissions and to avoid non-cooperative outcomes when governments change between

generations without explicitly being motivated by future benefits. These results point to the importance of inducing long-term motivation for the real-world decision-makers, and of ensuring that environmental policies are dynamically consistent across generations of decision-makers.

Jacquet proposes an alternative climate experiment in which cooperation rewards are not realized immediately after the game (Jacquet *et al.*, 2013). By altering a climate change experiment, she introduced delayed rewards for cooperation. The delay could be one day (T_1), seven weeks (T_2) or even decades long (T_3). The latter referred to donations that would be invested to plant oak trees for carbon sequestration instead of having a direct monetary reward. The difference between the first two temporal horizons (T_1 - T_2) is referred to as “intergenerational discounting” because in both of them, the same generation benefit, there is only a slight delay in T_2 ; on the other hand, the difference between T_3 and either T_1 or T_2 is called “intergenerational discounting” since benefits are spread among several generations in the future. During the experiment, participants were divided into groups of six and each of them was given 40 euros to invest. In the event that they cooperated and achieved the common goal of €120, each of them would receive, in addition to the expected sum, an amount of €45 on the three different time horizons above-mentioned (one day later, seven weeks later, or decades later). From the analysed data, it resulted that time discounting led to a decrease in cooperation. To be specific: in the first scenario (one day delay), 7 out of 10 groups reached the shared target; in the second case, where participants received the monetary amount 7 weeks later, only 4 groups out of 11 succeeded; in the third scenario, where the monetary amount was invested in oak planting, no groups out of 11 reached the prefixed target. In this experiment, the benefit for each of the 6 players depends on their individual level of cooperativity and it analyses whether different groups discount future gains and what impact this discounting has on cooperation by comparing the different treatments. The details of the study are referred to Jennifer Jacquet’s experiment of 2013. The review contained in this thesis is only a summary of the final results. As visible from the graph of the original study (Figure 4), which describes the average investment trend and the standard error over the 10 rounds, the average group investments in T_1 is €108.2 ± 9.6 which compared to T_2 (€83.2±13.6) and T_3 (€57.3±9.0) is respectively 30% higher than T_2 and 89% higher than in

T₃ (Jacquet *et al.*, 2013). To conclude, the delay in distributing the rewards of cooperation had an impact not only on whether the target amount was reached but also on the total amount collected for the climate account.

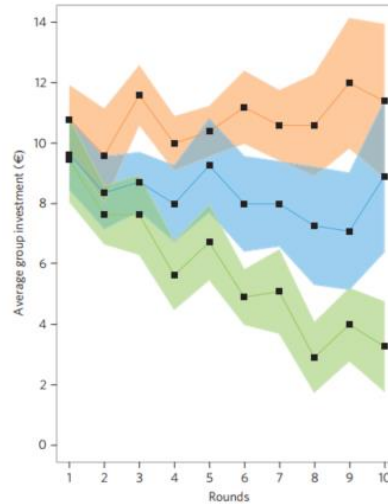


Figure 4. Average group investments and standard error with endowments received the next day (red), after 7 weeks (blue) and after decades (green), (Jacquet *et al.*, 2013)

2.3.3. Persistence of greenhouse gasses in the atmosphere

Another relevant contribution to the level of cooperation in international environmental agreements is provided by Calzolari et al. (Calzolari, Casari and Ghidoni, 2018). Differently from the classic public good games, climate change creates a situation where the time gap between decisions and corresponding results may create a myopic vision of reality where the short-term results are thought to be the only relevant decisional factor without considering decisions' impact on the long-term. As reported in the paper most of the experimental literature is based on static setup but climate change externalities are dynamic, therefore, the relevant contribution from Calzolari is given by the introduction of an experiment that involves a dynamic scenario. Moreover, the attention to the long-term is fundamental in the creation of climate policies since IPCC claims that 50% of the emissions remain in the atmosphere even after 30 years and from 20% to 40% stay even longer (around 1000 years) (IPCC, 2007). The study is based on a model where there is a long-lived decision made in

absence of a legally binding treaty and where each of the participants independently chooses the level of GHG emission (seems like a Paris Agreement where each country was free to choose). The experiment is divided into three games. In the first one, the emission generated in the first round fully remain in the atmosphere also in the following round and cumulate (persistent); another case is a situation where the whole damage is suffered in the first round (immediate); the last one is an intermediate case where emission cumulate from one round to the next but pollution dissipate over the time (intermediate). In the persistent treatment emissions cumulate and therefore never dissipate; the immediate treatment presents no persistence and the intermediate decreases the persistence of pollution by 50% at each round (rounds are indefinite). For the purposes of this review, only the results are reported (for additional details refer to the original publication). The analysis, contrasting with what was theoretically expected, demonstrated that the initial cooperation in the persistence treatment was higher than in the immediate treatment. However, cooperation decrease over time when there is an accumulation of pollution. (Calzolari, Casari and Ghidoni, 2018). A relevant contribution of this paper was the introduction of innovative research opportunities that can produce a more comprehensive understanding and possibly lead to more satisfactory cooperative models. Furthermore, a long-term approach emphasizes the urgency of an adequate climate policy and this could induce countries to put climate change at the top of their political agenda.

2.3.4. Awareness of the consequences and the impact of reputation

A multidisciplinary approach to international cooperation has revealed that collective agents do not exclusively act in accordance with rational motives, but may also be influenced by a sense of moral obligation. Based on the previously presented consumer behaviour model, Milinski designed an experiment to analyse the impact of climate awareness and reputation on consumers' decisions (Milinski *et al.*, 2006). He started from the standard public good game example (see Chapter 1), but contrary to the usual conditions of this latter, he assumed that the total contribution of the public pool was not redistributed among all the players at the end of the game but instead transferred to a “climate account”. To be more precise, in this

experiment there were 156 students divided into 26 groups. Each participant was provided with a €12 endowment each and he or she could decide if invest 0€, 1€ or 2€ over a total of 20 rounds. They were aware of the fact that the doubled sum resulting from their cooperative behaviour would not be returned but instead used to publish a press advertisement in a widely distributed daily newspaper to enhance climate protection. Specifically, they were shown a note suggesting the text for the advertising explicitly stating: “Professor Jochem Marotzke, Managing Director of the Max Planck Institute for Meteorology in Hamburg, Germany, will briefly summarize the current knowledge of climate change for the text of the advert, and will issue the following recommendations: Some future climatic consequences of human-induced CO₂ emissions, for example, some warming and sea-level rise, cannot be prevented, and human societies will have to adapt to these changes. Other consequences can perhaps be prevented by reducing CO₂ emissions. Everyday measures can contribute to climate protection. Household energy consumption can be reduced, for example by a slight reduction of room temperature in winter, or in transportation, by enhanced use of public transportation instead of private cars. The increased use of renewable energies likewise contributes to a reduction of CO₂ emissions” (Milinski *et al.*, 2006). Even though all players were given pseudonyms, rounds alternated between the display of each player's decisions under his/her pseudonym to the other participants and rounds in which no one could see what each player had done. In order to evaluate whether better knowledge of climate change influences behaviour, every second group, who are designated as well-informed (compared to little-informed) was given expert information about climate change. Moreover, to examine contribution in relation to reputation, non-anonymous rounds were decisions were public to the others, followed by a two-player “indirect reciprocity game” (Milinski *et al.*, 2006). It means that each participant (A) repeatedly became a potential donor or receiver and decides whether to donate a part of his sum (€1,5) to another participant (B) having perfect information about the previous contribution or donation made by B.

Results show that the highest level of cooperation was reached in the non-anonymous climate rounds with well-informed participants, both on average with $94,4 \pm 1,8\%$ (mean \pm SEM) and during the five rounds. As opposed to this result, the students showed far less willingness to contribute to the climate account during anonymous climate rounds than during non-

anonymous, either with well-informed or little-informed participants ($81,8 \pm 5,5\%$). Moreover, subjects were more cooperative in non-anonymous rounds rather than anonymous scenarios. This result demonstrates the impact of reputation on human behaviour. Both the well-informed and the little-informed participants revealed a level of contribution slightly above 80% with no significant differences in the presence of non-anonymous rounds (respectively $84,1 \pm 3,4\%$ and $81,4 \pm 4,2\%$) (Milinski *et al.*, 2006). Furthermore, the indirect reciprocity game showed that participants investing the global climate mitigation were socially rewarded and, in the same way, those not contributing were punished by the others. Analysing the data, from 93 cases of non-contributing players in a non-anonymous round, 30,7% were punished, in the anonymous round instead, only 19,8% of non-cooperative individuals were punished. To summarize, the results of Milinski's study show that:

- the cooperation level in non-anonymous rounds was higher in the well-informed groups
- the well-informed participants were more cooperative in the anonymous rounds; as a consequence, since contribution in an anonymous situation is an act of pure altruism, it is noticeable that more detailed information about climate change improve cooperation
- well-informed subjects contributed more often and higher amount of money (they contributed €2 three times as often in non-anonymous rounds)
- Reputation has a surprisingly strong effect on individuals' contribution

2.4. The limitation of laboratory experiments

Experiments on climate change represent the main tool to analyse the most satisfactory model to improve international cooperation and specific variables that have a direct effect on the level of GHG emission reduction; however, even if lab experiments can provide general insights on human behaviour, they are controlled scenarios, therefore, some limitation in the analysis occurs. Below is a summary of the main limitations:

- Number of participants. In the real world, the parties are more than six or a few people. It is not realistic to consider this limited number as an appropriate analogy with the

hundreds of countries, institutions and corporations which take part in the international agreements and the annual Conference of the Parties (Jacquet, 2015);

- Decision-making process. In a laboratory setting, decision-makers are represented by single individuals instead of nations and governmental organizations which means that interactions and communications are more complex and do not follow a linear path. Furthermore, climate negotiations are often attended by entities with varying levels of resources and political power. The emissions of carbon dioxide and methane from only 90 corporations represent nearly two-thirds of historical emissions. Cities are home to fifty per cent of the worldwide population, but they also generate 80 per cent of the global greenhouse gas emissions and they are contributing to climate change with different degrees (Jacquet, 2015);
- Participants are WEIRD. They came from Western, Educated, Industrialized, Rich and Democratic cultures and it may bias the results producing greater cooperation in lab experiments because it lacks to consider a substantial “poor” component of the real world; (Jacquet, 2015)
- Highly simplification of significant factors. The real world presents factors that are almost impossible to predict and set, for instance, the return from cooperative behaviour and the damages from climate change. Labs experiments set these factors in an approximate way risking to alter the result on the ability of nations to cooperate but, on the other hand, it allows further understanding in the field of climate change mitigation.

Despite these limitations, experimental methods provide an additional tool to improve the understanding of cooperation in the field of climate change. (Calzolari, Casari and Ghidoni, 2018). Once the possible deviations from the real world are specified, it is easier to analyse the outcomes of the theoretical models. Therefore, they are still one of the most relevant tools to provide information on cooperative behaviour and, as illustrated in this chapter, lots of variables have been identified thanks to climate change games and are fundamental to develop further methods of analysis and potential innovative climate policies.

3. An alternative climate negotiation: the Climate Club approach

The previous chapter outlined major limits to international cooperation on climate change. Starting from a theoretical definition of this pure public good, and the detailed description of its main characteristics, the research reveals the limitation to the achievement of broad participation, considerable emission reductions and stable international cooperation. Furthermore, the complex nature of climate change is not confined in its structural model but is experienced in multidisciplinary aspects of it. In particular, the analysis focused on the investigation of economic, social and behavioural elements. Through an empirical review, it illustrates intrinsic limitations to satisfactory abatement performances and an insufficient level of participation. The analysis demonstrates the possibility to modify the level of cooperation through the management of selected variables. As a consequence, researchers worked on game theory experiments to create a more satisfactory environment for international cooperation and better results, but even if it was possible to diminish the free-riding incentives, studied outcomes proved that it was never possible to completely avoid them since the cooperative mechanism previously used was based on a fallacious approach. According to Nordhaus (2015), free-riding occurs because emission reductions from a specific country, produce the majority of the benefits outside of its territory. For instance, China and the United States, two major players, would benefit at most fifteen per cent of their total mitigation efforts. On the same lines, a single country is liable for only a small fraction of the global costs of climate change, on average less than ten per cent. (Nordhaus, 2015a). These data explain why climate change mitigation does not appear to have the highest priority on the national government's agenda as it should. It is evident that there is a necessity to change perspective on cooperative models.

Starting from these assumptions, the third chapter analyses an alternative to the typical climate negotiation model: the Climate Club approach. A theoretical explanation of this model is presented in the first section. The model is based on a club mechanism proposed by the Nobel Prize winner W. Nordhaus. This structure would be made up of countries

committed to considerable emissions reductions providing incentives to promote cooperation while deterring the free-riding obstacle. This chapter intends to evaluate the potential of a club approach in the climate change context, seeking to find out whether it is possible to arrive at an effective international agreement. In the subsequent section, a literature review of different sets of proposals for climate clubs designs is presented; in particular, climate arrangements are divided on the basis of two specific characteristics: bottom-up and top-down approaches related to the different types of emergence, and distinct mitigation commitments that should be agreed to by the participants. In the Nordhaus climate club model, a sanction-based incentive system is proposed. After an extensive theoretical explanation of the functioning and the implementation of the climate club approach, the so-called C-DICE model (Coalition Dynamic Integrated Model of Climate and the Economy), the empirical model studied by Professor Nordhaus, is reported to provide a game-theoretical simulation of the club arrangement. The chapter concludes with political observations on the feasibility of climate clubs and also the possible relation of this structure to the ordinary multilateral negotiations developed under the UNFCCC.

3.1. Climate Club: a theoretical explanation

Climate change is posing a serious global risk, calling for an ambitious international and coordinated response, however, the global community is proving difficult to move beyond debates and conversations to effective climate policy-forming. To be considered effective, Hovi et al. (2016) stated that a climate agreement must “attract broad participation among major emitters, obligate the participating countries to cut their emissions considerably, and achieve high compliance rates” (Hovi *et al.*, 2016). The inadequacy of previous UNFCCC treaties is confirmed by the failure to meet these criteria; in particular, the Kyoto Protocol in 1997 was limited in the coverage of GHG global emissions, and the Paris Agreement in 2015 is far from a high compliance rate and strong cooperation given the individually determined emissions reduction targets (Hovi *et al.*, 2016); moreover, they are both based on a voluntary approach. More specifically, only 37 countries took part in the first Kyoto commitment period, from 2008 to 2012. They represented 20% of the global emission and their ambition was considered irrelevant (they aimed at reducing their emissions by 5% below the 1990

levels). After 2012 several countries withdrawal from the agreement further reducing the level of international participation. The different structure of the Paris Agreement appeared promising as his bottom-up approach was quite successful in increasing the number of participants. However, the lack of legally binding commitments and enforcement measures leads to an unsatisfactory reduction of GHGs (see Chapter 1). Therefore, it is evident the necessity to examine alternative types of climate negotiations that are more capable of bringing cooperative and effective climate solutions. The Climate Club approach studied by the Nobel prize-winning William Nordhaus is a potential option. He defines a club as “a voluntary group deriving mutual benefits from sharing the costs of producing an activity that has public-good characteristics” and he also adds that “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” (Nordhaus, 2015a). The model he presented assumes that a coalition of states committed to leading emission reductions would punish nonparticipating states through tariff measures. Despite the fact that each scholar has introduced different proposals, the central idea among all climate clubs’ structures is the same: the key to successful cooperation is to incentivize active participation and commitment by offering rewards to members who follow the rules and/or issuing penalties to those who do not (Nordhaus, 2020). As a matter of fact, the fundamental distinction between the club approach and the United Nations’ approach to negotiations is in the incentive structure. There are numerous examples in international agreements, such as trade agreements or military defence alliances, that demonstrate the potential of a climate club. Another example is the World Trade Organization (WTO): it emerged from a club of nations that shared the common goal of reducing international trade barriers to greater benefits for their citizens; by offering to the members access to a low barrier market, the club succeeded in creating a self-enforcing mechanism, so that joining the club would become more attractive in relation to a higher number of memberships (Håkan, 2020). The operating principle of the mechanism of clubs, based on the creation of voluntary groups deriving mutual benefits from sharing the cost of producing a shared good or service, could overcome the free-riding problem on the global public good of climate change. The idealized solution of the Climate Club was first proposed by William Nordhaus. It is based on a multilateral alliance among participating countries to enact harmonized emissions reductions within a period of time. Due to the structure of incentives, it

creates a strategic situation in which countries, acting in their self-interest will choose to enter the club and engage in strong emissions reductions. (Cramton *et al.*, 2017) proposed the adoption of a uniform global carbon pricing combined with trade sanctions for countries that are out of compliance. In summary, the idealized model moves from a voluntary agreement to a structure with obligation, responsibilities, and costs for reluctant countries (W. D. Nordhaus, 2017) where climate change penalties function as "internalization devices" that address the global externality from climate change, just like regulation and taxes used to internalize externalities within nations (*ibid.*). A central argument for Nordhaus is the difficulty in designing international climate agreements that are effective and stable.

3.1.1. Types of Climate Clubs

A wide variety of proposals arises in the literature for the structuring of the climate club. Its design does not consist of a single approach, rather it entails multiple opinions on the consideration of distinct aspects. The first aspect to consider is the emergence of the club: they can be "bottom-up" or "top-down" clubs based on the applied development approach. In his most prominent work entitled "Global Warming Gridlock", Victor (2011), after having divided and classified countries into *enthusiastic* and *reluctant*, claims that the prospect of starting with a small group of enthusiastic nations would be more promising than starting with a large group since, in order for nations to make real progress on reducing emissions, they should have a flexible system that enables them to decide what they should and will implement domestically. He defines *enthusiastic countries* as the "engine of international cooperation" for the reason that there is a willingness on their part to invest their own resources in emission control, whereas *reluctant countries* do not regard climate change mitigation as a major national priority and, as a consequence, their focus is mostly on the maximisation of their self-interest (Victor, 2011). His theory is founded on the assumption that typical international environmental treaties (as the UNFCCC treaties) are not under domestic governments' control and moreover, they motivate countries to "offer only the lowest common denominator" (*ibid.*) in terms of ambition and climate change mitigation effort. Furthermore, Victor believes that in smaller groups it is more accessible for governments to negotiate complex climate policies. Based on Falkner's analysis (Falkner,

2015), Hovi et al. also added that starting small provides benefits in at least three manners: “by facilitating dialogue and bargaining, by creating incentives for memberships, and offering great powers a privileged position” (Hovi *et al.*, 2016).

On the other hand, Nordhaus sustains the superiority of a top-down approach where the structure is “optimized to attract large number of participants and attain high level of abatement” (Nordhaus, 2015a) and then countries decide whether or not to join. He claims that the bottom-up approach previously discussed is based on the optimization of the participants’ individual self-interest and that the standard unsuccessful approaches developed in climate policy are founded on it. According to both theoretical and empirical studies, it has been concluded that bottom-up alliances for global public goods “tend to be small, fragile and unstable” (Nordhaus, 2015a). The limitation of this structure and the related instability in coalition formation is analysed in a work by Hart and Kurz (1983). They define a stable coalition as one in which no player may unilaterally improve his outcome. In light of the requirement of unanimous consent of international agreements, where no parties may be compelled to join coalitions and they can refuse to join them, this is a very weak condition: stability in international negotiations is affected by the deviation of any player from the collective commitment. They specifically emphasize that the main limitation in forming a coalition does not regard the overall efficiency within the coalition, but rather how this efficiency is perceived by the participants and how it is distributed among them. They assert that one should not lose sight of the fact that coalition formation does not eliminate the role of the individual decision-maker. Therefore, the outcome is not solely determined by what they obtain among the coalition, but rather by what they achieve within the coalition, keeping self-interest as the primary motivation (Hart and Kurz, 1983).

The limit of coalition formation and the instability of international agreements can be summarized by the “small coalition paradox” (Cramton *et al.*, 2017). To provide a more comprehensive explanation of this concept, consider the small bottom-up agreement between China and the United States in November 2014, when these large polluters merged and raised their abatement to a higher level, maximizing both their joint welfare and their individual welfare. This example demonstrates that as more countries join the level of abatement, its

costs become higher and the fraction of global emission covered by the agreement declines. (ibid.). Therein lies the paradox: successful agreements require the participation of most countries but, to be stable, a coalition needs to have few members since, as the number of countries rises, covered GHG global emissions declines and there are strong incentives for individual countries to withdraw. However, in large coalitions, when a country departs from an international agreement with n countries, the remaining parties ($n-1$) keep staying the game continuing to bargain as a single entity, trying to obtain as much as possible by preventing each other from exploiting their individual weaknesses when they are alone. However, the efficiency of abatement efforts is reduced and non-cooperative countries free-ride on the effort of the others. To summarize, environmental economics' studies found that international agreements tend to be small since the larger the group the larger is the free-riding incentive. Therefore, Nordhaus concludes that a climate club organized in a bottom-up approach is unlikely to result in an agreement that would effectively address climate change but instead result in either too few members or unambitious goals (Nordhaus, 2015a). Furthermore, Zenker (Zenker, 2019), aside from concerns of stability, claims that it is critical to assess the efficiency of international environmental agreements, especially if the coalition does not include all nations. Economic theory demonstrates that a coalition of a limited number of nations may find it simpler to agree on high mitigation objectives and enforce compliance. Substantial cooperation, however, might be easier to maintain since it could reduce abatement goals to levels that are not much different from the noncooperative result, broad collaboration (Zenker, 2019). There seems to be a trade-off between effectiveness and stability of international agreements on climate change mitigation agreements, which, quoting Barrett can be divided into "broad but shallow" or "narrow but deep" cooperation results, also renamed as the "small coalition paradox" (Barrett, 2003).

Another aspect that can differentiate climate clubs design is the type of mitigation commitment that the participants agreed on. There are two main opportunities based on this peculiar characteristic:

- Setting an international target price for carbon. Nordhaus is the main supporter of this approach. One of the reasons he believes it is the optimal solution is the provided

possibility to equalize carbon prices across all the countries giving rise to international efficient climate mitigation with no discordance among the parties. Moreover, a unique price greatly simplifies negotiations between different countries and avoid scenarios where country-specific emissions could generate strong distortions and inequality in setting limitation, often ending in no limits at all. Finally, it allows countries to choose the most appropriate approach based on their own preferences (taxes, cap-and-trade mechanisms, etc) (Cramton *et al.*, 2017)

- Controlling emissions quantitatively. This solution is proposed by Hovi. According to him, countries should agree on a fixed percentage of their GDP as their target for emission reduction (Hovi *et al.*, 2017).

This paragraph aimed to introduce the concept of climate club with all its particular nuances, allowing to conceive an overview of this alternative method and revealing the main features on which it is based. In particular, the characteristics described demonstrate that the climate club approach does not present a single form but gives the possibility to choose different alternatives for efficient climate change mitigation. However, in the following sections, the climate club approach will concentrate on William Nordhaus's proposal as the main structured and detailed analysis on this topic.

3.1.2. Sanctions

Studies on cooperation over the past decades have concluded that individual decisions do not produce strong collective outcomes (Cramton *et al.*, 2017). International coalitions are characterized by strong free-riding incentives and therefore outcomes are generally inefficient. Moreover, due to the small coalition paradox, the presence of a large number of participants, as is required by the international environmental agreements, tend to cause unstable structure and disappointing level of emission reductions, resulting in weak cooperation. For this reason, as already described in chapter two, a possible solution to sustain strong cooperative behaviour lies in the introduction of external incentives such as monetary sanctions. Many studies, both theoretical and empirical, have been done on cooperation in

climate change scenarios, confirming the incapability of countries to sustain the maximization of collective interest in the presence of greater short-term individual benefits. The failure or unsatisfactory results of previous international environmental agreements are based on the voluntary nature of the agreements, presenting strong free-riding incentives and a “lack of ability to induce reluctant nations to join international agreements” (Cramton *et al.*, 2017). To overcome this obstacle, Nordhaus proposed the introduction of monetary inducement moving from typical voluntary agreements to a model with consequences related to the addition of countries’ obligations and costs.

Nordhaus describes sanctions as “governmental withdrawal, or threat of withdrawal, of customary trade or financial relationships” (*ibid.*). As part of his analysis about possible sanctions to be imposed on international environmental agreements, he considered two types of punishments: carbon duties and uniform tariff measures. Differently from other tariff sanctions proposed, these approaches have the advantage of being incentive-compatible, meaning that they “benefit senders and harm receivers” (Nordhaus, 2015a). To clarify, it is useful to analyse these sanctions in detail and provide specific information about their function and application according to professor William Nordhaus and empirical researches’ results:

- Carbon duties are tariffs imposed on products imported by non-members where the taxed amount is based on the level of carbon content they generate or involve; as an alternative, the importers might be required to purchase allowances for emissions of carbon dioxide to compensate for the carbon content of imports. They are typically introduced where there are violations of trade agreements and, as Barrett illustrates they have been included in multiple IEAs (Barrett, 2005). In order to reduce emissions, carbon duties serve three important purposes: preventing leakage, leveling the playing field, and leveling the competitive playing field (Nordhaus, 2015a). Nevertheless, empirical researches suggest that carbon duty designs are difficult to apply, have limited coverage, and do not promote substantial participation because of the complexities involved. Consider, as an example, the emissions of CO₂ in the United States caused by coal-generated electricity. The latter represents one of the

main sources of emissions, however, since the United States only export 1% of it, carbon duties are not impactfully limiting US pollution and the implication of this sanction is barely invisible (according to the fact that 1% of export represents only a small fraction of the whole pollution production. (ibid.).

- Uniform tariff measures are a homogeneous percentage rate to be imposed on all the products imported by non-participants. Conversely from the above-mentioned sanction, Nordhaus considers this latter as more simple and transparent and therefore he chose it as a preferable sanction for his climate club's proposal, even if it is not specifically related to the carbon content of the import (Nordhaus, 2015a).

Nordhaus proposed and analyses these two typologies of sanctions in order to examine whether a climate club model with penalties for non-participants can provide a stable coalition even with a large number of participants and moreover, an equilibrium that is substantially larger than the non-cooperative one. It is important to keep in mind that the main purpose lies in enforcing and promoting strong cooperative effort in international climate agreements finding alternatives able to obtain significant results in comparison to the disappointing level of emission reduction obtained with the previous international agreements. Nordhaus claims that the main problem is the low participation level and therefore his analysis focus on introducing solutions able to provide strong cooperative inducements. He sustains that the main focus of potential solutions has to be in designing agreements that increase participation. According to this premise, it is evident that carbon duties are not an ideal solution since participation increase is not even included as one of the goals of the application of this sanction, while uniform tariffs are able to contribute to the enhancement of the level of contribution. Moreover, the fact that they are not specifically targeted on exported emissions, which can be seen as a defect in the beginning, allows taking into consideration the total emissions of greenhouse gases, without excluding a substantial part which is still relevant in evaluating the comprehensive damage of nonparticipants to other countries. (Cramton *et al.*, 2017). Therefore, his proposal is based on the introduction of uniform tariff measures.

3.2. Empirical analysis on Climate Clubs: the C-DICE model

In order to provide solid evidence on whether climate clubs are legitimately effective and to verify the correspondence of reality with the theoretical analysis, Nordhaus (2015) introduced a game-theoretical simulation model known as the C-DICE model or Coalition Dynamic Integrated model of Climate and the Economy, having the ability to represent a complex system that links multiple disciplines and variables. The multidisciplinary nature of climate change has already been evidenced in Chapter 2 in conjunction with the introduction of evidence on the extensive complexity of human behaviour. Climate Policy involves a wide variety of disciplines from game theory to psychological and philosophical questions therefore, global warming mitigation poses a significant challenge. Not only does it represent a threat for environmentalists, economists and climatologists, but it also involves a wide variety of issues concerning social science, psychological theory and philosophical questions. Accordingly, it is becoming increasingly necessary to develop models and policies reflecting multiple and complex interactions across different fields and areas of research (W. Nordhaus, 2017). Integrated assessment models play a crucial role in bringing the different pieces together. They integrate knowledge from more areas into a single framework analysing the interactions and the presence of trade-offs among different disciplines and variables and, as a consequence, they explain how decisions or choices in a determined setting influence other part (ibid.). In particular, Nordhaus uses this model to understand the implication of climate policy decisions and climate sensitivity.

The C-DICE model is specifically designed by professor Nordhaus to discover elements and scenarios in which international cooperation on climate change mitigation are possible and where countries are willing to join the coalition of high-abatement countries and provide boundaries for stable coalitions. The model investigates 44 different “regimes”, where a regime is delineated as “a combination of target carbon price and tariff rate” (Nordhaus, 2015a). He assumed four different levels of target prices: \$12.5, \$25, \$50, and \$100 per ton of CO₂. The considered uniform penalty tariffs are instead 11 and they are estimated in a range from 0% (no penalties) to 10% (both the trade and enforcement systems would suffer serious effects if this percentage were implemented). Adopting this model, Nordhaus analyses the

existence of stable coalitions. He used a base set of participants and he determined stability by using multiple restarts and two platforms. In the following section, the major results from the implementation of this method are described referring to the data reported in Nordhaus' work entitled "Climate Clubs: Overcoming Free-riding in International Climate Policy" (Nordhaus, 2015a). In particular, it is interesting to review results of potential climate clubs connected with participation, stability and level of emissions' abatements:

- *Participation and stability.* First of all, results indicate that each of the regimes analysed tends to produce stable coalitions and therefore cooperative results considering all the different parameters. Out of 44 regimes, only six present instability, however, they result in average quasi-stable coalitions. Therefore, trade sanctions seem to be relevant enough to influence countries' participation or nonparticipation in international trade. Another relevant result, probably the main research question of Nordhaus' study, is about whether the penalty structure analysed is adequate to achieve a high level of participation. Figure 5 presents results based on a total of 15 regions. The graph shows different levels of participation based on the regimes above-described, with 4 different levels of target price and 11 increasing percentages of uniform penalty tariffs (bars are respectively arrayed from 0% on the left to 10% on the right following an increase by 1 point percentage). To clarify, the vertical scale represents the number of participants, while the horizontal one represents the four different target prices applied; bars are sorted from left to right based on different percentages of potential sanctions. Hence the figure shows 44 results in total.

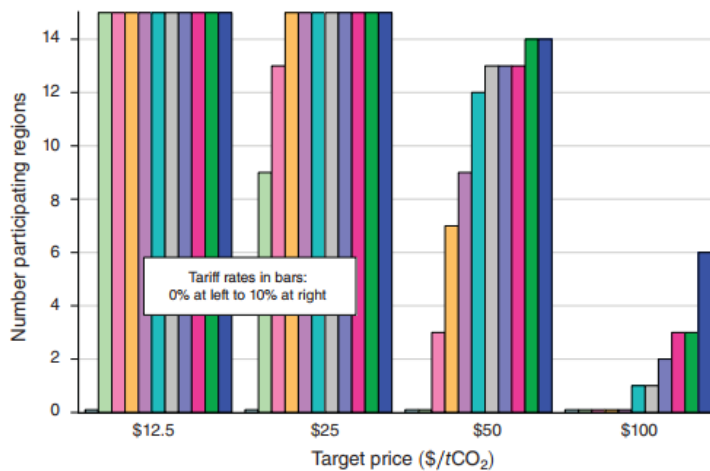


Figure 5. Number of participating regions by different target price and tariff rate (Nordhaus, 2015a)

Theoretical assumptions are confirmed by the findings: zero participants when percentage tariff is 0% in all the different target price levels proposed; hence, in the absence of trade sanctions, the equilibrium will deplete to a low-abatement, NC regime.

By examining the various parameters applied more in detail to the Climate Club model, it is noticeable that: when carbon prices are set at the lowest levels (\$12.5 and \$25 per tonne of CO₂), full participation and efficient abatement are achieved with relatively low tariffs, such as a 2% tariff (Cramton *et al.*, 2017); However, as the target carbon price increases, achieving full participation becomes challenging. In particular, the graph shows that, with a target price of \$50, participation of at least 90% is reached only when tariff rates are 6% or higher, and full participation is never reached. Moreover, with a carbon price of \$100 per ton of CO₂, full participation is not met even at the highest analysed tariff rates (10%).

- *Actual carbon prices and emissions abatement.* Another relevant question analysed by the C-DICE model is on the efficiency of Climate Club in inducing emission abatements. Actually, the analysis illustrated in the graph in Figure 6 focuses on averaged global carbon prices and it is only later translated into emissions reductions

level. In particular, it shows that, for the two target carbon prices of \$12.5 and \$25, the global carbon price equals the target price in more or less all the different percentages of tariff rates analysed (however, as expected, it is nearly zero with a 0% tariff). Instead, by imposing a target carbon price of \$50, the target carbon price is almost achieved with a 5% or higher tariff rate (Nordhaus, 2015a). Finally, with a carbon price of \$100, there is no gain until the 10% tariff rate, which represents the higher rate. It means that almost all countries choose to accept the penalties because the cost of abatement is too high in the \$100 regime. Therefore, countries prefer not to participate in the club, and the penalty for non-participant results low.

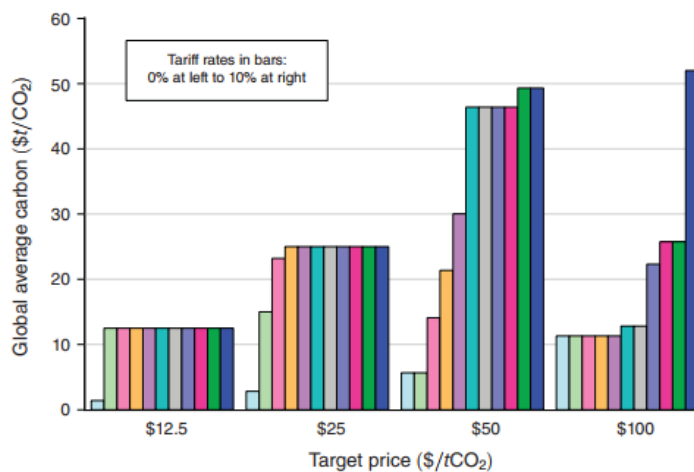


Figure 6. Global average emissions abatements with target carbon price and tariff rate (Nordhaus, 2015a)

Contrary to what might be expected, results from Nordhaus' study revealed that all countries prefer a Climate Club with penalties and not excessively high carbon prices to a model without sanctions for nonparticipants (voluntary approaches). Moreover, non-participants, as well as participants, have expressed their preference for this approach and this is because, if the tariff rate is not too costly, benefits for participants of the club exceed the losses caused by sanctions imposed on nonparticipants. As a result of Nordhaus' analysis (Cramton *et al.*, 2017), an international climate treaty combining carbon pricing targets and trade sanctions could result in a large reduction of global emissions and a substantial level of participation compared to the previous international environmental agreements. To conclude, observations

from the model suggest that imposing moderate trade penalties on reluctant countries will induce a coalition that provides the optimal level of abatement when the target carbon prices are not too high. Climate clubs result in a more suitable and preferable approach compared with the current international agreements on climate change mitigation, where international climate agreements are voluntary and mostly ineffective according to the insufficient level of participation and abatement and the possibility for countries to free-ride on the effort of the others.

3.3. Feasibility of Climate Clubs: political obstacles

Empirical analysis has demonstrated that climate clubs represent a superior model for a cooperative solution on climate club mitigation, providing greater participation and a substantial level of abatement compared to the past agreements flawed by free-riding incentives and based on voluntary contribution. However, regardless of their effectiveness, climate clubs seem to raise practical obstacles to their implementation, especially in terms of political limitations. Firstly, to analyse the problem in detail, it is necessary to distinguish between the different types of climate clubs. The introductory section illustrated the presence of multiple types of clubs that differ according to some specific characteristics as the development approach (bottom-up or top-down) and the type of mitigation commitments. Furthermore, Falkner et al. ideally classify them into three main categories based on differentiating aspects and various levels of stringency (Falkner, Nasiritousi and Reischl, 2021). From the less severe to the most ambitious there are:

- *Normative club*. They represent countries promoting common normative commitments to achieve a certain goal. Members should adhere to shared climate policy ambitions in order to qualify for membership. This latter is generally open-ended, so any country participating in the commitment (e.g. net-zero target) may join, regardless of whether they are a significant emitter. The main purpose of normative clubs is not to establish elaborate, legally binding rules, but to gather actors around a specific policy goal; the

strength of a normal club results from its moral ambition combined with its membership size.

- *Bargaining club*. A bargaining club serves as a mechanism for facilitating more effective negotiations, particularly between powerful or influential players in a particular area. Significant international status, power, and relevant capabilities are essential membership criteria. The objective of a bargaining club is not to unite like-minded actors behind an ambitious set of norms as in normative clubs, but instead to promote compromise-seeking between significant actors, even representing diverging norms. While bargaining clubs can promote deeper levels of cooperation than multilateral forums and therefore provide an alternative to the typical international agreements, they often support them presenting major powers to achieve initial results that will then improve international negotiation efforts.
- *Transformational club*. Their members share the same goals, but they also seek to change the incentive structures of their members. In particular, they aim to minimize free-riding incentives and improve international cooperation with ambitious goals. Due to their great aspiration, they are the most challenging club approach in terms of implementation. They are based on the creation of tangible benefits for the members in order to increase their interest in joining the club.

The table below (Figure 7) illustrates the main factors characterizing these three typologies of climate club. The division is based on the presence of climate policy ambition, the concrete negotiation of measures and rules and the application of sanctions.

	Raise climate policy ambition	Negotiate measures and rules	Club good/sanctions to change incentives
Normative club	Yes	No	No
Bargaining club	Yes	Yes	No
Transformational club	Yes	Yes	Yes

Figure 7. Classification of climate clubs and main characteristics (Falkner, Nasiritousi and Reischl, 2021)

Nordhaus’ climate club proposal belongs to the transformational clubs, which means that it represents the most stringent model and the most problematic to implement in international negotiations as it requires the satisfaction of all the three criteria, especially the last one about

the introduction of severe sanctions on non-members. As a consequence, what at the beginning seemed to be the most effective and promising alternative for the achievement of greater international cooperation and ambitious emission reductions, is however limited in terms of concrete feasibility in international scenarios. Several studies have been published to explain the significant obstacles to the implementation of climate clubs. Falkner (2015) claims that, even if the hypothesized tariffs suggested by Nordhaus (2%) seems to be reasonable, his model ignores two political barriers: first, the possibility that non-members do not join even in the presence of a universal punitive tariff and second, principal emitters (except for the EU) reject binding emission targets imposed through international law (according to the Westphalian Dilemma). Furthermore, he adds that to prevent behaviours of initial adhesion to the club which do not correspond to equal efforts in reality, a monitoring system should be integrated. However, evidence from previous attempts demonstrated the avoidance of powerful countries to submit to strong control and verification obligations in the sustainable field (Falkner, 2015). Therefore, the model proposed by professor Nordhaus seems to be unrealistic and far from being politically acceptable.

Another factor that contributes to low support for climate club implementation is not exclusively related to a structural and practical model issue but is more closely tied to the fact that many decision-makers are unfamiliar with the concept of climate clubs and, in general, have limited knowledge of their functioning and, if they have, it is usually restricted to the simplest structures, therefore those lacking substantial binding commitments. This statement is based on a study conducted by Falkner et al. (Falkner, Nasiritousi and Reischl, 2021) which considers the perception of the political legitimacy of the club through exploratory interviews. Precisely, they conducted a total of 24 interviews, among which there were 5 academics, 4 policymakers, 14 diplomats and one UNFCCC official. Questioned about the potential of an international cooperation model based on climate clubs, 17 interviewees stated that they were not used to the concept, six of them indicated some forms of climate clubs but nothing more than the less restrictive forms with basic requirements and only one of them mentioned a carbon regulation. However, after introducing to them the transformational club such as the main proposal of professor W. Nordhaus (Nordhaus, 2015a), an interviewee emphasized the substantial importance of including major emitters, in verbatim he claimed: “if you operate in

small groups and these groups represent 80% of all global emissions, then I think it's a great idea" (Falkner, Nasiritousi and Reischl, 2021). As a consequence, the literature indicates that climate clubs seem to have greater effectiveness than typical international agreements applied in the past, due to the introduction of sanctions and binding commitments; however, they lack of political legitimacy and equity. Furthermore, among the several models, the transformational club is undoubtedly the most sophisticated and demanding, as it requires countries, even the most reluctant, to agree on legally binding rules and sanctions. Nordhaus has conducted a wide variety of experiments specifically built upon detailed theoretical models and supported by mathematical procedures. Nonetheless, what is clear is how Nordhaus' club model would work once in place, but its work falls short of explaining how to achieve significant results in cooperative efforts which could lead to the structure described (Falkner, Nasiritousi and Reischl, 2021). In order to create an agreement that provides monetary incentives and enforcement (joint carbon pricing scheme and tariffs), jurisdictions must have a solid legislative framework. Moreover, as previously mentioned, the club will result in a disappointing outcome if other colossal emitters (China, India, Japan and Russia) are not included, therefore, complexity in implementing the club structure among a large number of countries with strongly divergent interests are even larger.

Gampfer defines the limitation of the climate clubs' feasibility as a potential lack of "political legitimacy" (Gampfer, 2016) and he divides its definition into two different concepts: procedural and outcome legitimacy. Procedural legitimacy is defined as "normative desirable characteristics of the governance process" intended as the preferences of participants' rights and obligations; outcome legitimacy is instead the "problem-solving performance" of the agreement and it refers to the extent to which the latter is effective to mitigate climate change (Gampfer, 2016). According to Gampfer, the low support of climate clubs implementation can be summarized into four main barriers (ibid.):

- Climate Clubs lack of procedural legitimacy meaning that they are not sustained by a global influential organization like the United Nations for the UNFCCC, which make it the "default venue for cooperating on global problems";

- Mitigation will only affect member nations while the benefits will accrue to all nations regardless of their participation, so there is a likelihood that populations in so defined cooperating nations will be unwilling to contribute due to the present unfairness
- Opposition among potential members could be identified in the proposed division of countries into two different categories and therefore in the creation of inequality between participants and nonparticipants
- Climate Club effectiveness is not certain, therefore, supports is difficult to obtain both from potential participants and non-participants, especially in the absence of main emitters in the coalition (United States, China, India, Russia). This concern has already been introduced as a potential barrier to climate club's implementation in Falkner's analysis (Falkner, 2015).

Therefore, although theoretical analysis on club structure suggests the introduction of consistent advantages on the global level of cooperation, practical implementation lack of political legitimacy and consent. Consequently, while the potential benefit of this model has been successfully demonstrated by sophisticated theoretical analysis, its implementation will be constrained by multiple limitations associated with political issues. Inadequate political legitimacy generates scepticism among policymakers and the general public. The majority of the discussions deal with the relative priority that climate action should receive in relation to other economic policy goals, and how to design climate policy without jeopardizing the country's ability to compete internationally (Gampfer, 2016). This is particularly relevant for developing nations that, simultaneously with the priority of environmental sustainability, have further priorities related to the satisfaction of primary needs such as poverty reduction and economic development. According to R. Gampfer (2016), citizens seem to understand that the governance architecture has high relevance for these obstacles, especially when it comes to the participation and responsibilities of developing countries in international environmental agreements. As a result, governments in democratic countries will therefore be reluctant to implement proposals that, in citizens' perspective, involve huge expenditures without guaranteeing proportionate benefits and therefore are frowned upon by the majority. In light of this, policymakers, as well as government leaders, are influenced by citizens' preferences even when those matters are mainly decided by intergovernmental bodies (Gampfer, 2016).

Monetary incentives and sanctions have to be further investigated and, even in presence of potential meaningful achievements on international cooperation, the government must have the domestic approval before taking any action, in order to ensure that they maintain a high reputation and political credibility, therefore their actions are connected to population's preferences, even if these lead to dangerous choices corresponding to non-optimal results and are associated with concerning risks. Evident results reveal that the need to obtain political superiority both at the level of the national government and as an international power at the expense of other nations has an insurmountable influence and currently is the priority that guides political choices and international cooperation. Yet, since the absence of political legitimacy prevents citizens from believing in positive theoretical results highlighted by the examined structure of climate clubs, the domestic support of this alternative international environmental agreement is extremely low.

To conclude, climate clubs serve as an efficient alternative to enhance the cooperation level in international environmental agreements and reinforce subsequent commitments on GHG emission reductions. The establishment of international agreements is one of the most effective ways to prevent the mismanagement of common global resources. The complexity of an international agreement on pure public goods concerns the fact that they must be designed on the basis of global consensus in a world of sovereign nations. Nonetheless, when countries have diverse agendas and goals, such designs will tend toward what is acceptable to low-ambition countries rather than what is efficient. An agreement with a high level of global coverage will result in low levels of obligations and reciprocity (Håkan, 2020). As illustrated in this chapter, a climate club structure proposes a theoretical alternative to the previously insufficient treaties, but concrete progress is still limited. However, it is not a problem of practical implementation, but more a political obstacle and ethical barrier where self-interest and international superiority are preferred over the protection of the planet, our primary source of life.

4. A new field of investigation: the ethical and epistemological framework

Cooperation on international climate agreements has long been regarded as one of the greatest economic and social dilemmas. As a result of theoretical and empirical analysis, several limitations have been identified, both from the standpoint of the definition of climate change as a global public good and from the standpoint of the typical internationally recognized approaches used to aggregate States on the pursuit of common aims (e.g. Kyoto Protocol, Paris Agreements), that is, agreements which are based on a voluntary approach and with strong free-riding incentives. Consequently, international participation and emissions reduction level have always been limited and insufficient to address the tragic consequences that scientists have revealed clearly and with considerable concern for decades. Existing international environmental agreements have proved to be inadequate to achieve satisfactory outcomes when it comes to climate change, which, in 2022, “continues to be perceived as the gravest threat to humanity” (World Economic Forum, 2022). Climate cooperation has primarily been examined in economic studies and empirical examples are merely based on innumerable variations of classic public good experiments. As demonstrated in the second chapter of the research, a purely economic analysis is limited and does not allow the complexities of a subject to be expressed. Human behaviour is influenced by numerous variables that are outside the definition and the scope of traditional economic analysis, thus demonstrating the need for a more comprehensive understanding. Accordingly, the idea of multidisciplinary of cooperation in the context of international climate change mitigation has been introduced. The incorporation of psychological and social factors has enabled an increased understanding of human behaviour and a detailed review of empirical examples providing a comprehensive explanation of the insufficient level of cooperation. Nonetheless, obstacles to cooperation are still countless and, although significant progress has been made, collective actions are barely taken into consideration with an attitude of international superiority. The previous chapter also demonstrated that sanctions and incentives can be introduced to create more stable and participatory coalitions. Even though the model has revealed enormous advances and excellent theoretical results, on a practical level, it still

suffers from some limitations. In its evolution from a classic voluntary agreement to a model founded on responsibilities and obligations, the climate club approach has revolutionized international cooperation, however, the model remains confined to the economic sphere and does not reveal insights into the complexity of human choices and peculiar behaviours. In particular, this approach reveals political and ethical obstacles to the practical implementation and therefore, it indicates that further investigations are necessary.

States' inability to cooperate may be regarded as a manifestation of epistemic vice. Epistemic vices are intellectual character traits or mindsets that obstruct the “effective and responsible inquiry” (Cassam, 2016), as well as the acquisition and transfer of epistemic good (Cassam, 2018). In order to understand this definition, it is necessary to start by understanding the context within which it is discussed. This concept pertains to the general framework of ethics and epistemology and specifically in a context in which these two philosophical branches are entangled. Ethics is the study of actions. There are two fundamental interpretations of this science: one considers it as the study of the aim to which human activity must be directed, and the other defines it as the science of the motive of human behaviour and strives to establish that peculiar cause in order to regulate and conduct the behaviour itself. The first refers to the ideal that man's nature directs him toward, and hence to man's nature or essence. The second, on the other hand, discusses the reasons, or causes, that drives a person to act in a given way. (Abbagnano, 2013). Epistemology is instead defined as the theory of knowledge. Different aspects of epistemology have drawn attention over its long history. For instance, according to Plato, epistemology was an attempt to comprehend how knowledge (as opposed to a "true opinion") benefits the knower. Locke's epistemology instead tried to understand the processes of human understanding while Kant adopted this definition to describe an attempt to comprehend the foundations of human understanding (Steup and Neta, 2020). In each case, it is always referred to the activity of inquiring, the process of acquiring knowledge. The aim of epistemology is the truth. With reference to intellectual vices (epistemic and intellectual are to intend as synonyms in this thesis) vice epistemology, a particular branch of this discipline, is defined as “the philosophical study of nature, identity, and epistemological significance of intellectual vices” (Cassam, 2016). The entanglement between ethics and epistemology is to find in the presence of vices into different ways of conducting inquire and therefore

intellectual vices are reflected into practical actions. In the context of climate policy, the failure in achieving an acceptable level of international cooperation may be a consequence of actions and decisions subject to epistemic vices.

How does the ethical and epistemological framework fit into the context of cooperation in international environmental agreements? As anticipated at the beginning of the chapter, the failure of cooperative actions on emission reduction can be defined as epistemic vices or cognitive defects. Considering the real decision-making process at a governmental level, vices are disruptions to the excellent performance. To clarify, scientists are claiming the extreme danger of climate change since decades, however current emission reductions are still irrelevant. Definition and analysis of climate change in the context of epistemic vices and ethical framework introduce the possibility of identifying the primary causes at the basis of the failure of international climate change mitigations that the economic and social fields have so far been unable to disclose. The contribution of vice epistemology in climate change is based on the provision of a more comprehensive and realistic model of examination, the possibility of identifying epistemic vices in the culture or the environment of a country (intrinsic motives and values), and the consequent amelioration of epistemic conduct in cooperative scenarios. Epistemological perspective is a way to understand the detrimental impact of intellectual vices and to acquire awareness on how these vices negatively influence the pursuit of the truth.

4.1 Introduction to Ethical Cooperation

Ethics is concerned with the concepts of right or wrong, in particular, the aim of ethics is directed towards the achievement of goodness. However, the analysis of the concept of goodness reveals the presence of ambiguity in relation to the object pursued. In the context of ethics, in fact, the good can be distinguished in two ways: the first relating to the metaphysical theory that the good is the perfect reality or real perfection and that is desired precisely as such, and the second according to the subjectivistic theory in which it is defined as an object of appetite, as what pleases and therefore more similar to the motive that guides human behaviour than its ultimate aim to the "supreme good" (Abbagnano, 2013). By applying these

theories to human behaviour in the context of cooperation on climate change mitigation it is possible to note the presence of this ambiguity in the political choices pursued by the different states. Countries for example aim for different ambitions, each of which seems to correspond to what is good for the country. As a consequence, they may always justify their political decisions with ethical intentions. However, in the context of a global pure public good, the individual satisfaction of the national self-interest is usually detrimental to the supreme good as the perfect reality. The two interpretations of ethic goodness seem to reflect two opposing ends that in economic theory have been precisely distinguished in personal interest and collective interest demonstrating, also through empirical examples, the difference in results obtained at the level of cooperation. In particular, there can be richer countries that are not specifically oriented to the reduction of their greenhouse gas emissions given the fact that implementation of these peculiar policies could jeopardize their economic development and political power. From a purely theoretical point of view, given the ambiguity of the definition of goodness, the choice of a State to pursue the national interest may therefore seem to be an ethical and flawless behaviour. However, such a narrow application of ethical motives corresponding exclusively to the achievement of a partial good is extremely insufficient and as a consequence, they create unethical results themselves. To clarify, it is necessary to consider countries in the whole system of which they are part. It has been defined that ethics corresponds to the science of conduct (Abbagnano, 2013). In the context of international relations, and as is particularly evident in the context of a global public good such as climate change, actions taken by a single country are interconnected with other agents and reflect strong implications for the well-being of others, therefore, an ethical analysis could not avoid the examination the entire general framework. Considering, moreover, that countries are aware of the presence of this interrelation, not only their choices aimed at the unique satisfaction of personal interests are unethical, but they constitute a real epistemic vice.

4.2. Epistemic vices: a theoretical framework

A major thesis of this chapter is that States' inability to cooperate may be regarded as an epistemic vice. Professor Cassam defines epistemic vices as “character traits, attitudes or thinking styles that systematically, though not invariably, get in the way of knowledge”.

(Cassam, 2018). The prevailing assumption is that humanity is vulnerable in the way of preserving the goodness of knowledge and the process of inquiry is permeated with vices. Arrogance, closed-mindedness, carelessness are all representations of epistemic vices. To clearly explain the concept of epistemic vices, Cassam proposes a concrete example about an individual, Oliver, that is obsessed with the conspiracy theory of 9/11 (Cassam, 2016). He spends his spare time reading tons of articles that support his idea that the collapse of the Twin Towers was caused by explosives situated in the buildings by a government agent rather than by the plane impacts, and the large amount of time dedicated to reading this information makes him believe to be an expert on the topic. He is convinced that the aircraft impacts were physically impossible and he tries to rationalize his explanation through data found in the articles without realizing their limited scientific credibility. Cassam claims that “responsible inquirers have a good sense of when they are in danger of being duped but Oliver’s sense of this is poor” and while he has high levels of trust for these dubious sources, he is extremely distrustful of genuine experts' efforts to debunk them (Cassam, 2016). Oliver fails to see the absurdity of the conspiracy theory because of his gullibility, an intellectual character trait that Cassam defines as epistemic vice. Quoting Cassam verbatim “being easily cheated or duped makes us less effective at discovering the answers to our questions and trying to understand the events we are trying to understand. Being careless or negligent diminishes the effectiveness of our inquiries and also opens us up to the charge of acting irresponsibly” (ibid.). This example is limited to the definition of a peculiar mindset; however, it perfectly clarifies the concept of epistemic vice. As previously mentioned, in the context of climate change, epistemic vices may define the primary causes of the limitation to cooperative behaviours. But before applying this concept to concrete examples of political obstacles in climate cooperation, it is necessary to extend the theoretical framework to a more comprehensive overview of the main intellectual vices. In particular, since the agents of climate change cooperation and decisions on international environmental agreements are countries, and therefore collective subjects, it may be relevant to associate the analysis of political obstacles in climate cooperation to specific collective epistemic vices that have been identified in organizational structures made up of multiple individuals (e.g., companies). A significant contribution is given by Baird and Calvard (Baird and Calvard, 2019). They based their research on four selected and inter-related categories of epistemic vices:

- *Epistemic malevolence*. It is the active and intentional hostility towards epistemic goods and it is usually recognized as the ground of many other vices (Baird and Calvard, 2019). Examples are provided by dictatorial regimes or more simply by fake news. Instigation of doubts is a strategy used to make individuals unable to recognize the truth and therefore vice is recognized in the intentional spreading of disinformation and as a consequence the diffusion of ignorance;
- *Epistemic insouciance*. It is the indifference or the demonstration of a “casual lack of concern towards epistemic goods” (Baird and Calvard, 2019). MacKenzie defines it as an unintentional act of lying resulting in a consequent absence of care for the truth (MacKenzie and Bhatt, 2020). It is specifically applied when the subject is aware of the danger the truth can cause to the organization. The vicious behaviour is recognised in the spread of texts and talks concerning “little respect for or relationship to evidence or justification” (Baird and Calvard, 2019);
- *Epistemic hubris*. It is an “inflated sense of epistemic privilege and pride” (Baird and Calvard, 2019). Privilege is conceived as the epistemic authority where instead one lacks it; consider a situation in which the ignorance of the truth results in superior well-being. It is the advantage of not being touched by the ignored problem which Medina describes not as passive indifference to the truth but as a mechanism of oppression that reinforces ignorance (Medina, 2013). Pride is instead the arrogance of a subject that goes against the open dialogue; it describes a situation in which the subject is not open to different ideas and it is convinced he already has the whole knowledge on the specific topic (Baird and Calvard, 2019);
- *Epistemic injustice*. It is directed to the depletion of credibility and the capacity of the others as knowers (Baird and Calvard, 2019). It can be divided into two main forms: testimonial, where the different level of credibility is given by the social status, and hermeneutical, where the credibility of the others is inficiated by their lack of social resources (Fricker, 2007). An example is the injustice related to minorities, both in terms of their social status and their economic wealth. In this case, minorities are at risk of remaining marginalized and oppressed.

4.2.1. Epistemic vices in climate cooperation: a critical analysis

According to Baird and Calvard (Baird and Calvard, 2019), epistemic vices are interrelated and therefore in concrete cases, they may not be easily differentiated. The following example attempts to provide an accurate understanding of the effects produced by the described vices in order to identify the impact of these obstacles. It is not strictly related to cooperation on international environmental agreements, nevertheless, the reasoning behind it corresponds to one of the primary causes that generate a distorted view of reality and prevents some of the major world powers from undertaking international cooperation policies to limit the main global risk.

On September 14, 2020, during a briefing in California occurred after the disastrous fires that led to the destruction of thousands of acres on the West Coast, the former President of the United States, Donald J. Trump, in response to a statement made by one of the officials regarding the concern on climate impact, deliberately stated that climate "will start getting cooler", adding that he does not think science knows actually (Reuters, 2020). The opinion of Trump has certainly baffled the majority of those present, who in the face of the obvious gravity of the facts, could not agree with him. Nonetheless, there are several explanations for his behaviour and one of these may consider his reply as a necessary defence mechanism. Since the election in 2016, Trump has based his political strategy on the emphasis of American wealth and the economic supremacy of the country. Looking at the data collected in 2020, a GDP of \$20.89 trillion (World Bank Group, 2020) seems to confirm his approach. In particular, the GDP of California in 2019 reached \$3 trillion (Bureau of Economic Analysis, 2019) making it the largest economy in the United States and this number has constantly increased through the years. Despite all, natural disasters are destroying this state. In 2020 California had a record wildfire year with nearly 4 million acres burned and the worst level of drought in America. (Davis, 2020). However, even looking at the evidence of the drastic devastation of the territory, the increasing GDP appears to make the concern about the climate issue irrelevant. The reality is that gross domestic product is expanding because of natural disasters: America had to invest a lot in economic terms to recover from losses caused by environmental damage. Investments have been massive in California but they do not

correspond to equal growth in richness. Does Donald Trump really think climate change is not an issue? The answer is not known. What is sure instead is that denying the existence of global warming is probably the best choice from an economic perspective because it enhances the monetary stability, assuring America the first place in the ranking. Cognitive knowledge can be severely distorted by a limited vision of the events. Only different perspectives can lead to an exhaustive recognition of biases which, if not intercepted, could be fatal in the long term. In light of this example, it is simple to understand that if the reasoning for assessing the global risk of climate change is permeated by such insidious epistemic vices, international cooperation on climate agreements cannot be considered a priority for the countries.

There are several doubts regarding the interpretation of Trump's response. A comprehensive analysis could be provided by the vice epistemology framework, declining the inquiry in accordance with the four major vices described above. This study represents the applications of epistemic theory to a real-world circumstance and is based on personal considerations:

- *Epistemic malevolence.* According to the feasibility of climate clubs and the need for public approval introduced in chapter three, Trump's response could turn out to be an economic strategy in which the omission of fundamental data in the description of the country's economic situations, could allow the former leader to maintain a high reputation due to his perceived capacity of preserving or expanding the supremacy of the country. California was inevitably the richest state of the US concerning financial resources, but analysing the big picture, economic data as GDP are meaningless without a broader context where also the environment, along with society, is part of the entire vision. Trump could therefore have purposely provided a distorted vision to obtain consensus from the citizens, even in view of potential re-election. The same principle can be applied concerning the difficulty of implementing climate clubs: many leaders know that the introduction of monetary sanctions would produce discontent and distrust in the government which would be therefore perceived negatively as, instead of promoting economic development, it limits the resources of its citizens. Obviously, this vision is further distorted by the presence of other epistemic vices that do not allow the population to perceive the risk of climate change.

As mentioned above, epistemological vices are interrelated, and the greater the interrelations between them, the greater their pervasiveness in the process of acquiring knowledge, whereby a country where climate change has never been put at the top of the economic agenda, hardly allows citizens to perceive the importance of introducing green sanctions or other forms of punishment of greenhouse emissions.

- *Epistemic insouciance*. This interpretation sees Trump’s response as a “casual lack of concern” (Baird and Calvard, 2019). Thus, unlike epistemic malevolence, the distortion of reality is described as unintentional. For example, politicians want to gain votes, and for their campaign to succeed they have to talk about things they don't really know a lot about and since they have nothing really useful to say, they simply say whatever they think would be intriguing to their crowd. In this way they make it appear like they know what they are talking about (Frankfurt, 2016). The American philosopher Frankfurt defines it as “bullshit”, a crude term that strongly criticizes the dangerous behaviour often present in major political leaders that, with little respect for the truth and scientific evidence, are involved in the creation and dissemination of falsehood and disorientation. This is considered much worse than a pure lie because it makes reality indistinguishable from unfounded news and is therefore often accepted without a thorough inquiry process. In an interview, Frankfurt specifically claims that “the most qualified scientists in the world are telling us that we are having serious issues with the climate and that is an established fact, scientific. There should be no questions about it, but a lot of politicians denied it and they just say it is not the truth, that this is an attempt to prevent economic development and it comes close to be a lie but it is bullshit. Politicians assume climate change is a lie because it does not fit into the political or economic agenda” (Frankfurt, 2005). This epistemic vice is closely related to the epistemic malevolence, but unlike it, in this case, the main subject (Trump) is considered incapable of distinguishing reality from falsehood, therefore, is himself the victim of a distorted vision. Epistemic insouciance is about how individuals want to see the world, rather than what the world truly is like (ibid). A similar situation is also visible in the implementation of the climate club model. In particular, two assumptions lead to this epistemic vice: inadequate political legitimacy

and uncertainty of results. Both these elements are related to a form of scepticism about the potential of this model and, as concrete results are not verified but only analysed on an empirical basis, people and countries' major leaders may not be willing to change, even if theoretical analysis by scientific experts already demonstrated the potential of this innovative model. Scepticism makes people insecure of the truth and consequently makes them easily influenced by epistemological vices, especially in those countries, usually more developed, where the damage caused by climate change is not directly perceptible.

- *Epistemic hubris*. This intellectual defect has already been introduced during the description of the case study. The basic idea is that ignoring the truth creates a privileged situation for the ignorant subject. Medina defines it as "culpable ignorance" (Medina, 2013). Considering the example analysed, it is evident that limited knowledge of the truth allows the United States to consider themselves in a situation of superiority. The epistemic blindness relative to the damages caused in California by climatic disasters merely associates the large investments in the state to an increase in the general wealth; instead, if they are promptly linked to the expenses necessary to repair the damage (or to the irreparable hardships of climate change), they would show all the fragility of this state. A more inherent application to cooperative behaviours on international environmental agreements could be related to the different perceptions of global risk. As previously mentioned, some nations are strongly affected by climate damage, while others, usually those characterized by greater economic well-being and social status, are often not even directly affected by the problem and indeed, it often happens that they are the ones to create it. The consequence is the development of a sense of superiority of the latter, which, since not directly affected by the problem, ignore the climate risk and thus became accomplices to the problem. From this last analysis, it follows that the asymmetries between the various nations create a wide gap between them in terms of priorities and the economic superiority of some nations enforces a condition of oppression against the less prosperous inducing injustice.

- *Epistemic injustice*. In the analysed example this epistemological vice has no direct impact, but the country involved in the study, the United States, is an excellent representation of this peculiar vice in the global context; in particular, the influence of the president of this country in international decisions reveals the dangerousness of epistemic injustice. The latter is described as a form of injustice directed to the credibility and capacity of the others as knowers (Baird and Calvard, 2019). According to historical analysis, it is clear that the United States has always played a leading role in the political decisions on international climate cooperation, being moreover one of the biggest polluters in decades (see Chapter 1). The same power cannot be attributed to all participant countries. Previous climate treaties have demonstrated that the impact of decisions made by the few major emitters can generate a strong impact on a global dimension. Consider for example the decline of the United States to join the Kyoto Protocol which strongly reduced the efficiency of the treaty, or the withdrawal from the Paris Agreements: the decision taken by the American government had consequences on the entire globe and precisely, their political superiority has been and still is able to impose, through international decisions, their individual decisions over those of the others. In light of this power asymmetry, it is evident that there is a political hierarchy and therefore opinions of poorer countries have a lower influence in international decisions and are usually not listened to. Moreover, since they are usually also those mainly affected by climate change disasters, this injustice can be further defined as epistemic violence. Epistemic violence is “a refusal, intentional or unintentional, of an audience to communicatively reciprocate a linguistic exchange owing to pernicious ignorance” (Dotson, 2011). In international environmental agreements, it is the unjustified exclusion or silencing of countries from public discourse on environmental policy-making due to their status and economical influence (Allison, 2014).

The case presented is, however, just an example of the application of vice epistemology to the analysis of cooperation in international environmental agreements. A wide variety of epistemological vices have been identified in the process of knowledge acquisition but the application of this philosophical framework to contemporary issues is still limited.

International climate cooperation is a particularly topical concern and there are countless possible examples to consider for further investigation.

4.3. Lack of responsibility and vice responsibilism

The identification of epistemic vices in the framework of international cooperation provides a more comprehensive explanation of political obstacles in the implementation of adequate climate policies. Through the deepened examination of four vices specifically related to collective subjects, it was possible to identify the reasons causing limitations in the achievement of excellent performance. What, however, has not been accurately elucidated is the level of responsibility associated with each of them and the entity in charge. The presence of asymmetric and collective subjects is likely to decrease the sense of responsibility or limit it. For instance, since the example analysed in the previous section is based on the description of one of the main uncooperative countries according to historical review, someone may argue that not all countries are indifferent to climate change and therefore, some behaviours are not subject to epistemic vices, as evidenced by their efforts to reduce greenhouse gas emissions in the Paris Agreement and in the previous attempt in 1997 with the Kyoto Protocol. In some cases, intentions were sustained by virtues belief, however, outcomes failed to achieve the expected results. In this peculiar context, countries have not displayed any vices, therefore they do not appear responsible for the negative outcome. The concept of responsibility is another of the key aspects to be considered in the analysis. Is it appropriate to hold States responsible in this scenario? The answer to this question is provided by Miranda Fricker in her discussion of institutional epistemic vices (Fricker in Kidd, Battaly and Cassam, 2020).

Imagine a school with qualified instructors but provided with a poorly functioning IT system used for homework submission and general communication. The bad performance of the system results in major communicative failures among the subjects involved. Teachers are working hard and are motivated by the best of intentions, however, the IT system does not reflect their efforts and results in a disappointing outcome. Assume this situation persists for a year: teachers have largely abandoned the use of the platform and no replacement has been

implemented yet, resulting in an atmosphere of distrust among students and families. It is evident that there is an element of epistemic vice. Considering the institution's behaviour, however, this vice is not directly related to the school but instead is a result of a separate form of inefficiency. Ten years later, despite the possibility to improve, the school remained inefficient in exchange of information and communication level; no alternatives have been implemented to overcome the limitation of the IT system. The school has failed in the implementation of information-sharing systems and performance remained unsatisfying. Ten years later the school demonstrated an epistemic vice of improper information-sharing. The multiple culpable failures of virtue have coalesced into a systemic failure, causing the institution's basic nature to alter for the worse. (Fricker in Kidd, Battaly and Cassam, 2020). Fricker divides epistemic vices in respect to ethos and implementation where the ethos is the presence of appropriate intrinsic values behind any given process of epistemic conduct (stable motives) and implementation is the “outer performance” (outcomes deriving from the inner ethos). According to the example described and the theoretical framework, it appears that the school is responsible for epistemic vice in information-sharing, even in the presence of appropriate ethos. To summarize, in the contest of responsibility is essential to consider both the motivations of the subject and the related results obtained, which if detrimental and persistent are synonyms of epistemic vices.

Applying the theory presented in Fricker's example to international cooperation for the mitigation of climate change, it is evident that although the intention of the States may be aimed at reducing emissions, the disappointing results achieved in decades without the ability to implement alternative methods that meet the needs empirically verified by scientists and climatologists, make States responsible of epistemic vices. Furthermore, the optimistic vision in which countries always act in the pursuit of goodness is limited and misleading. Scientific evidence on the danger associated with climate change and previous attempts to international cooperation reveal the possibility that countries are guided by vicious motivations and that they intentionally decide to ignore the global risk or unethically prioritize their self-interest to the detriment or the efforts of others. As defined by Baird and Calvard, “vices get their negative value not simply by producing bad epistemic ends but also involving bad motivations” (Baird and Calvard, 2019). Therefore, vices are not merely the absence of

virtues at the same level of a lack of capability, but subjects are responsible for their actions.

4.4. Ethics and Epistemology contribution to climate cooperation

The presence of epistemic vices and the consequent introduction of a responsible vision on individual and collective actions reveals that agents have some control over them. In particular, the main idea is that political and ethical obstacles to cooperation in international environmental agreements are caused by cognitive defects in the process of knowledge acquisition. According to the potential implementation of a climate club model, as presented in the previous chapter, it is evident that although the model is theoretically functioning, it still lacks a relevant analysis component. Nordhaus proposed the transition from a voluntary model to a model based on obligations and responsibilities, however, he limits the level of responsibilities to a monetary dimension with punishment for the emitters and rewards for the cooperative members. The proposal ignores that monetary incentives increase extrinsic motivation while undermining the intrinsic one since they induce subjects to adopt behaviours they would normally not adopt (Ryan and Deci, 2000). As claimed by Milinski, if players are paid to embrace a cooperative action, this may no longer be considered pure altruism (Milinski *et al.*, 2006). Therefore, the identification and analysis of cognitive flaws could allow involved subjects to recognize the primary causes behind the unsatisfactory level of cooperation and reduction of emissions. The investigation on epistemic vices could be the initial step toward an amelioration process with the purpose of confining the vices and reducing their influence. Cassam calls it an “exercise in self-knowledge” (Cassam, 2016). In the absence of a transformative process by which countries recognize their epistemic vices and consequently follow an ethical approach becoming fully responsible for the impact of their actions, the possibility of overcoming obstructions to cooperation is drastically reduced. Therefore, identifying and correcting epistemic vices is a fundamental issue for responsible thinkers. Ethics and epistemology demonstrated that interference to cooperative behaviour in international environmental agreements have to be found in the intellectual sphere of the main actors of climate policies decisions and this involves further investigation and application of this framework to the cooperative scenarios that have so far been studied from an almost purely economic perspective.

Conclusion

During a Security Council of United Nations in 2021, the naturalist David Attenborough claimed that the only way to tackle climate change is through unprecedented levels of global cooperation (United Nations, 2021). Although progress has been made, results still fall short of the scientific target set by the IPCC, being comparable to a situation of climate inaction. The present study offers a comprehensive analysis of international cooperation on climate change mitigation and the identification of specific obstacles to climate policies implementation. Several attempts have been made over the years. The first approach was initiated in 1992 with the Rio Convention and then formalised in 1997 through the Kyoto Protocol, considered the first legally binding international environmental agreement. Further, the Paris Agreement was implemented in 2015 after the failure of the previous treaty. Despite UNFCCC efforts, in-depth analyses revealed inherent limitations of implemented regulatory models, which have always been perceived by nations as economically unattractive and, due to their voluntary character, permeated by free-riding incentives. Given the limitations identified in the previous treaties, this analysis provides a further potential approach: the climate club model. The model was introduced and extensively examined by Nordhaus (Nordhaus, 2015a) but to date, potential results have been studied exclusively at the theoretical and empirical level. This thesis argues that despite the theoretical feasibility of this innovative and economically advantageous model of cooperation, the actual implementation is limited due to political and ethical obstructions.

A significant contribution of this investigation lies in the fact that the concept of a rational subject, exclusively guided by the maximization of economic gains, represents a limited view of the problem that fails to understand the complexity of international relations. Over the years, the study of climate policy has mainly been the subject of economic analysis. However, as discussed in the second chapter, a multidisciplinary approach is required to identify factors that operate outside the scope of the economic sphere. In particular, the fourth chapter introduced an innovative field of analysis that can strongly contribute to the identification of the primary causes behind the unsatisfactory level of cooperation and reduction of emission.

Further investigation on cooperative behaviour in international environmental agreements could therefore benefit from the application of an ethical and epistemological analysis aimed at identifying the interference of cognitive flaws on countries' decisions. Despite the considered case represents a basic introduction to this particular framework, the investigation is restricted to four selected epistemic vices. Additional cognitive defects could be introduced into future investigations, which could yield further insights about international climate cooperation. Among the major problems of international cooperation is the lack of responsibility of nations towards the consequences of their actions, an aspect that economic and social studies have never been able to examine in depth. Ethics and vice epistemology introduce the observation of bad motivation in the decision-making process and as a consequence, they recognize the moral responsibility of countries in cooperative performances and an associated level of control over them. Further research could therefore identify significant insights into cooperative behaviour and possibly provide a consequent amelioration of the cooperative conduct and the performance on climate change mitigation at an international level.

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