Master's Thesis

Global Climate Policy and National Voluntary Contribution

An experimental study of cultural belief and cooperation with target groups.

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Abstract

When we talk about global issues, the topic of 'climate change' has survived decades and ranks at the top of the list for being the most difficult to deal with. This paper presents an experimental setting to understand cross-cultural implications to the current global climate policy. It looks at some issues that may hinder the success of the Paris Agreement, specifically, considering the agreement's national voluntary approach.

The research is based on theoretical perception of climate being a global public good which ensues collective action problem and that rationality defies voluntary contribution approach for climate change abatement. A threshold public good game experiment is designed under the framework of game theory and the unique nature of the global climate change regime, to empirically understand cultural differences and biases, and how they affect investment decisions towards a common good.

The results of the study show that people from China have significant difference in contribution, cooperation and beliefs, compared to their western counterparts. Moreover, the group behaviour of the Chinese people is also significantly different than the others.

The study also serves as a post-policy analysis regarding some of the characteristics of the international climate change regime. A broader implication of this research can be considered to confirm, if, and to what extent. the national voluntary contribution approach of the Paris agreement will sustain, given that it requires cooperation of private actors.

Keywords: Public good, Game theory, Voluntary contribution, Climate Change, Culture, Cooperation, Global Climate Policy

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"By comparison to what it could have been, it's a miracle.

By comparison to what it should have been, it's a disaster." – George Monbiot

1. Introduction

When we talk about global issues, the topic of 'climate change' has survived for decades and ranks at the top of the list for being the most difficult to deal with. Recently, the world gained a flash of optimism regarding climate change as 195 countries adopted the first-ever universal and legally binding global climate deal, which made the Paris agreement[1] 'historic'. It is the first-ever deal binding all the world's nations, rich and poor, to a commitment to cap global warming caused mainly by the burning of coal, oil and gas, while also acknowledging that each country has "common but differentiated responsibilities and respective capabilities" (Paris Agreement: Article 2, Clause 2), meaning different nations have different capacities and duties for climate action, no specific division being provided between developed and developing nations.

As of June 2017, China has sent a clear message about who will lead the fight to address climate change in the coming years, when China played a convening role by bringing together countries from across the globe for a discussion on the deployment of clean energy. Its participation in international climate change negotiations has evolved from playing a peripheral role to steadily moving to central stage. While the president of the United States announced his plans to withdraw from the climate deal, China stands firmly on her decision to invest more than 350 million dollars in domestic renewable power generation by 2020, expanding a cap-and-trade program to stretch across the entire country. One of the most important developments in the Paris agreement compared to that of the Kyoto commitments 20 years ago was the fact that the focus shifted from developing vs developed country designation for the responsibility for reducing emissions to the inclusion of many of the largest emitting countries such as China and India. This particularly led to the success of persuading 195 countries to sign the Paris agreement. The agreement acknowledges that developed countries must take the lead in reducing emissions, but it does not exempt developing countries from setting and meeting targets. Yet, one of the main arguments presented by the US administration in favour of pulling out of the agreement is that the Paris Agreement is "unfair" because large polluting countries such as India and China are not required to do anything until 2030.

[1] Link to the Paris Agreement: https://unfccc.int/sites/default/files/english_paris_agreement.pdf

In addition to the points above, there are a number of others that should be addressed, particularly relating to the role of the two major players: Chine and the US. First, the Paris Agreement presents a new, and possibly worrying, model of voluntary "nationally determined contributions" by governments. Many of the results are expected to be delivered by the magic of markets and not-yet-commercially available revolutionary technology, with world leaders guaranteeing the changes required to achieve the success of the Paris Agreement. The success of the system depends too much on the good will of world leaders. The agreement's reliance on state participation and lack of mechanisms to ensure implementation begs the question: are voluntarism and naming and shaming enough to make it work?

Second, China insisted on some core principles and elements that had to be incorporated into the agreement in Paris. For example, China has argued that developing countries should be allowed to let their emissions rise while their citizens grow out of poverty. The pledges that China made as part of the Paris agreement reflect that idea. Instead of agreeing to a firm ceiling on emissions, China pledged that it would cut carbon intensity[2].

Third, it is worth pointing out that during the negotiation process, the United States pushed to make the agreement flexible to bring all countries on board and to keep them in the fold even if their situations and priorities changed[3]. However, despite President Trump's announcement, US states, cities and businesses are forging ahead, many of them with an even stronger sense of conviction. Even after the announcement of withdrawal of the United States from the Paris agreement, more than 2,500 governors, mayors and CEOs pledged to adhere to the goals of the Paris Agreement[4].

So, what happens if the United State pulls out of the agreement? First, the US emission reduction pledge under the Paris agreement accounts for more than a fifth of all the emissions avoided through 2030, that is 21% of the total pledge by all the nations put together. Urpelainen et al 2017 argue that US non-cooperation does not essentially alter US emissions, which are unlikely to rise even in the absence of new federal climate policies; nor does it undermine nationally determined contributions under the pledge and review as the Paris Agreement has introduced a new reason for domestically driven climate policies and the cost of

[2] https://www.nytimes.com/2017/06/02/world/asia/chinas-role-in-climate-change-and-possibly-in-fighting-it.html

[3] For more on the discussion, see https://www.brookings.edu/blog/planetpolicy/2017/06/01/trumps-paris-agreement-withdrawal-what-it-means-and-what-comes-next/

[4] For details, see http://www.wri.org/blog/2018/02/there-are-still-opportunities-us-china-climate-cooperation

low-carbon technologies keeps decreasing. However, from the point of view of behavioural economics, the concern remains that the US non-participation in raising climate finance could raise high barriers to global climate cooperation in the future. The Exit of the US has not just raised concern that the US will miss its domestic emission reduction targets, but also that other parties to the Paris Agreement might backtrack on their initial pledges regarding emission reductions or financial contributions.

There are also other features of the agreement regarding its approach in reaching the set goals. Evident from Article 7.2, the agreement demands a national-level policy initiation for the countries to be able to meet the requirements of the international agreement[5], and expects the private sector to uphold and promote regional and international cooperation. This particularly puts the success of China's role under scrutiny as the country's goal of meeting the 2030 hard commitments will require effective cooperation from local governments. However, the past three decades of Chinese economic reforms observed a shift in control over resources and decision-making to local governments. This decentralisation has put environmental administration in the hands of local officials and polluting enterprises who are primarily concerned with profit making and economic growth and not the environment. The central government has had great difficulty obtaining effective cooperation from local governments in meeting energy-saving and pollution-cutting goals (Zhang, 2012b). Turning nationally determined contribution pledges into policies is the next challenge for governments, a challenge the failure of which means facing the threat of severe climate change (Baranzini et al. 2016). Moreover, to achieve greater acceptance of national climate policy and international agreements, public belief in climate change and understandings of risk associated with it is crucial (Hopkins, Markowits, 2017) in order to gain public cooperation. Thus, to be successfully able to avoid severe climate change consequences, an extra layer of cooperation is required, essentially cooperation at the domestic level.

The fact that the Paris Agreement takes a new approach to universal participation based on national contributions in which each country sets its own objective conforms to numerous theories and concepts postulated by economists and policy makers over the last few decades. Since the approach of the current global policy on climate change demands a national-level

[5] Article 7.2 recognises the role of non-Party stakeholders in addressing climate change, including cities, other subnational authorities, civil society, the private sector and others. Through Articles 8 to 10, they are invited to scale up their efforts and support actions to reduce emissions; build resilience and decrease vulnerability to the adverse effects of climate change;

policy initiation for the countries to be able to meet the requirements of the international agreement, it is worth evaluating the relative effectiveness of these adapted approach from a theoretical perspective as well as practical implications.

1.1. Research Idea

In the past four decades, debate has focused on the economic impacts of environmental degradation and regulation. Recently, however, the influence of economics on climate policy has evolved from a narrow focus on cost to large systemic change (Harris el al, 2017). Many of these systemic changes are observable in the newly implemented global climate change policy agreement. While it is considered as a beacon of hope in the battle against climate change, it cannot be ignored that the initiation and the success of the agreement is based on an individualistic approach[6]. An economic analysis of the Paris Agreement conducted by Giraud, Lancesseur, and Roulleau and published by Ministère de l'Économie et des Finances provides a comprehensive interpretation of the possible success of the agreement that can be expected in the future. It is also evident that the agreement conforms to some of the aspects of previously postulated economic theories[7] regarding climate change policy construction. On the other hand, the impossibility of the "bottom-up" approach of the agreement to create an arrangement where countries are clearly held chargeable probably means that a principle-agent problem can be expected on a global scale!

Keeping this in mind, and the fact that the US and China are the two major players in today's global climate change scenario, this research investigates cooperation in a targeted population sample (Chinese) in a public good situation with implications for climate change. This is done under the framework of economic analysis, along with the use of the logic of 'national culture' to understand aspects of public policy. More specifically, the study aims to examine the effect of individual beliefs (in case of climate change) and their social preferences on the level of cooperation in terms of distributional aspects of investing in the provision of public goods in an economic experimental setting. This, in turn, is expected to provide means to

[6] "Ratifying countries can independently decide on how to lower their emissions. This is a big deal: previous attempts at a climate deal required that similar measures be adopted by all signing parties. However, because economies, cultures, and nations differ so greatly, a common denominator was hard to determine and, therefore, achieve. Allowing ratifying countries to determine the best way forward for them, individually, galvanized support for the agreement"

[7] For example, a version of Ostrom's polycentric approach.

tweak environmental/climate change policies that are required to be implemented on the domestic level to meet national commitments in international agreements. In this thesis, I present a model for a laboratory experiment with target groups to determine cross-cultural differences in human perceptions/beliefs regarding climate change consequences and the factors that influence individuals' willingness to cooperate in a threshold public good game.

The interest of this thesis is based on the difference in attitude and effort level towards climate change mitigation by the two nations who are accountable for over 40% of total global emission: United States and China. The study will also serve as a post-policy analysis regarding some of the characteristics of the international climate change regime. A broader implication of this research can be considered to confirm, if, and to what extent. the national voluntary contribution approach of the Paris agreement will sustain, given that it requires cooperation of private actors (that is, cooperation on domestic level is required where the actors are assumed to be mostly profit-maximisers).

1.2. Research Questions

Combined with the idea that the cultural and/or national characteristics of a person's belief might, to some degree, influence their monetary decision strategy, a laboratory experiment will be designed with target participants (ideally from China and US). Due to its close resemblance to the real-world global climate change contribution scenario, the voluntary contribution model with a threshold mechanism has been adopted for the experiment. In order to empirically determine cultural beliefs and biases, a survey will be implemented which is framed for climate change perceptions[8]. The objective of the experiment is to answer the following research questions:

1) Which population tends to contribute towards the highest provision point? Are they able to cooperate and gain sanction for the highest threshold?

2) How does cooperation among the two groups differ when the factor of communication is introduced?

[8] based on the survey questionnaire of Robert E. O'Connor et al (1999), which was made to examine the relationship between risk perceptions and willingness to address climate change.

3) Is there any influence of the cultural belief factors (risk perception, attitude towards the role of government, and general environmental beliefs) on cooperation? How does it differ (if it does) between the two groups?

In the next chapter, I discuss the theoretical framework of the study, in which the topics of culture, global public good, collective action problem, and the game theoretic approach to it are explained. Furthermore, the concepts of cooperation in climate change abatement actions and the assumptions that come along with these concepts are also discussed in more detail. The chapter that follows examines the relevant studies done so far. The fourth chapter provides an insight into and justification for the chosen model. The fifth chapter considers in more details of the model and the design of the experiment, in that it provides the experimental predictions and the general hypotheses of the study. The sixth chapter deals with the details of the pilot conducted for this research. The next chapter presents the results and analysis of the data collected from the experiment. A discussion is given in the chapter that follows, which describes the findings in relation to the motive of the research, the limitations and provides suggestions for future studies. The thesis ends with a chapter that gives the concluding remarks and draws a relationship to the current policy in action.

2. Theoretical Framework

The main theoretical framework of the thesis falls under the framework of behavioural economics of climate change, which deals with social preferences and the behaviour of individuals and nations. In this section, I attempt to sum up some of the basic theoretical concepts that have shaped the way climate change is dealt with in public and political economics over the years. As one of the concepts that this thesis deals with is ‘national culture’, the next subsection provides a brief description of what is meant by the term ‘culture’. For a better understanding of the national voluntary contribution and game theoretic approach to climate change, the subsequent subsections provide a brief look at how some of the most important climate economists have theorized the related issues.

2.1. Culture:

A general definition of culture refers to a system of basic common values that help shape the behaviour of the people in each society (Granato, et.al, 1996). In the language of economics,

culture can be translated as the social norms and the individual beliefs that sustain Nash equilibria as focal points in repeated social interactions (Greif, 1994; Tabellini, 2005). Cultural (societal) values on a cross-cultural basis can be described as “the collective programming of the mind that distinguishes the members of one group or category of people from another” (Hofstede, 2001, pp-9). This ‘programming’ typically happens early in life and leads to behavioural patterns that continue over time, shaping the institutional environment (Hofstede, 1980).

2.2. Public Good, Global Public Good, And Collective Action Problem

Public goods are defined as goods that are non-rival and non-excludable in nature. It is non-rival in the sense that consumption of the good by one person do not prevent others from using it, and it is not excludable in the sense that nobody can be excluded from consuming it. The characteristic of non-excludability from consumption results in a free-rider problem and the characteristic of non-rivalry lead to the under-provision or under-consumption of the public good when it is financed on a voluntary basis (Stiglitz, 2000). The two defining characteristics of public goods predetermine public goods for public provision and prevent market mechanisms from supplying them efficiently (Samuelson, 1954). In other words, the existence of public goods usually serves as an argument for public intervention in the economy. Kaul et al. (1999, pp-16) define global public goods as those which “tend towards universality in the sense that they benefit all countries, population groups and generations”. They have the following characteristics ‘at minimum’: 1) their ‘benefits extend to more than one group of countries’; and 2) they ‘do not discriminate against any population group or any set of generations, present or future’. Climate can be classified as a global public good due to the universality of its non-excludable and non-rival characteristics.

Mancur Olson dealt with the provision of public goods by groups. He focused on the non-excludability property of public goods. According to Olson, a "common" or "collective" good is one that is available to every individual, regardless of whether he or she pays for it. Collective goods have two characteristics: if they are available to one, they are available to all (access cannot be restricted), and one’s use of the good does not reduce its availability to others. Collective goods are those that are characterized by "jointness" of supply and the impossibility of exclusion. Thus, with the term collective action problem he mainly referred to the free rider problem in the organization of interests (Olson 1965). According to Ostrom,

the term “collective action” refers to settings where decisions about expensive actions are made independently but outcomes jointly affect everyone involved. If independent decision makers seek only short-term material benefits, they do not achieve feasible outcomes that yield higher returns for all who are involved regardless of whether they make costly contributions (Ostrom, 2010). Thus, the term "collective action" refers to the joint actions of several individuals which aim to achieve and distribute some gain through co-ordination or co-operation. The strategic assembly of actors can be such that they lead to difficulties in achieving the goals of collective action. All difficulties that arise in the pursuit of these goals and that are a consequence of strategic interaction are "collective action problems".

Olson (2000, pp-71) points out that voluntary collective action works better in small groups and that when one party obtains sufficient benefits from a collective good that the party benefits by providing some of the good entirely on their own expense. However, voluntary provision does not work in large groups because individuals in large groups receives minuscule share of the benefit and is not enough to typically motivate individuals in a large group to contribute (Olson, 2000, pp-77).

Barrett (2008) states that climate change may or may not be the most important problem the world has ever faced, but it is certainly the greatest challenge for collective action the world has ever faced. While there might be an exaggeration on Barrett’s part, the climate change regime does indeed face a collective action problem. To stop the progress of future global warming, greenhouse gas emissions should be lowered globally. Though most countries should contribute, many would prefer not to as the effort of contributing towards climate change is perceived to be a costly effort, and the incentive for free-riders is too strong. That is, countries are expected to act in their self-interest which is justified by the rational choice theory: a goal of rational individuals in the group is to free-ride while others pay (Olson, 2000, pp-83). Rational choice theory implies that an individual will act to maximise his or her expected utility function.

However, the standard model of rational action submits that, while the model is influential in predicting the outcomes in auctions and competitive market conditions, it is complex in explaining the coordination of collective action. “Recent work in game theory – often in a symbiotic relationship with evidence from experimental studies – has set out to provide an alternative micro theory of individual behaviour that begins to explain anomalous findings.” (Ostrom 2000, pp-138).

2.3. Game theoretical approach to the collective action problem

The first thing to look at when examining a collective action problem is the payoff structure. Who gains from the results of climate change and is less interested in abating it? The greater the mutuality of interests, the greater the likelihood the players would choose to cooperate; the greater the conflict of interests, the more likely the players would choose to defect.

Several authors claim that the climate change collective action problem is a prisoner's dilemma (Barrett, 2006, Gardiner, 2001). The prisoners' dilemma is a simple case to demonstrate the decision dilemma of a situation with different pay-offs depending on the other player's action. This type of games has a unique Nash equilibrium. The Pareto-optimal outcome is the outcome that is preferred both collectively and individually in prisoners' dilemma games, that is, the pareto-optimal outcome is preferred over the equilibrium outcome. However, pareto-optimal outcomes are not usually achieved by the players as there is an incentive for the individual to deviate if the other player conforms. Thus, the players are tempted to defect. In the prisoners' dilemma, both the Pareto-optimal outcome and the Nash equilibrium are equality outcomes (Holzinger, 2003).

In assessing voluntary contribution in climate change abatement issues, prisoner's dilemma is a good basis to answer questions like: Shall a participating country exceed the settled emission quotas? Cheat or not in emission reports? Do the short-term individual and the long-term global interest meet each other in carbon dioxide emission?

The assurance/stag hunt game has been more preferred model for the representation of the climate change collective action problem. The assurance game describes a state when players are unable to seize an opportunity for cooperation that seems obvious. There is one best solution, and if it is spoiled, the worst payoff will be realized. There is no inequality in the equilibria, and players maximize joint gains in the optimal equilibria. The main problem for the players is to co-ordinate their strategies such that at least one of the equilibria, and hopefully the optimal equilibrium, will result (Holzinger, 2003). That is why players are very cautious and do not act in uncertain circumstance but wait for the other's action or own certainty. However, after a while, cost of passed time matters, so the players will accept the second-best solution. This game eliminates the countries' motivation for free riding. The stag hunt game models, for example, the situation when small or less developed economies are waiting for larger countries' initiation or technologically first comers' advantage (Kutasi, 2010).

Table X represents a stag hunt game between the two countries. Here, the players are willing to contribute to reduce emission given that one player already cooperates. But if one of the players is not cooperating, the other will defect as well. Hence, reducing emission becomes the first preference for the countries in anticipation of the other to cooperate.

Table X: Climate Change and Assurance/Stag hunt game

Country A			
Country B		Reduce Emission	Don't Reduce Emission
	Reduce Emission	4, 4	1, 3
	Don't Reduce Emission	3, 1	2, 2

But the dominant strategy of both players is not to contribute, that is, to free ride. The game results in a Nash equilibrium characterized by not contributing to reduce emission: combination (2,2). On the other hand, a Pareto optimal situation would be reached if both players contributed to reduce emission: combination (4,4); and the mutual benefit was maximized (mutual benefit=4+4). However, without the intervention of an external authority, this form will always result in a non-efficient outcome as there are no incentives for individuals to contribute and emission level will not be reduced.

In order to get the Pareto-optimal outcome, a better approach is the chicken game. As Kutasi (2010) notes, the chicken game is a useful frame to describe a situation when two or more opposite approaches, opinions, interests are wanted to be realized for any price by the players. Table Y represents the same situation as before but in the form of a chicken game:

Table Y: Climate Change and Chicken game

Country A			
Country B		Reduce Emission	Don't Reduce Emission
	Reduce Emission	4, 4	4, 5
	Don't Reduce Emission	5, 4	3, 3

According to the payoffs in this game, neither player has a dominant strategy. Though, there are two equal Nash equilibria ((5,4); (4,5)) representing a situation where one player

contributes while the other does not. In this case, the equilibria are even efficient as 5+4 > 4+4. If the players managed to coordinate their actions, they could reach the efficient outcome and maximize social benefit. The problem, however, is that usually the players do not get the opportunity to communicate to agree on a joint strategy; even if they can communicate, there is no control or enforcement mechanism ensuring that the agreed strategy will be respected.

The application of the prisoner's dilemma in common goods problems does not necessarily consider the expectations of the different actors. In case of global climate deals, if a state expects the others to free ride, it is likely to defect. Ostrom (1998) supports this matter by finding that those who intend to cooperate in a particular one-shot social dilemma also expect cooperation to be returned at a much higher rate than those who intend to defect.

Thus, there is an emphasis on the role of institutions in the expectations of states. Institutions can alter a country's expectations about the actions of others through the provision of information and the credible threat of retaliation.

Incentives and institutional structure are known to affect the divergence between individual and collective outcomes for public good provision (Andreoni 1988; Issac, Walker, and Samuelson 1954), and knowledge of how individuals respond empirically continues to limit the outcomes supported by mechanisms proposed to generate revenues in support of public goods. The divergence between individually and socially optimal outcomes encourages the development of mechanisms that enable individuals to act according to their own interests while simultaneously maximizing the total welfare of society.

2.3. Concepts of Cooperation

From the perspective of the participating countries, many reasons can be considered as to why they would choose to contribute. First, given that climate change is one of the most important issues of our time, participation would give the country a good reputation and consequently the ability to achieve goals through attraction rather than coercion.

When the use of reciprocity is common - this being the situation where one cooperates on the first move and then does whatever the other player did on the previous move - it is beneficial to have the reputation of 'co-operator' because it allows a state to engage in mutually produc-

tive social exchanges (Ostrom, 1999, Ostrom 2010). Secondly, even if a country is not directly affected by future climate change, it would still be indirectly affected because of global warming. Moreover, the climate change regime is very fragile and one country dropping out can thwart the efforts of the entire coalition when it comes to international agreements. Ostrom (1998) claims that norms can be important in public good problems and have to be factored into the objective costs of action but the influence of norms cannot be discounted in the case of climate change. Whether norms feature heavily depends on the social distance between the actors (Kopelman et al, 2002). Groups which interact repeatedly have higher cooperation rates in social dilemmas than groups that are rebuilt every time. Ostrom (1998) found that face-to-face communication is an especially effective method of increasing trust, creating and reinforcing norms and developing a group identity, which enables cooperation to take place.

2.3.1 Assumptions

Various circumstances in our daily life involve social dilemmas and the solutions of which require cooperation, most of which entails the provision of public goods or the management of common-pool resources. Maintaining cooperation in those settings characterises one of the major attainments of our society as cooperating in social dilemmas calls for overcoming the temptation to free-ride, often making contributions towards a common good at the expense of personal benefits. Climate change is considered global public good[9] and to prevent free-riding, we need a multilateral negotiation to obtain cooperative solution. As the research is focused on cooperation among individuals in groups, most of the theoretical assumptions are drawn from previous studies on cooperation, especially on the intuitions drawn from the works of Elinor Ostrom.

Cooperation represents an anomaly that infrequently fits the model of a rational actor (utility maximizing agent) from an economic perspective (Dawes and Thaler, 1988). Yet, cooperation is often observed, suggesting that either individuals are not always rational actors or that preferences on personal benefits of individuals shift when acting as part of a group. Even though it could be tempting to assume that our societies can operate with morality and in public spirit (Hirschman 1984), understanding cooperation is a significantly challenging task for economists, more so when we are talking about cooperation on a global

[9] Public good is a good that is non-rival and non-excludable in nature. Detailed discussion in Chapter 3.

scale. Basing on the traditional economic perspective of rational selfishness, under the principle that the representative *Homo economicus* pursues his objectives according to narrow self-interest, the first assumption of the research can be stated as follows:

Assumption 1: Cooperating for the provision of public goods, entails sacrificing individual interests for group interests, which goes against both individual rationality and, from an evolutionary perspective, natural selection.

According to Elinor Ostrom, subjects may be willing to cooperate, even in a global setting, if they expect others to reciprocate. Ostrom (2009) supports this intuition by providing evidence on several local communities and subnational entities that organised and jointly engaged in favour of climate-change mitigation. Whether policy-makers will be able to influence individuals' willingness to cooperate also depends on their consideration of when and why cooperation in the climate commons works. Simon Caney, on determining the polluter or the 'unit of analysis' in terms of polluter-pays principle, proves that while there are numerous contributing agents, such as individuals, economic corporations, states, international regimes and institutions, etc, "the relevant unit of analysis is the state and that the other options collapse into it" (Gardiner et al, pp-127). Given that states are formed by groups of individuals who are, supposedly, rational economic actors, it can be deduced that states/governments will always act to maximize their own utility even in an international setting (for example, when negotiating with another country). Thus, it can be implied that cooperation among/between states encompass similar characteristics of individual cooperation. This leads us to the second assumption of the research:

Assumption 2: International cooperation follows the pattern of individual co-operations.

3. Literature Review

A wide range of studies done on how to approach the issue of climate change has sprung the literature on distinct categories. Storm (2009, pp:1030-1031) presents a radical view against 'fossil fuel capitalism' and an argument against market-based measures to mitigate climate change. According to Storm, global warming is a public good problem and a capitalist society is simply inept in dealing with it. Market is incapable of thinking ahead to prepare and protect from the needs of the future and hence, market failure exists widely in the climate market. The world needs systemic transformation based on growth scepticism, a planned transition to

a non-fossil fuel economy, democratic reform, climate justice, and changed global knowledge and corporate and financial power structure (Storm, 2009, pp:1032). A comprehensive study put forward by Ostrom (2012) suggests a 'polycentric' approach to climate change policy-makers. That is, neither a market-based approach nor a command and control base approach is efficient on its own to tackle the global warming problem. The government, in this case, is required to play an active role in creating incentives for individual market actors to perform in a way that helps alleviate climate change. To be able to avoid disastrous consequences, it is important that the vulnerable economies grasp the idea of adaptability to climate change (adaptation refers to adjustments by individuals and the collective behaviour of socioeconomic systems). It is crucial that actions that increase adaptive capability are considered as they are in correspondence to the activities required for sustainable development (Smit et al, 2003). However, it has been proven time and again by researchers that a rising temperature effect the poor and developing countries with higher intensity than it does to the developed countries (Burke et al, 2016; Doda, 2013; Storm, 2009).

As the global climate change agreements has the characteristic occurrence in the decentralized international space, it makes it a common pool resource (CPR) problem. This problem was described and explained by Garrett Hardin (1968) as the tragedy of commons. Herdin gives an example involving a common pasture in which it is expected that every herdsman, being rational, is going to try keep as many cattle on the commons as possible in-order to try and make the most profit which leads to overgrazing, resulting is lowered productivity causing each herdsman to add more cattle to bring their profits back up. It is in this desire for self-interest that the tragedy of the commons arises This type of "motivation to increase the using without limit in a limited world" (Hardin 1968, pp-1244) is very often temptation in case of the global resources like the climate.

In assurance of the fact that all individuals are selfish, Ostrom (1999) illustrates a model to handle the common-pool resource problem regarding climate change. She states that solving common-pool resource problems involves two distinct elements: restricting access and creating incentives (usually by assigning individual rights to, or shares of the resource) for users to invest in the resource instead of overexploiting it. Both changes are needed. Humans adopt a narrow, self-interested perspective in many settings, but can also use reciprocity to overcome social dilemmas. The concept of property rights plays a significant role in instilling appropriate incentives to cooperate.

- *Property Rights:* The four broad types of property rights (Ostrom 1998, 1999) to regulate common-pool resources are summed up in Table 3. Degradation and potential destruction are the consequences when valuable common-pool resources are left to an open-access regime. Ostrom provides evidence to reject the notion that resource users cannot themselves change from no property rights (open access) to group or individual property. However, studies show that no single type of property regime works efficiently, fairly, and sustainably in relation to all common-pool resources. This is particularly true in case of the climate change issues as the problems continue to exist in regulated settings. It is important to identify which of Ostrom's design principles are more relevant to successfully govern the common-pool resource problem associated with climate change.

Table Z: Property Rights to regulate common-pool resources

Property Rights	**Characteristics**
Open access	Absence of enforced property rights
Group Property	Resource rights held by a group of users who can exclude others
Individual Property	Resource rights held by individuals (or firms) who can exclude others
Government Property	Resource rights held by a government that can regulate or subsidize use.

- *Ostrom's Design Principles:* Ostrom identified eight design principles that enable CPR groups to effectively manage their resources: clearly defined boundaries, proportional equivalence between benefits and costs, collective-choice arrangements, monitoring, graduated sanctions, conflict resolution mechanisms, minimal recognition of rights to organize, and appropriate coordination among relevant groups. Emphasis should be put in monitoring and appropriate coordination when talking about the climate change regime. As discussed earlier, managing a common is fundamentally vulnerable to free-riding and active exploitation. Unless these undermining strategies can be detected at relatively low cost by norm-abiding members of the group, the tragedy of the commons will occur (Wilson et al, 2012). Moreover, for groups that are part of larger social systems, there must be appropriate coordination among relevant

groups. Every sphere of activity has an optimal scale. Large scale governance requires finding the optimal scale for each sphere of activity and appropriately coordinating the activities, a concept called polycentric governance (Wilson et al, 2012; Ostrom, 2012).

Giddens (2008) puts forward an intriguing suggestion to mitigate the climate challenge by putting the international market and the state together by declaring that the problem can only be solved by integrating the government, NGOs, individual households and business entities: in which the role of the government is to monitor and ensure that every individual institute has an effective role in reducing greenhouse gas emission. An even comprehensive study put forward by Ostrom (2012) suggests a polycentric approach to climate change policy-makers. That is, neither a market-based approach nor a command and control base approach is efficient on its own to tackle the global warming problem. The government, in this case, is required to play an active role in creating incentives for individual market actors to perform in a way that helps alleviate climate change. Ostrom also points out that framing problems related to resource use in a social context do affect actions. Thus, numerous measures could be taken by the government on a micro-level to influence cut in energy consumption. For example, government could provide subsidies to households that purchased a solar power electricity, this in turn would raise the consumption of solar power; creating competition among households and groups and giving them credits for using less electricity could reduce carbon emission from households, that is, providing incentives to cooperate.

Because of its complexity and high uncertainty, in case of climate change the variable sum and dynamic approach is the most useful to model the behaviour of actors of international relation (Kutasi, 2010). As certainty of occurrence and local/regional impact of temperature change gets stronger, it has repercussion on the preference of decision makers in the international space. Change in preferences can be caused, also, by change in political leadership or regime. (Keohane 1984, pp-116). The climate change related behaviours can be easily modelled under game theoretic framework. “Game theory is concerned with the actions of individuals who are conscious that their actions affect each other” (Rasmussen 1992, pp-21). Thus, In the next section, literature on game theoretic experiments are discussed.

3.1. Previous Experiments and Climate Change

Milinski et al (2006) conducted a lab experiment focusing on the issue of expert information about climate as well as opportunity to build a reputation and showed that cooperation is enhanced in the treatment in which participants were well informed about climate, and it was also enhanced in the "public rounds" in which participants built a reputation and experienced the costs or benefits of that reputation in the indirect reciprocity game. Milinski et al (2008) confirmed a threshold public good game on risk perception and the results of the experiment the difficulty of collectively dealing with even high levels of risk. Another lab experiment by Tavoni et al (2011) studied inequality and communication in a threshold public good game and showed that while inequality made it difficult to achieve cooperation, communication cause success in cooperation and meeting the threshold. Milinski et al (2011) studied inequality and intermediate climate targets in another threshold public good game. Jacqet et al (2013) conducted an experiment focusing on intragenerational and intergenerational time discounting and found that majority of groups cooperated when the benefits were paid out the next day. However, five of these experiments were done on a population sample from Germany and only one was done on a population sample from South Africa.

Yamagishi (1988) and Fehr and Gachter (2002) have shown that sanctions, even costly to the punisher, work as a mechanism to enforce cooperation. Effect of punishment, however, depends on the society: in particular, Russians have shown to exhibit large share of antisocial (spiteful) punishments (Herrmann et.al, 2008)

In general, people are known to be reasonably good at reaching disequilibrium cooperative decision (Ostrom et al., 1993); however, in case of global disagreements, coordination in social dilemmas may be difficult (Kass et al, 2015). Barrett and Dunnenberg (2012), Milinski e.a. (2009) and others discuss the role of coordination in climate-change issues, and show experimentally that cooperation is feasible, even under conditions of payoff uncertainty and free-riding. A large literature (Chen and Li, 2010; Grimalda et al, 2016) also shows that social image may be more important than sanctions to promote cooperation.

3.2. Public Good Provision and Climate Change

There are two lines of literature regarding the public good provision game. One is called the "linear" public good provision game[10]. The linear game asks subjects to allocate a certain number of tokens between a private fund that benefits only the individual investor and a group fund that generates profits for everyone. which is the voluntary provision mechanism. The other line of literature uses the provision point mechanism to provide the public good in a discrete unit (e.g., Alboth, Lerner, and Shalev 2001; Laussel and Palfrey 2003; Schram, Offerman, and Sonnemans 2008). The provision point mechanism evolves from the binary public good game that asks individuals to make decisions on whether to contribute toward a public good. The provision point mechanism can also relax the dichotomous choice constraint so that each subject can make a continuous offer (Cadsby and Maynes 1999). The public good is funded if the aggregated offers reach or surpass the predetermined cost. The linear public good game asks participants to act against their own best interest, at the margin. In contrast, the provision point mechanism, at least in principle, enables participants to contribute toward provision up to their marginal benefit. Thus, the provision point mechanism could enable contributors to benefit such that their benefit always equals or exceeds their own cost for contribution. The incentive to free ride or cheap ride is then motivated by rent seeking or strategic opportunities to avoid cost partially or entirely. Bagnoli and McKee (1991) find that a provision point mechanism together with money back guarantee can potentially induce Pareto efficient outcomes in a single-unit provision environment.

Significant amount of effort has been given by empirical studies to identify the main factors that affect the likelihood of successful collective action (Ostrom, 2001). In public good experiments (Davis, Holt 1993; Ledyard 1995), as well as in other forms of social dilemmas, it has been established that face-to-face communication produces considerable rises in co-operation (Ostrom and Walker 1997). For example, individuals who are primarily distrusting are more willing to contribute to sanctioning schemes and are likely to be transformed into strong co-operators by the availability of a sanctioning mechanism (Fehr and Gächter, 2000). The fact that face-to-face communication is more efficient than computerised signalling is explained by the language structure and the "intrinsic costs involved in hearing the intonation

[10] For example, Andreoni 1995; Bernheim 1986; Isaac and Walker 1988; Palfrey and Prisbrey 1996

and seeing the body language of those who are genuinely angry at free riders" (Ostrom 2000, pp-141).

4. Public Good Provision: Experimental Models and Assumption

As the focus of the thesis is on voluntary contribution, this chapter provides a detailed discussion of the voluntary contribution mechanism and the type of modification that is adopted for this research experiment.

4.1. Voluntary Contribution Mechanism (VCM)

A simple model is used to describe the central problem with public goods called the voluntary contribution mechanism (VCM) in game theoretic experiments. Arifovic and Leyard (2012, pp- 7) provides a complex modelling of a VCM game, which can be simplified as follows: in a VCM experimental setting, participants are provided with an amount of token as initial endowment (a disposable income), and is given a situation in which they are asked to decide which part of their endowment they would contribute to a group account used to produce units of public good and which part they would keep for themselves. For further clarification, suppose, there are N players and Player i has endowment e_i of tokens and chooses a number x_i to contribute to a public account (choices are simultaneous) keeping $(e_i - x_i)$ to herself. The total earning of the individual player can thus be represented by the following model:

$$e_i - x_i + m \sum_{i=1}^{N} x_i$$

where, m is the marginal per capital return (or MPCR). Marginal Per Capita Return (MPCR) or marginal per capita income is the ratio of profit from one payment unit invested in public goods and the opportunity cost of investing of that unit (Holt, 2005: pp- 293).

Considering only two players, standard VCM can be modelled as the Prisoner's dilemma, where each player makes his/her decision whether to contribute to a public good or not. The dominant strategy of both players in this case is not to contribute to the public good and the game results in single Nash equilibrium corresponding to a situation where no one contributes anything (and the public good is not provided) (Davis, Holt, 2003).

If, 1/N < m < 1 this is a public goods problem. Consider an example where there are N = 4 players, and everyone is endowed with 100 tokens and the MPCR is m = 0.5, What are the efficiency implications? If everyone keeps tokens to themselves, each earns 100 while if everyone contributes, each earns 0.5 × 4 × 100 = 200. But, this is not the Nash equilibrium. Modelling a standard VCM with two players as Prisoner's dilemma, where each player makes his/her decision whether to contribute to a public good or not. The dominant strategy of both players in this case is not to contribute to the public good and the game results in single Nash equilibrium corresponding to a situation where no one contributes anything and the public good is not provided (Davis, Holt, 2003). In the example of four players, suppose everyone else is giving the full amount: if one person gives the full amount he/she earns 100 but if the player gives nothing he/she will earn 250, which results in a fall out of cooperation and free riding takes place. Thus, everyone should give zero to the public account in a Nash equilibrium.

Together with the condition regarding m, implies two phenomena typical for the problem of the voluntary provision of public goods (or, more generally, for social dilemmas):

1. The dominant strategy of player i is fully free-rider, i.e., $xj = 0$.

2. The aggregate payoff is maximized if everyone fully cooperates, i.e., $xj = ei$ i for every player i.

Two variables affect payoffs in the basic VCM game: the number of participants and the MPCR. The larger the MPCR, the less people are deviating from best response by cooperating and the less expensive cooperation is. Early investigators hypothesized raising the MPCR would increase cooperation (Bohm, 1972; Dawes et al., 1977). A large N will increase the efficiency of cooperating as every token helps more people, and hence, should increase cooperation; but there is also a chance of coordination failure (or at least make it harder) with larger groups and altruistic motives become less salient in a less personal setting. Thus, cooperation could decrease.

Previous experiments pursued to answer the question like how much people are willing voluntarily contribute for public goods. As shown by Davis, Holt (1993), the usual rate of contribution is between 40-60% of the maximum total group contributions in the first round and the share tends to decrease in the following rounds. Marvell and Ames (1980) provided the results of an experiment using VCM which considerably weakened the conventionally accepted conclusion of the traditional economic assumption the individuals are utility

maximisers and hence will not contribute (as their payoff will be lower if they do). They showed that in a situation of contributing to a public good, in most cases, participants tended to defy the rational theory and did voluntarily contribute to the provision of public good. However, the results of further experiments showed that repeating the game under the given conditions brings almost certainly higher level of free riding than in case of one-shot game (Isaac, McCue and Plott, 1985).

The earlier experiments have shown that it is possible to specify a "usual range" of contribution level to public goods[11]. The presence of the range suggests that the level of voluntary provision can be affected not only stochastically but also systematically. Thus, the positive or negative effect on the contribution amount also depends on the characteristics of such factors that influence contribution. Ledyard (1995) was the first to provide a review of the factors affecting the rate of voluntary contributions to public goods, and divided those characteristics into the three following groups:

1) Environmental factors: number of participants, the degree of economic profitability of free riding, the rate of repetition of the situation or gender.

2) Personal factors: economic education, risk aversion, beliefs, innate altruism, experience, learning effect, identification of oneself with a group, etc.

3) Factors associated with the nature of the experiment, that is, factors defining the particular form of the environment and the mechanism: the possibility of communication or punishment.

4.2. Threshold Public Good Game

To increase contribution, variation in the payoff structure can be induced in the VCM by introducing a specified threshold (Holt, 2005: pp- 301). With a threshold, or provision point, the provision of a public good is conditioned by some minimal amount of contributions. Unless this amount is collected, the public good is not provided. This modification changes the theoretical equilibrium, and even the type of game: Suppose, a public good will only be provided if a sufficient amount of money, T is invested. Contributions to the public good

[11] Summary of experiments carried out up to 1995 is presented by Ledyard (1995), experiments using meta-analysis are summarized by Zelmer (2003), experiments examining the conditional cooperation are summarized by Chaudhuri (2008).

generates the same amount as before but only if $x_i \geq T$. This family of mechanisms is sometimes referred to as a threshold public good or a pivot point mechanism (Isaac, Schmidt and Walker, 1989). There are several variations that alter what happens to contributions higher than the threshold. The threshold public good game can be run with varying provision point, along with different rebate or 'money back' treatments. In case of failing to meet the threshold, two basic mechanisms of further behaviour can be offered: either the funds given for public goods are considered lost and contributors will not be refunded, or participants are ensured that if there are not enough funds contributed to the public good, the invested funds will be returned to the contributors.

Introducing a threshold mechanism to the voluntary contribution mechanism, causes the occurrence of two optimal Nash equilibriums:

1) A group of inefficient Nash equilibriums where the threshold is not reached and the public good is not provided, and,

2) A group of efficient equilibriums corresponding to a situation where the threshold is just reached, a public good is provided, and the entire group behaves efficiently.

Number of such equilibria increases with the number of participants. Croson, Marks (2000, pp-3) formulates the conditional models that serves as the conditions to satisfy the Nash equilibrium in a threshold public good game:

$$\sum_i \sigma_i = K \quad \text{(i)}$$

$$\sigma_i \leq v_i \quad \text{(ii)}$$

where K is the cost of providing the public good (threshold level), σ_i is a contribution of a player i to a public good and v_i is individual valuation of the given public good by the player i. The explanation behind these conditions is that, since each of the participants can contribute with a different amount, Nash equilibrium is constituted at individual contributions where the threshold is reached exactly, and the sum of contributions equals the costs of a public good, and where none of the individuals contributes more than his own valuation of the public good is. Provision point could serve as a focal point leading to high contributions or could drive people from making even modest contributions.

It is possible to observe where the sum of contributions to the threshold limit meets in case of repeated games, which consequently enables to point out the optimal Nash equilibrium.

Based on the theory developed by Bagnoli, Lipman (1989), that does not mean that a free riding behaviour does not exist in a threshold provision game. The theory only implies that with the gradual increase in the threshold it is possible to expect an increase in contributions, given that the threshold is lower than the overall benefit of potential contributors.

5. Experimental Design

As mentioned in Chapter 1, for a country to be able to meet the set goals in the Paris Agreement, cooperation from the private actors are essential. The intention of the thesis is to be able to take into account some of the more practical climate change policy scenario. The objective of the study is to address some of those real-world factors by means of laboratory experiment. Hence, the experimental design is required to imitate the real-world scenario as closely as possible. The factors and the mechanisms used to reflect them are as follows:

1: If national/domestic level actors can cooperate to meet climate change abatement targets set by the international body.

In the laboratory experiment, it is done by providing different provision points (to depict set targets), in which, the group members must cooperate to reach an investment threshold together for sanction and if the group's total investment does not reach the threshold, the money invested will be lost.

2: If private actors act altruistically to meet the high ambition of emission control by forgoing their own earnings to meet the high investment demand towards climate change abatement.

This is done in the experiment by providing increasing threshold/provision points which depicts increasing risk in investment (chances of losing more money if others in the group does not invest enough to meet the targets).

3: Does the cooperation differ on a domestic level (where the population belongs to the same country) and on a global level (where people from different countries must cooperate with each other).

The experimental setup is done by dividing the participants into two groups, where one is a culturally homogenous group and the other is a culturally heterogenous group. The two groups are given the same situations through-out the experiment so that their responses can be observed in the same environmental setting.

4: Different nations display different levels of climate change belief and/or scepticism and people's belief regarding global climate change consequences might display a national/cultural bias. Does cultural belief influence the level of cooperation?

In order to empirically measure their cultural biases in the lab, a short survey will be conducted after the experiment in which the participants have to record their demographic information and respond to ten sentences regarding climate change risk perception, government role, environmental belief, human rights and global cooperation on Likert scale of agreeableness/disagreeableness.

To sum up, the experimental design is that of a threshold public good game, in which, they are provided with an initial endowment to invest in the provision of a public good. The game is repeated in several rounds with increasing provision points. The participants are selected as such that at least one group comprises of individuals who belongs to the same nationality. In order to represent national and global contribution, and to realize the effect of communication on cooperation, the game is played in two stages:

- The first stage: In the first stage, individuals are expected to cooperate for the provision of the public good without communicating with their group members. This stage of the game is representative of domestic/national effort where individuals are required to make the decision to invest in public good or to maximize their own income. There are 10 rounds in this stage, the first 5 rounds are with low provision points and the next 5 rounds have increased provision points.
- The second stage: Cooperation effort in the second stage is representative of global effort. This part of the game too is comprised of 10 rounds, except there is a treatment factor added: the group members can communicate with each other before choosing to invest. The provision point in this stage is also increasing but at a higher rate than that of stage 1.

Individual payoff is realised according to the following model:

$$e_i = (t_i - x) + R_{pp}\ , \qquad 0 \leq x \leq t_i$$

Where, e_i is individual earning, t_i is total initial endowment, x is amount invested by player i and R_{pp} is provision point return which is realized if the total group investment is greater than or equal to the threshold provision points.

A short survey will be conducted after the experiment (20 rounds) in which the participants are asked to record their demographic information, along with their response on ten sentences on Likert scale (agree/disagree). The survey questionnaire was constructed based on the survey questionnaire of Robert E. O'Connor et al (1999) which was made to examine the relationship between risk perceptions and willing-ness to address climate change. However, only the parts of the questionnaire that is relevant to this study is selected. That is, ten statements are selected from the original questionnaire which consisted of three statements on risk perception; four statements on governments' role, of which, two were positively framed and two were negatively framed; two statements on environmental belief; one on human rights and one on cooperation.

5.1. Experimental Predictions

Based on the results of previous experiments as reported from Chapter 2 through 4, as well as the design of the experiment, the following predictions are made for this experiment:

1) Cooperation will decrease with an increase in number of rounds. As mentioned in Chapter 4, Section 4.1, repetition of the game will tempt an increase in free-riding.

2) Once high cooperation is met, the following rounds will have high level of cooperation as well due to reciprocal behaviour. Similarly, rounds in which more people defect, will be followed by rounds with high level of defection.

3) Communication will cause a rise in cooperation level, that is, average cooperation in the second stage of the game in every round will be higher compared to that of stage one as players will be concerned about reputation as a defector among their group members.

4) Individuals with higher agreeableness to the risk perception statements will tend to have higher average investment.

5) Individuals with higher agreeableness to the positive government role statements will have higher average investment. Similarly, individuals who are more agreeable with the negative government questions will have lower average investment towards the public good provision.

5.2. Hypothesis

Considering an experimental setting with target population sample from China and United States, and the stated assumptions so far, the following hypotheses are constructed:

- Hypothesis 1: Both population sample will have a decreasing rate of contribution with an increase in rounds.
- Hypothesis 2: Effect of communication will be undermined by rebate rules (money back guarantee will induce higher cooperation while no money back guarantee will cause defection even after communication)
- Hypothesis 3: Groups with high agreeability to risk perception, environmental belief, human rights and global cooperation statements will have higher average investment, hence more cooperative.
- Hypothesis 4: Groups with higher agreeability to positive statements on government roles/ high disagreeability to negative statements on government roles will reach higher threshold.

6. Pilot Experiment

A pilot for the experiment was done on 26 March 2018 at University of Tampere. The initial sample population targets were of people from China and Americans living in Tampere. Invitation to volunteer for the experiment was sent out through social media groups and personal contacts and it was declared that there would be a monetary reward. However, due to the lack of American participants, the sample population consisted of 7 Chinese participants, and 7 participants from America and Europe. Thus, the one group of culturally homogeneous participants were represented by the Chinese sample population (Group 1) and the rest of the participants belonged to the culturally heterogeneous group (Group 2). All 14 participants were provided with clear instructions on the experiment, which came along with a declaration that the experiment was solely for the purpose of this master's thesis study and enabled them to leave at the beginning of the experiment (Appendix A).

6.1. Experiment Set-up

A pilot for the experiment was done on 26 March 2018 at University of Tampere. The initial sample population targets were of people from China and Americans living in Tampere. Invitation to volunteer for the experiment was sent out through social media groups and personal contacts and it was declared that there would be a monetary reward. However, due to the lack of American participants, the sample population consisted of 7 Chinese participants, and 7 participants from America and Europe. Thus, the one group of culturally homogeneous participants were represented by the Chinese sample population (Group 1) and the rest of the participants belonged to the culturally heterogeneous group (Group 2). All 14 participants were provided with clear instructions on the experiment, which came along with a declaration that the experiment was solely for the purpose of this master's thesis study and enabled them to leave at the beginning of the experiment (Appendix A).

The experiment was conducted on an online interface designed and written by Charles Holt. For access, the participants had to log in to game sessions on the website: http://veconlab.econ.virginia.edu/login.htm with different session names for the two stages of the game, instructions for which were included in the experiment instruction provided in Appendix A.

The reward payment was in Euros and the conversion of the electronic amount was clearly mentioned in the instruction. The reward was due to the highest earners of the groups in each stage. The electronic amount is converted as follows:

1 electronic currency = 1 x 0.10 Euros

There was no show up fee. However, there was no restriction on the maximum amount that can be earned either.

6.3. Hypothesis

Based on the set up and sample population structure, the previously stated hypothesises are reformed as follows:

1) $H0_1$: Defection will occur at a higher rate in Rounds 6 to 10 in both stages due to high threshold points.

2) $H0_2$: Communication will increase average investment in all rounds of Stage 2

3) $H0_{3\text{-}1}$: Average investment will be higher in Stage 2 Rounds 1 to 5 due to the rebate rule of return

$H0_{3\text{-}2}$: Effect of communication in Stage 2 Rounds 6 to 10 will be lower as rebate rule of return is removed and risk of losing money is increased.

4) $H0_{4\text{-}1}$: Individuals/groups with a more agreeable risk perceptions of climate change have higher average investment/is more cooperative (positive correlation between the agreeable score on risk perception and the investment in high threshold public good).

$H0_{4\text{-}2}$: Group displaying lack of trust in Government Role in dealing with climate change will tend to contribute less.

6.4. The Game: Treatments and Pay-off

The experiment consisted of a total of 20 rounds. In each round, the participants were matched with the same group of six other people. The amount earned by each participant is determined by the decisions that the group seven make.

In the first treatment of the first stage of the game, there were 5 rounds, and in all rounds participants began with a new endowment of 25 tokens, each of which could either be kept or invested. All seven people in the group were provided with the same amount of token. Everybody earns money in the same manner: $0.10 for each token kept, and a per-person fixed payment that depends on the total number of tokens invested by the seven people. The range of total group investments and provision points in Stage 1, Rounds 1 to 5 are given in table 1:

Table 1: Stage1: Treatment 1: Rebate=No

Range of Total Group Investments:	below 30	reached 30, but below 60	reached 60 or above
Provision-Point Return:	$0.00	$5.00	$10.00

According to the payoff model (in Chapter 5), the individual payoff can be realized in three ways, given the provision points and provision point returns. Thus, in Stage 1, Rounds 1 to 5 three possible individual pay-off structures are represented in the following table:

Table 2: Stage 1, Rounds 1 to 5: Individual Payoff Structures

Group Investment Range of all 7 players	**Individual Earnings e_i , $(0 \leq x \leq 25)$**
Total Group Investment ≤ 30	$e_i = [(25 - x) \times 0.10] + 0$
30 ≤ Total Group Investment ≤ 60	$e_i = [(25 - x) \times 0.10] + 5$
Total Group Investment ≥ 60	$e_i = [(25 - x) \times 0.10] + 10$

The second treatment of Stage 1 of the game was imposed in the Rounds 6 to 10. Everything else remained same, except, they were presented with four investment options with increased provision points as shown in table 3:

Table 3: Stage1: Treatment 2: Rebate=No

Range of Total Investments:	below 70	reached 70, but below 140	reached 140, but below 210	reached 210, or above
Provision-Point Return:	$0.00	$5.00	$10.00	$15.00

The individual payoffs are realised in the same way as was in Rounds 1 to 5. The table below presents the possible payoffs:

Table 4: Stage 1, Rounds 6 to 10: Individual Payoff Structures

Group Investment Range of all 7 players	**Individual Earnings e_i , $(0 \leq x \leq 25)$**
Total Group Investment ≤ 70	$e_i = [(25 - x) \times 0.10] + 0$
70 ≤ Total Group Investment ≤ 140	$e_i = [(25 - x) \times 0.10] + 5$
140 ≤Total Group Investment ≤ 210	$e_i = [(25 - x) \times 0.10] + 10$
Total Group Investment ≥ 210	$e_i = [(25 - x) \times 0.10] + 15$

After the first ten rounds, the participants were asked to log in to a different session to play for Stage 2. The first 5 rounds in the second stage had the same investment options and provision point returns as that of Rounds 1 to 5 in Stage 1 (table 5):

Table 5: Stage2: Treatment 1: Rebate=Yes

Range of Total Group Investments:	below 30	reached 30, but below 60	reached 60 or above
Provision-Point Return:	$0.00	$5.00	$10.00

However, the participants could communicate with their group members and coordinate the investment if they wished to do so. The participants were given five minutes to discuss before investing. In Rounds 1 to 5, the treatment of rebate was also introduced. That is, if the total group investment did not reach any threshold/provision point, any tokens invested was returned to participants and they earned $0.10 on each of those returned tokens. The possible individual payoff structures for Stage 2, Rounds 1 to 5 are given in the following table:

Table 6: Stage 2, Rounds 1 to 5: Individual Payoff Structures

Group Investment Range of all 7 players	**Individual Earnings e_i , $(0 \leq x \leq 25)$**
Total Group Investment ≤ 30	$e_i = (25 \times 0.10) + 0 = 2.5$
30 ≤ Total Group Investment ≤ 60	$e_i = [(25 - x) \times 0.10] + 5$
Total Group Investment ≥ 60	$e_i = [(25 - x) \times 0.10] + 10$

In Rounds 6 to 10 of the second stage of the game, the participants were given a new endowment of 50 tokens and the rebate was removed from the treatment. That is, tokens were not returned upon failure to meet any provision point. The participants were again allowed to communicate with their group members for 5 minutes before investing and the provision points were increased along with the range of total group investment options as shown in table 4:

Table 7: Stage2: Treatment 2: Rebate=No

Range of Total Group Investments:	below 70	reached 70, but below 140	reached 140, but below 210	reached 210, but below 280	reached 280 or above

Provision-Point Return:	$0.00	$5.00	$10.00	$15.00	$20.00

The payoff structure for Rounds 6 to 10 in stage 2 for each provision point is summarized in table 8. As the provision point was raised, the initial endowment also had to be raised (from 25 tokens to 50 tokens) in order for the participants to be able to reach the threshold successfully.

Table 8: Stage 2, Rounds 6 to 10: Individual Payoff Structures

Group Investment Range of all 7 players	**Individual Earnings e_i , $(0 \leq x \leq 25)$**
Total Group Investment ≤ 70	$e_i = [(50 - x) \times 0.10] + 0$
70 ≤ Total Group Investment ≤ 140	$e_i = [(50 - x) \times 0.10] + 5$
140 ≤Total Group Investment ≤ 210	$e_i = [(50 - x) \times 0.10] + 10$
210 ≤Total Group Investment ≤ 280	$e_i = [(50 - x) \times 0.10] + 15$
Total Group Investment ≤ 280	$e_i = [(50 - x) \times 0.10] + 20$

The game lasted for 2 hours as the participants were allowed to go on their own pace to complete each round. After the game, the survey was conducted. In order to answer the survey questions, the participants were asked to log in a different session on the same website. After the whole experiment was done, the winners (one from each group) were announced and paid through bank transfer.

In the next Chapter, the results are presented along with the analysis of both stages of the game.

7. Results and Analysis

The pilot experiment had a sample population of 14 participants but only 4 were male and 10 were female. On the other hand, all the participants were within the age range of 20 to 30 except one. Thus, controlling for age is also not possible. As an analysis controlling for gender and age with such a small and skewed population sample is unlikely to offer any conclusive results, these control factors are omitted in the analysis.

In this Chapter, I will focus on several questions in accordance with the hypotheses stated in section 6.3. In Section 6.5.1, I present the analysis of the experiment results, which includes overall contribution rate of both groups in both stages, and in Section 6.5.2 the survey data is analysed in comparison of contribution levels of the two groups.

7.1. Experiment Data analysis

In this section, the analysis focuses on the first three hypotheses mentioned in section 6.3.

Figure 1 and 2 represents the average contributions of Group 1 and 2 respectively. In the figures, the straight lines represent the provision points to be met by the total group contribution to get threshold returns. Each of these lines are the socially optimum equilibrium. Each dot of the scatter plot is the average group contributions per round.

Figure 1: Group 1 Average Voluntary Contribution: Stage 1, Rounds 1 to 10

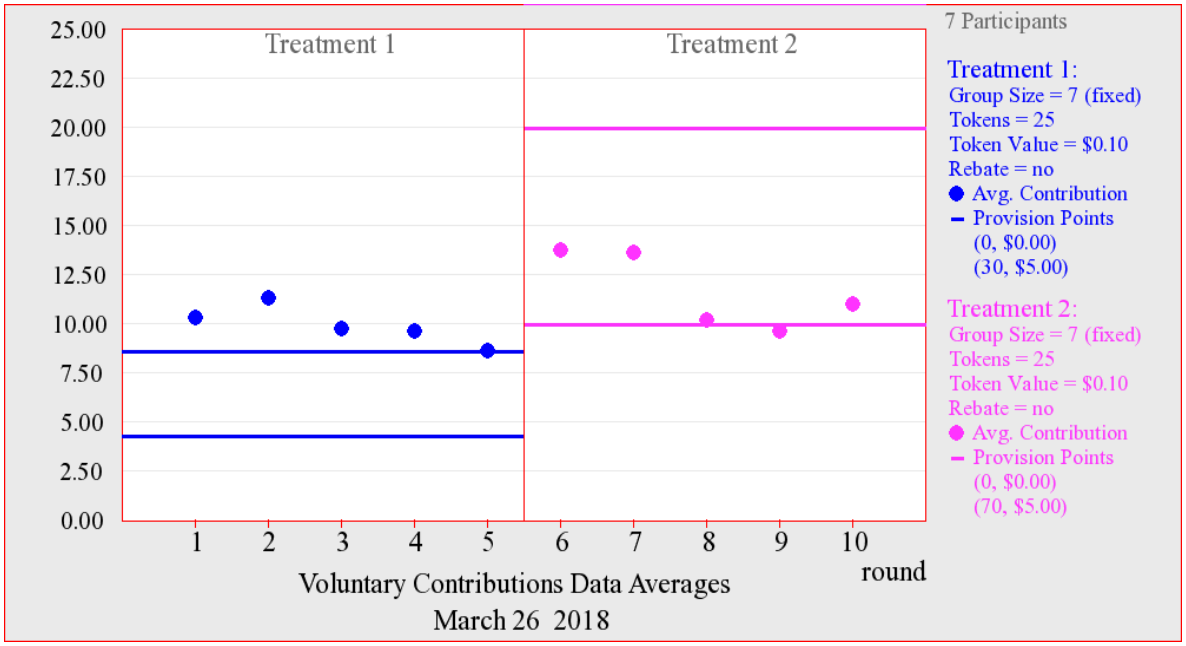
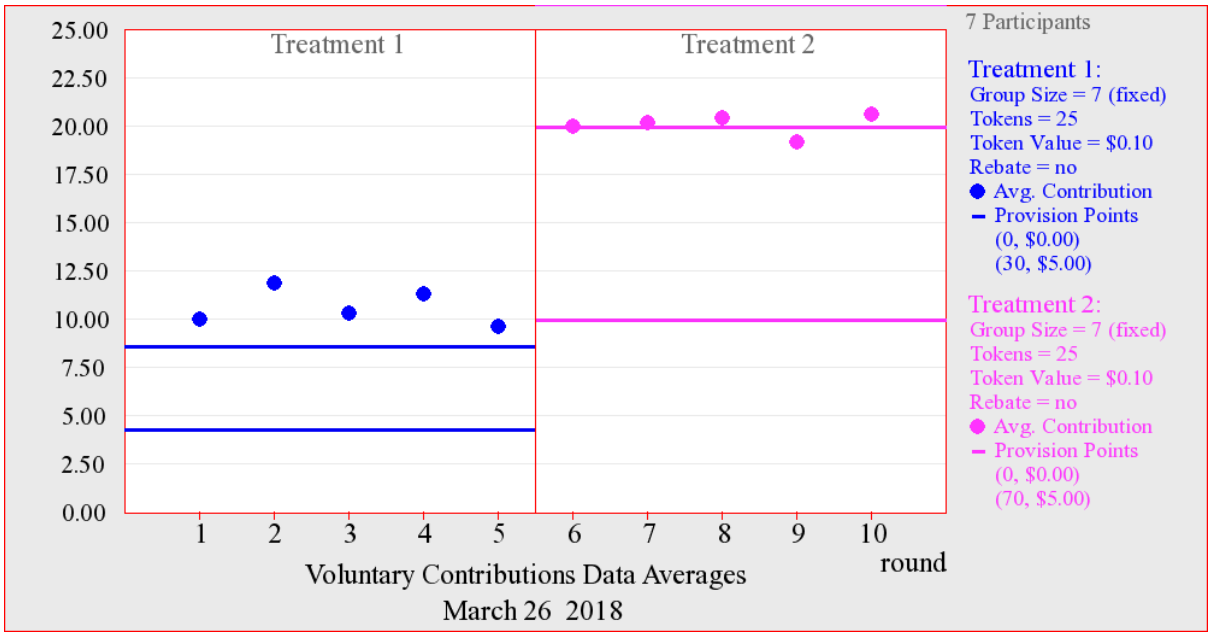


Figure 2: Group 2 Average Voluntary Contribution: Stage 1, Rounds 1 to 10



Looking at the data, it can be seen that both groups contributed more than required amount for the highest provision point (the socially optimum equilibrium). Nevertheless, the data shows that both Groups shows a tendency to diverge towards the equilibrium point by the 5th round, but only Group 1 was able to meet the equilibrium in the 5th round, while Group 2's average contribution was still higher than the equilibrium.

The second treatment (Rounds 6 to 10) represents an increment in the threshold for provision point return, that is, in these rounds, the socially optimum equilibrium requires higher group contribution. The average group contribution of Group 1 in Rounds 6 and 7 was higher than the lower threshold but shows a tendency to diverge to the lowest threshold in Rounds 8 to 10. On the other hand, Group 2 was more successful in reaching the highest threshold, that is, Group 2 could meet the highest socially optimum equilibrium in most rounds from Round 6 to 10, except in Round 9 where they marginally fail to meet the equilibrium contribution point.

At this point, two claims can be made:

1) Group 2 (the culturally heterogenous group) demonstrates a tendency to contribute to the highest threshold. Group 1 (the culturally homogenous group) shows a tendency to deviate to the lowest threshold and failed to meet the highest socially optimum equilibrium in all rounds in the second treatment.

2) Cooperation was successfully achieved without communication by the culturally heterogenous group, but not by the culturally homogeneous group.

Figures 3 and 4 presents the average voluntary contribution of Group 1 and Group 2 respectively in the second stage of the game in which they could communicate before investing for the provision of the public good. The communication took place twice: once before playing for Rounds 1 to 5 and another time before playing for Rounds 6 to 10. Along with the factor of communication, the rebate rules were different for treatment 1 and treatment 2, in that, treatment 1 had a rebate rule of return but treatment 2 did not. Round 1 to 5 in this stage had the same threshold points as that of Rounds 1 to 5 in Stage one. However, from Rounds 6 to 10, the participants were provided with four provision points as can be seen in the figures 3 and 4.

Figure 3: Group 1 Average Voluntary Contribution: Stage 2, Rounds 1 to 10

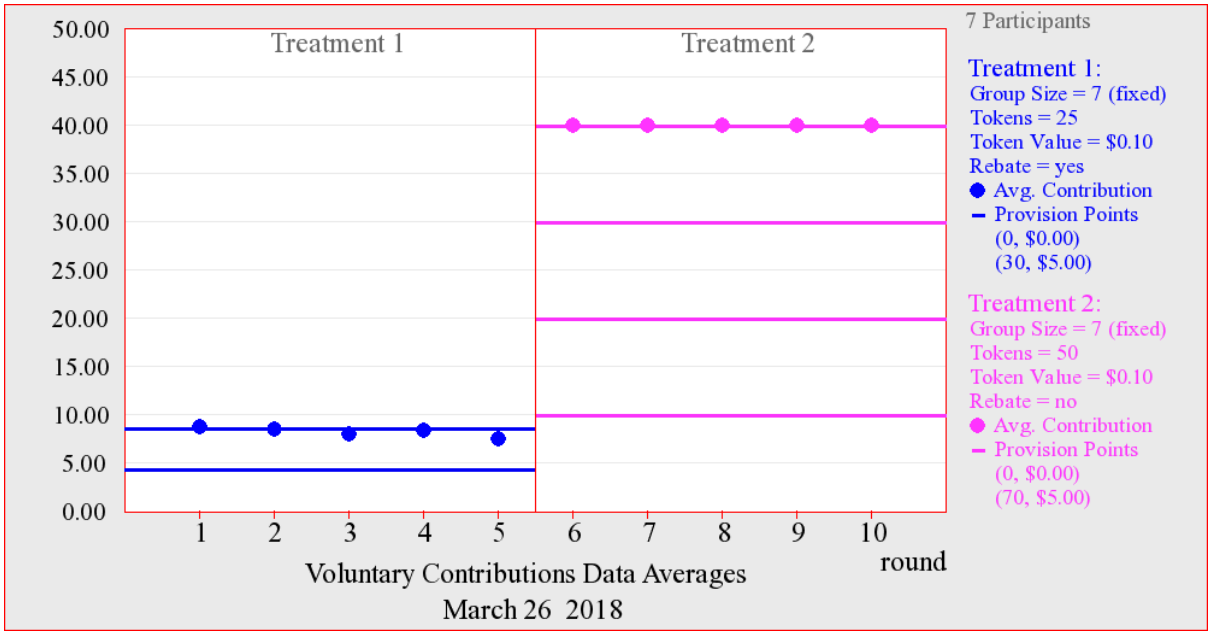
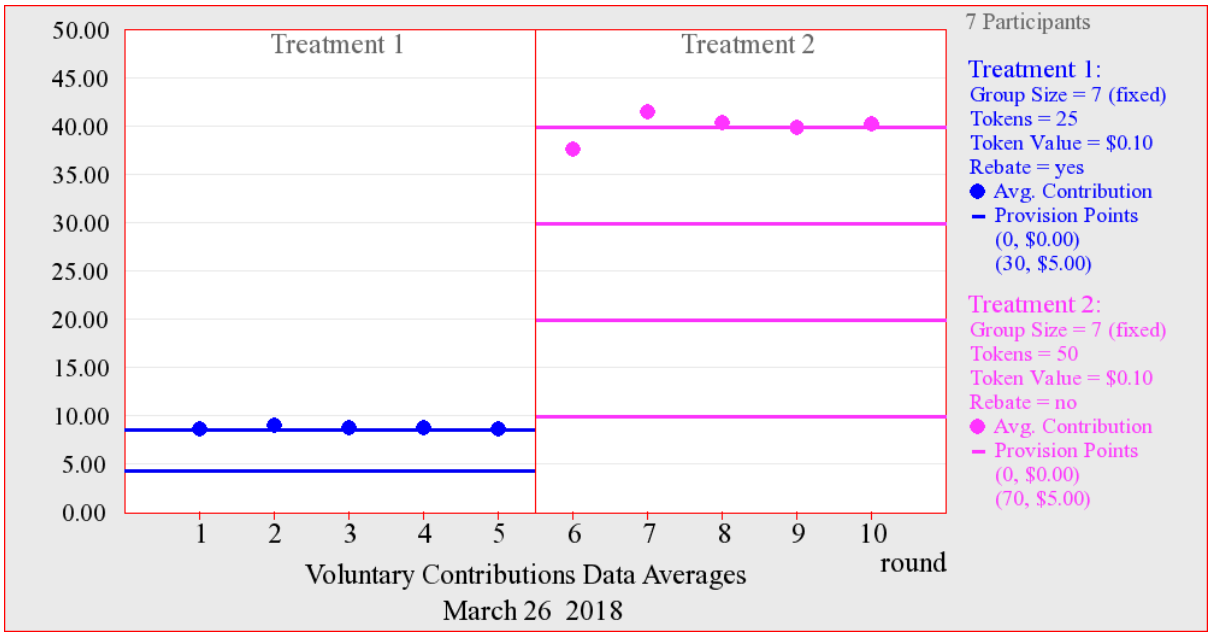


Figure 4: Group 2 Average Voluntary Contribution: Stage 2, Rounds 1 to 10



The results of the second stage favour the prediction that cooperation will increase due to communication as can be seen in both Figures 3 and 4 that both groups contributed towards the highest threshold and was able to operate at the socially optimum level.

In round 6, group 2 failed marginally to meet the highest threshold which points towards the existence of defection. However, the subsequent rounds show that there was no tendency of punishment as the group managed to contribute more than the threshold requirement.

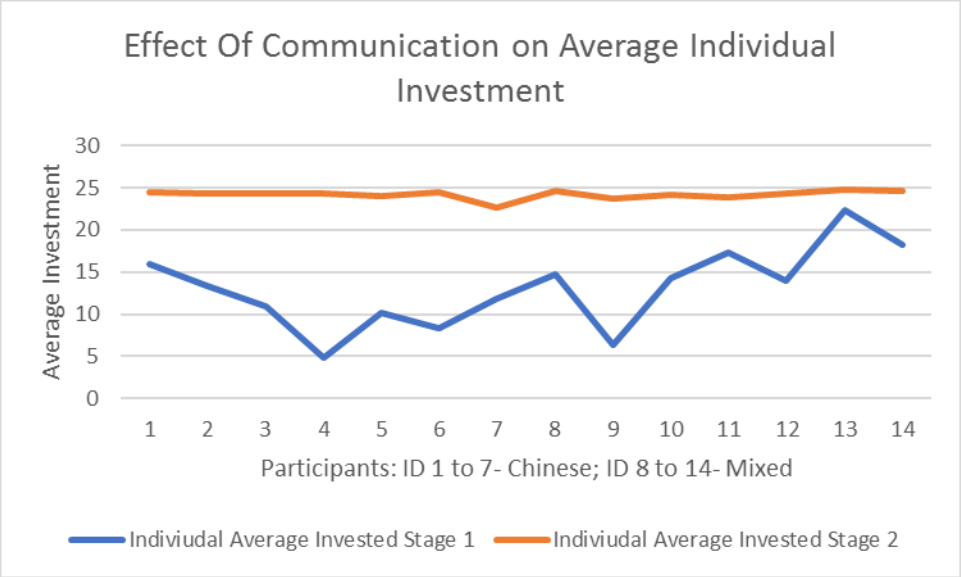
The results of Group 1 at this stage demonstrates that they were able to contribute the exact amount for the socially optimum output from Rounds 6 to 10. At this point, the hypothesis *$H0_1$: Defection will occur at a higher rate in Rounds 6 to 10 in both stages due to high threshold points* can be rejected.

While in Rounds 1 to 5, it was Group 2 who's contribution remained at the socially optimum equilibrium and Group 1 shows a slight tendency to defect in Round 5. One explanation for this would be that the rebate rule of money back increased cooperation in Group 2 but did not eliminate the tendency of defection in Group 1. This can also be verified from the failure of meeting the highest provision point by Group 2 in round 6 when the rebate rule was again change to 'no return'. However, while it may suggest that difference in rebate rule have an effect on individual contribution level, it does not undermine the effect of communication as both groups were able to contribute at the socially optimum level in the subsequent rounds.

Thus, the hypothesis *$H0_{3\text{-}2}$: Effect of communication in Stage 2 Rounds 6 to 10 will be lower as rebate rule of return is removed and risk of losing money is increased* is rejected.

Moreover, to know whether cooperation was achieved or not due to the treatment factor of communication, it is important to look at individual average contributions in the control stage (Stage 1) and the treatment stage (Stage 2). The difference in individual average contribution is the two stages are presented by Figure 5 below:

Figure 5: Effect of Communication on Average Individual Contribution in both stages



In Figure 5, individual average contribution in Stage 1 through Rounds 1 to 10 is represented by the blue line and individual average contribution in Stage 2 through Rounds 1 to 10 is represented by the yellow line. From this result, it can be said that while some players were more generous regarding their individual contribution level in the control stage (stage 1), the treatment effect of communication in Stage 2 clearly shows cooperation in terms of average individual contribution. Thus, we accept the hypothesis *$H0_3$: Communication will increase average investment in all rounds of Stage 2*

Although, the total group contribution reduced in Rounds 1 to 5 in Stage 2 from that of Rounds 1 to 5 in Stage 1. Individual contribution per stage, along with the difference in contribution is given in table 9. It is worth noting that in introducing the factor of communication, all other factors being held equal, participants of both groups reduced their amount of contribution. More precisely, in case of the Chinese population sample, the contribution level reduced by 17.34% upon the introduction of communication in the 1st five rounds of Stage 2 when all else were held equal to that of Stage 1. In case of the mixed western population, the

contribution level reduced by 17.79% under the same scenario. However, the contribution level was increased from Rounds 6 to 10 in Stage 2 upon introducing higher threshold level. Which means, participants had a clear tendency to cooperate for the provision of the high cost public good. Here, the hypothesis *$H0_{3\text{-}1}$: Average investment will be higher in Stage 2 Rounds 1 to 5 due to the rebate rule of return* is rejected.

Table 9: Change in total Contributions in Rounds 1 to 10 for both Stages.

Round	Group 1, Stage 1 Total	Group 2, Stage 1 Total	Group 1, Stage 2 Total	Group2, Stage 2 Total	Change in contribution: From Stage 1 to Stage 2: Group 1	Change in contribution: From stage 1 to Stage 2: Group 2
1	72	70	61	60	-11	-10
2	79	83	59	63	-20	-20
3	68	72	56	61	-12	-11
4	67	79	58	61	-9	-18
5	60	67	52	60	-8	-7
6	96	140	280	263	184	123
7	95	141	280	290	185	149
8	71	143	280	282	209	139
9	67	134	280	279	213	145
10	77	144	280	281	203	137

As the sample size is small, a t-test using paired two sample-mean was conducted to determine the mean difference of contribution decision of each group in the two stages. Table 10 summarizes the result for Group 1's contribution in the two stages and Table 11 summarizes the statistics for Group 2:

Table 10: t-Test: Paired Two Sample for Mean: Group 1: Stage 1 and 2

Group 1	Stage 1	Stage 2
Mean	75.2	168.6
Variance	143.0666667	13794.04444
Observations	10	10
Pearson Correlation	0.534658281	

Hypothesized Mean Difference	0	
Df	9	
t Stat	-2.648653491	
P(T<=t) one-tail	0.013267349	
t Critical one-tail	1.833112933	
P(T<=t) two-tail	0.026534698	
t Critical two-tail	2.262157163	

Table 11: t-Test: Paired Two Sample for Mean: Group 2: Stages 1 and 2

Group 2	**Stage 1**	**Stage 2**
Mean	107.3	170
Variance	1243.566667	13245.11111
Observations	10	10
Pearson Correlation	0.989316447	
Hypothesized Mean Difference	0	
Df	9	
t Stat	-2.467193449	
P(T<=t) one-tail	0.017867216	
t Critical one-tail	1.833112933	
P(T<=t) two-tail	0.035734432	
t Critical two-tail	2.262157163	

Comparing the actual t-test value to the t-Critical two-tail statistic, P (T <= t) two tail (Group 1:0.026534698; Group 2: 0.035734432) gives the probability that the absolute value of the t-Statistic (Group 1: -2.648653491; Group 2: -2.467193449) would be observed that is slightly larger in absolute value than the Critical t value (2.262157163). Since the p-value is greater than 0.05 in both cases, the alternate hypothesis that there is a mean difference is accepted. The Pearson correlation statistic suggests that Group 2 has a more uniform decision in both

stages as it is almost perfectly correlated (0.98), but in case of Group 1, the correlation coefficient is 0.53 which suggests non-uniformity in behaviour of the Group between the two stages.

For a better understanding of the difference in total contribution of the two groups in all ten rounds of both stages, a Wilcoxon Sign rank test was done to verify behavioural differences between the contribution level of the two groups taking similar approach to the game. The box plot of the variances in total contribution are given in Appendix B. The results suggest that there is a significant difference between the two-group's contribution in Stage 1 (p-value=0.006838; Group 1 median= 71.5; Group 2 median=108.5). The difference is reduced to a non-significant level in Stage 2 (p-value=0.1677; Group 1 median=170.5; Group 2 median= 163). This confirms that though the groups were provided with the same situations throughout the game, Group 1's contribution level significantly increased in Stage 2, while Group 2 demonstrated success in reaching the highest threshold in Stage 1. That is, it is evident that the treatment effect of communication was greater on the Chinese participants, while the heterogenous group members could coordinate without communicating.

Thus, at this point, it can be claimed that:

1) In accordance with previous literature of public good experiments, communication significantly increases cooperation, however, it has been proven by establishing both correlation and causation that the effect of communication is substantial in the culturally homogenous group.

2) No significant impact of rebate rule of return/ no return could be determined.

7.2. Survey data analysis

In this section, I analyse the post experiment survey which asked basic questions about the participants, such as, age, gender, nationality, education level and profession. The questionnaire also included 10 statements on climate change beliefs which are presented in table 12 along with the average response score. The purpose of the questionnaire was to control for behavioural biases.

Table 12: Survey Questionnaire: Belief Statements

Beliefs on:	Statements	Average Response Score
Risk Perception	1. Due to climate change, my chances of suffering from a serious disease will increase	2.00
	2. Starvation and food shortages will occur where I live.	3.00
	3. It will be necessary for richer countries to make large donations of financial aid-to poorer countries.	2.50
Government Role	1. Government is almost always wasteful and inefficient in waste management.	2.93
	2. Government often does a better job than people give it credit for.	3.57
	3. Government regulation of business is necessary to protect the public interest.	2.29
	4. Most elected officials don't care what people like me think.	2.29
Environmental Beliefs	1. Pollution generated here harms people and effects the general health of people all over the earth.	1.93
	2. Laws to protect the environment will limit my choices, personal freedom and will threaten jobs for people like me.	4.00
Human Rights	Climate change and its consequences are not human rights issue	4.00
Global Cooperation	Every country needs to contribute to protect the earth.	1.64
Answers on Likert Scale	**1= Strongly Agree 2=Agree 3=Indifferent 4= Disagree 5=Strongly Disagree**	

Descriptive statistics calculation for the summated total score for each statement was conducted using Poisson distribution formulas because of discrete nature of the data which includes central tendency, variability (standard deviation and range), skewness, and symmetry (kurtosis) in order to define agreeable score for the group of participants. That is, mean score, standard deviation, skewness and kurtosis of the response of each group per statement was calculated to determine which group is more agreeable. The detailed statistics are provided in Appendix C. A tabular presentation of which group was found to be more agreeable to each survey statements are provided by Table 13.

Group 1 (participants from China) is found to be more agreeable on the risk perception statements compared to their western counterparts. On the other hand, Group 2 is found to be more agreeable to one of the negative government role statements (Government role statement 1 with probability of agreeability of 77%) while Group 1 is more agreeable to the positive government role statement (Government role statement 2 with probability of agreeability of 58%). This simply reflects China's belief and reliability on their government system. However, both groups had same degree of agreeability on Government role statements 3 and Government role statement 4 (mean=2.28571429 for both groups with probability of agreeability was found to be 80% on both statements).

For the environmental belief statements, Group 2 was found to be more agreeable to statement 1 with a probability of agreeability of 94% and Group 1 was more agreeable in case of statement 2 with a probability of 58%. In case of the global cooperation question, participants of Group 2 provided a uniform distribution (probability of agreeability of 98%) while more people from Group 1 agreed to the human rights statement (probability of 55%).

Table 13: Listing of agreeable group per statement

Statements	*More agreeable Group*
Risk Perception 1	Group 1
Risk Perception 2	Group 1
Risk Perception 3	Group 1
Government Role 1	Group 2
Government Role 2	Group 1
Government Role 3	Same Agreeability
Government Role 4	Same Agreeability
Environmental Belief 1	Group 2
Environmental Belief 2	Group 1
Human Rights	Group 1
Global Cooperation	Group 2

As the aim of the thesis is to establish relationship between contribution estimates and beliefs, after the response pattern of each group to the survey statements are established, the Pearson coefficient is calculated for each group's investment in the two stages of the game with the different categories of belief statements were done separately.

A comparison of the correlation results of Group 1 with Group 2 for each statement is done using Pearson's correlation coefficients. Table 14 summarizes the statistics correlation between risk perception and individual average contribution for both groups in stage one.

A negative correlation means that participants whose response was on the agreement side (1 to 3) of the statements, contributed more or participants whose response was on the disagreement side of the scale (3 to 5), contributed less (as the scale is 1=Strongly Agree to 5=Strongly Disagree).

Group 1 shows a positive correlation with risk perception statement "It will be necessary for richer countries to make large donations of financial aid-to poorer countries" and previously it has been seen that Group 1 was more agreeable to the statement which suggests that participants of the group who agreed to the statement relatively contributed less. On the other hand, all three risk perception statements have a negative correlation with the contributions of participants in Group 2, which means agreeing participants probably contributed more and disagreeing participants contributed less relatively speaking. However, the correlation

coefficients for Group 1 suggests most of the risk perception statements are moderately correlated, and for Group 2, risk perception 1 is weakly correlated but risk perception 2 and 4 are moderately correlated. Although, the p-value suggests the test is insignificant which might be because the sample size is too small.

Table 14: Pearson's Correlation Statistics: Risk Perceptions and Stage 1 Contributions

Average Individual Contribution	Belief Statement	Correlation Coefficient	t-test	df	p-value	Confidence Interval
Group 1 Stage 1	Risk perception 1	-0.1553387	-0.35162	5	0.7395	-0.8132622, 0.6769029
	Risk perception 2	-0.3864674	-0.93697	5	0.3918	-0.8826467, 0.5170768
	Risk perception 3	0.3779914	0.91295	5	0.4031	-0.5243118, 0.8804343
Group 2 Stage 1	Risk perception 1	-0.0613298	-0.1374	5	0.8961	-0.7784359, 0.7252226
	Risk perception 2	-0.2961621	-0.69334	5	0.519	-0.8578878, 0.5880464
	Risk perception 3	-0.42762	-1.0578	5	0.3386	-0.8930846, 0.4800133

In case of the government role statements, the correlation is stronger in general than that of risk perception statements' correlations (table 15). For government role 1, Group 1 has a negative correlation of -0.58 along with the previous finding of the Group being less agreeable in this statement means participants contributed relatively less. For the same statement, Group 2, the more agreeable group, also has a negative correlation but is moderately correlated at -0.21. That is, participants believing that 'Government is almost always wasteful and inefficient in waste management' showed a tendency to contribute more.

For government role statement 2, Group 1 has a positive correlation of 0.16 whereas Group 2 has a negative correlation of -0.29. Though moderately correlated, it suggests that people who

shows more agreeability with the fact that 'Government usually does a better job than people give it credit for' tends to contribute less for the provision of a public good.

As both group's agreement level for government role statement 3 is the same, the correlation between the belief statement and contribution level is 0.66 for both groups. In case of government role 4, which showed same agreement for both groups as well, has a negative correlation of -0.62 with contribution for Group 1 but a positive correlation of 0.20 with contribution for Group 2. This suggests that in terms of Group 1, the more participants agree to the statement, the higher they contribute while in case of Group 2, the more participants disagree, the more is the tendency to contribute. That is, while feeling of insignificant in state official decision-making process have a different effect on contribution level for the two groups.

Table 15: Pearson's Correlation Statistics: Government Role and Stage 1 Contributions

Average Individual Contribution	Belief Statement	Correlation Coefficient	t-test	df	p-value	Confidence Interval
Group 1	Govt. Role 1	-0.5837404	-1.6076	5	0.1688	-0.9285964, 0.3021321
	Govt. Role 2	0.1594655	0.3612	5	0.7327	-0.6746036, 0.8146901
	Govt. Role 3	0.6644945	1.9883	5	0.1035	-0.1772701, 0.9447813
	Govt. Role 4	-0.6206637	-1.77	5	0.1369	-0.9361631, 0.2485793
Group 2	Govt. Role 1	-0.2103999	-0.48124	5	0.6507	-0.8316833, 0.6448267
	Govt. Role 2	-0.2932023	-0.68576	5	0.5234	-0.8570297, 0.5901628
	Govt. Role 3	0.6644945	0.12331	5	0.9067	-0.7281899, 0.7759461
	Govt. Role 4	0.2081056	0.47575	5	0.6543	-0.6462262, 0.8309421

For the environmental belief statement 1 and contribution of Group 1 has a positive correlation of 0.33 and Group 2 has a stronger positive correlation of 0.49. For environmental belief 2, Group 1 has a weakly negative correlation of -0.19 and Group 2 has a moderately strong negative correlation of -0.41. In case of participants' belief that climate change is a human rights issue, Group 1's contribution level with the belief statement shows a stronger negative correlation of -0.67 while for Group 2 the correlation is strong and positive of 0.80. For the human rights statement, the test is significant at p-value<0.05 only for Group 2.

For the statement suggesting that every country should contribute to protect the earth, contribution level and belief on this statement shows a strong correlation of 0.75 for Group with p-value=0.05. For Group 2, it is a perfect correlation at +1 (the results show NA due to the uniform distribution of the standard deviation).

Table 16: Pearson's Correlation Statistics: Environmental Belief, Human Rights, Global Cooperation and Stage 1 Contributions

Average Individual Contribution	Belief Statement	Correlation Coefficient	t-test	df	p-value	Confidence Interval
Group 1	Environmental Belief 1	0.325277	0.76917	5	0.4765	-0.5665618, 0.8661657
	Environmental Belief 1	-0.1898914	-0.43248	5	0.6834	-0.8249782, 0.6571368
	Human Rights	-0.6668043	-2.0007	5	0.1018	-0.9452249, 0.1732500
	Global Cooperation	0.7535877	2.5634	5	0.05044	0.001224548, 0.961180420
Group 2	Environmental Belief 1	0.4890005	1.2535	5	0.2654	-0.4179753, 0.9077745
	Environmental Belief 2	-0.4126667	-1.013	5	0.3575	-0.8893490, 0.4938663
	Human Rights	0.8004063	2.9856	5	0.0306	0.1191908, 0.9692479

	Global Cooperation	NA	NA	NA	NA	NA

Though the majority of the test results are insignificant at p-value>0.05, it can be at least claimed that level of beliefs framed under climate change and contribution level for the provision of public good has a varying correlation for the two groups.

8. Discussion

The results offer some noteworthy differences in group behaviour in a threshold public good game. In contrast to theoretical predictions, participants contributed voluntarily towards the provision of public good and were successfully able to provide socially optimum results. On the other hand, the effect of communication has proved, in accordance with previous literature, to have high significance on the level of contribution and cooperation. However, there was no evidence of punishment in this particular experiment, and whether the cooperation was a result of reciprocity could not be determined either. Contrary to previous experiments and literature, contribution and cooperation in this experiment increased with repetition of the game.

The study has confirmed that a mixed western population sample showed a tendency to contribute towards the highest provision point and were able to cooperate and gain sanction even without having the factor of communication introduced. One might argue that there was a financial incentive in the lab to cooperate. It is worth pointing out that the real payoff structure suggested to win the reward for the game, one must maximise his/her own payoff in the game which stays in line with the equilibrium output and not the socially optimum output in the game. Thus, the study reflects on the fact that for some countries, private sector can efficiently contribute towards the provision of public good.

Upon the introduction of the treatment of communication, the contribution level of the population sample representative of China offered a substantial rise in contribution level. The effect of the treatment is most visible in case of this population sample as there was significant change in contribution pattern and effectiveness in meeting the highest threshold. As discussed in the previous Chapter, total contribution level decreased upon the introduction of

communication when all other factors were held equal (threshold points and initial token endowments) which suggests that communication does not only increase cooperation in terms of meeting provision points, but also reduces inefficiency as less wastage of investment occurred in the rounds after the treatment. On the other hand, it is also demonstrated that participants were more eager to meet the threshold as they increased their contribution in Rounds 6 to 10 in the second stage to invest in the highest provision point. This specific finding is in contradiction with previous finding of cooperation and contribution to public provision reduces in repeated games with increased number of rounds. This may also suggest that the image of a co-operator matters when relationship is established among the group members. The factor of maintaining a good-will among social members plays a role, probably more so in some nations than others.

In case of cultural beliefs, it has been shown that there is a correlation between contribution level and different categories of beliefs. Particularly, people who believe that climate change influences their personal lives (risk perception), tends to contribute more than those who does not share the same level of belief. On the other hand, participants who showed more trust towards the government (positive government role statements: 1 and 4), tended to contribute less while participants who showed lower level of trust in the role of government (negative government role statements: 2 and 3) demonstrated a tendency to contribute more to the provision of public goods. For example, participants with a more agreeable response to the statement 'Government is almost always wasteful and inefficient in waste management', contributed more and majority of the participants sharing this perception belonged to the culturally heterogenous group. On the other hand, participants whose response was more agreeable with the statement: 'Government usually does a better job than people give it credit for', contributed less and the majority of the participants sharing this view belonged to the culturally heterogenous group.

Additionally, the unanimous agreement on global cooperation by the heterogenous group implies that the expectation of global cooperation in terms of climate change is higher among the western population, while disagreements could be seen among the Chinese population sample. This submits to the developed vs developing nation arguments regarding global climate change cooperation. However, that is a whole other topic!

8.1 Limitations and Biases

The thesis has proved significant differences in behaviour of homogenous and heterogenous groups in a repeated threshold public good game. However, the experiment had a few limitations and biases which were due to geographical and financial constraints.

First, the homogeneous group in the experiment was meant to be representative of national population, but the participants in the experiment were currently residing in Tampere, Finland. This is likely to have an effect on participants perception and behaviour. Finland being one of the highly committed nations in abating climate change consequences[12], living in the country can be expected to have significant behavioural and belief impacts. Hence, a considerable bias in the behaviour of the participants in this experiment is expected. Second, a more comparative analysis regarding cultural beliefs could be done if the experiment was done between two culturally different groups, that is, instead of the culturally heterogenous group, a separate culturally homogenous group being compared to that of the Chinese group would have provided more conclusive results on cultural beliefs and the differences. For example, if the study was done with one group from US and the other from China, more conclusive results could be provided on how individual perspectives/beliefs effects contribution level and cooperation in the lab. Third, the lack of randomization in the sample restricted any sophisticated analysis of the results. A small sample size also contributed to this issue. Fourth, due to time constraints, the survey questions were kept at minimum. A more intensive questionnaire would have amplified the scope of the study. Fifth, the sample population had a gender bias as the majority of the participants were female. A sample population with more male participants may have different results.

8.2. Future Possibilities

The design of the experiment leaves plenty of room for these constraints and biases to be avoided in future studies. Due to the nature of the experiment, it is not mandatory to conduct the experiment in on room with both the groups. It is possible to provide conclusive results by conducting the experiment in two separate locations if environmental factors regarding the experiment is maintained in both locations. Given the time and resources, the experiment can be conducted in different countries for a more accurate result. A larger sample with a more randomized population would provide the scope to control for other factors like gender, age,

[12] http://www.climatechangenews.com/2014/06/06/finland-reveals-new-climate-change-laws/

profession, and social status. Moreover, focus on each belief categories can be enhanced by increasing the survey contents. On the other hand, the experiment can be focused on each survey statement factors, for example: a more intensive risk perception questionnaire will provide results on risk perception and how it effects contribution and cooperation for public good provision; a higher focus on beliefs regarding government role will deliver results that can be used to understand how each nation's perspective on their government affects their contribution towards public goods; or how different population's environmental beliefs influence their behaviour, etc.

9. Conclusion

The aim of the research was to analyse effectiveness of the national voluntary contribution approach of the global climate change policy through an economic experimental approach. This was done by examining the cross-cultural differences regarding voluntary contribution for the provision of public good in a repeated public good game. Some assumptions were derived from previous literatures on cooperation and public good games in order to justify laboratory participants' behaviour as a representation of the behaviour of a wider population, specifically, international cooperation follows the pattern of individual co-operations which entails sacrificing individual interests for group interests.

Basing on the unique nature of the global climate regime and game theoretical framework, a detailed experiment was designed to verify individual and global effort in terms of monetary expenditure. The analysis of the experiment results successfully answered the three research questions.

The study was able to prove that between a Chinese population sample and a mixed western population sample, the mixed sample had a higher tendency to contribute for the provision of public good, as they were able to cooperate even without communicating and contribute to the highest threshold point. Further analysis reinforced the significance of effect of communication on contribution level and cooperation on both correlation and causal study. The factor of communication significantly improved cooperation for both groups, however, the impact was greater on the Chinese population sample. The contributions of the group provided a socially optimum outcome after the factor of communication was added.

Furthermore, the study found correlation between different beliefs and contribution level. In that, group who believed to have higher personal risk associated with climate change tended to have a higher level of overall contribution. Groups that showed lower trust in government role to abate for climate change consequences showed a tendency to contribute more, while participants who showed empathy/trust towards government had a lower level of contribution. A descriptive statistical test showed that the Chinese population sample were more agreeable to the risk perception questions which mirrors the climate change consequences that the country is facing. Moreover, it was the same population sample that was more agreeable on the positive government role statements, demonstrating trust towards the government. As the results suggests that higher trust in the role of government invokes a tendency to contribute less, one might wander: to what extent does the political system of a nation affects one's decision to invest for climate abatement options? If this is indeed the general national belief, China might be able to meet her ambitious global climate policy target of 2030 if the government puts enough pressure on the private actors to contribute. However, in case of the western population sample, the participants showed higher level of distrust towards the role of government and had a higher level of cooperation as well. Which, not-so-surprisingly, implies that cooperation on a domestic level from the more democratic societies will be achieved through private market rather than coercion.

Though the test results were not significant, these finding may have better policy implications if done on a larger scale. Meaning, if these relations are consistent, it will enable policy makers to determine which sector of a given nation, private or public, will provide a socially optimum output concerning climate change abatement investments and to what extent.

The research did more than answering the research questions-the results of the experiment were exceptions in two cases: first, it did not provide evidence for the previously theorized concept that defection is followed by defection as group members tend to do so in order to punish the defector even at higher personal cost; second, cooperation did not decrease with subsequent rounds. If anything, cooperation increased, and the participants provided socially optimum output even on the last rounds.

Taking a last look on the Paris agreement, the discussion confirms the polycentric approach taken by the agreement, based on immediate actions to reduce GHG emissions at multiple levels, global, national and subnational, may be justified by economic analysis, even if the

analysis is not based on the conventional approach. The polycentric approach allows for implementation of different types of policies, so that the resolution of the problem no longer depends on a single solution whose failure would be catastrophic. As Ostrom ultimately argues that the most rational approach involves multi-policy, multi-scale action, the Paris agreement seems to be the first step towards that direction. However, the success of achieving the long-term goals of the agreement, will depend primarily on building greater trust and confidence across countries, as well as, between private actors and governments. This thesis suggests a possible way to understand and analyse to what extent these sorts of beliefs varies across nations.

10. References

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Appendix A: Experiment Instruction

Welcome to the Experiment!

Declaration*: This is an investment decision-making experiment, conducted on-line, solely for the purpose of research and does not, in any way, reflects your cognitive capability or intelligence. You can choose to stay anonymous by providing pseudonym if you want. You can leave now if you don't wish to participate.*

Instructions for the Experiment:

You are required to not speak to each other unless said otherwise by the instructor.

To play the game, you first need to go to the following website: http://veconlab.econ.virginia.edu/login.htm

The game will be played in three sessions. For each session, you are given a log in id. Please do not log in unless you are asked to by the experimenter.

After logging in to each session, you will be provided with further instructions.

Please used the following session names when asked to log in:

- **Experiment Stage 1: Session 1: tpgz1**
- **Experiment Stage 2: Session 2: tpgz2**
- **Survey: Session 3: tpgz2q**

Conversion of the winning amount:

There will be 2 winners, one from each part of the game. Your earnings are determined as 'electronic currency' in the game but the real pay-off amount will be converted as follows:

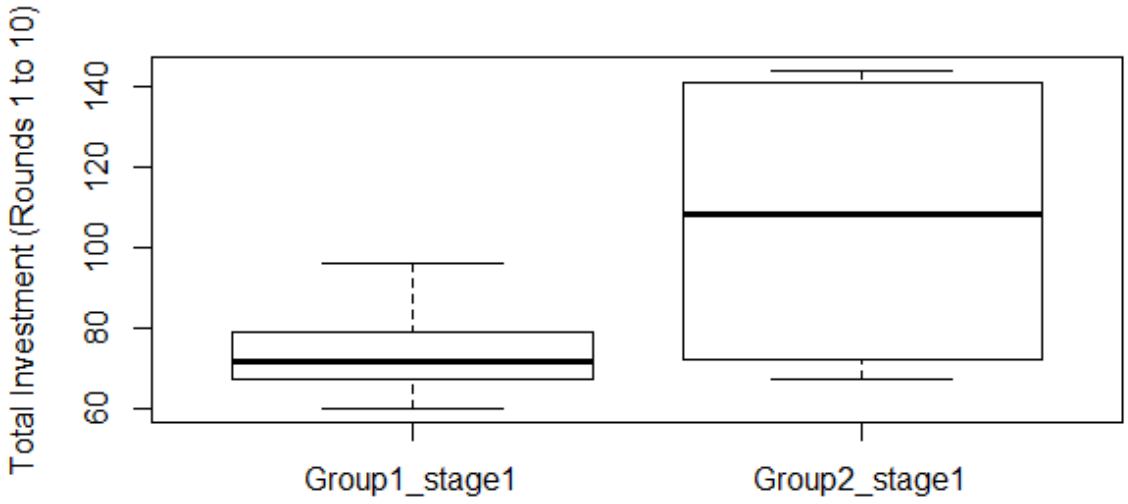
1 electronic currency = 0.10 Euro

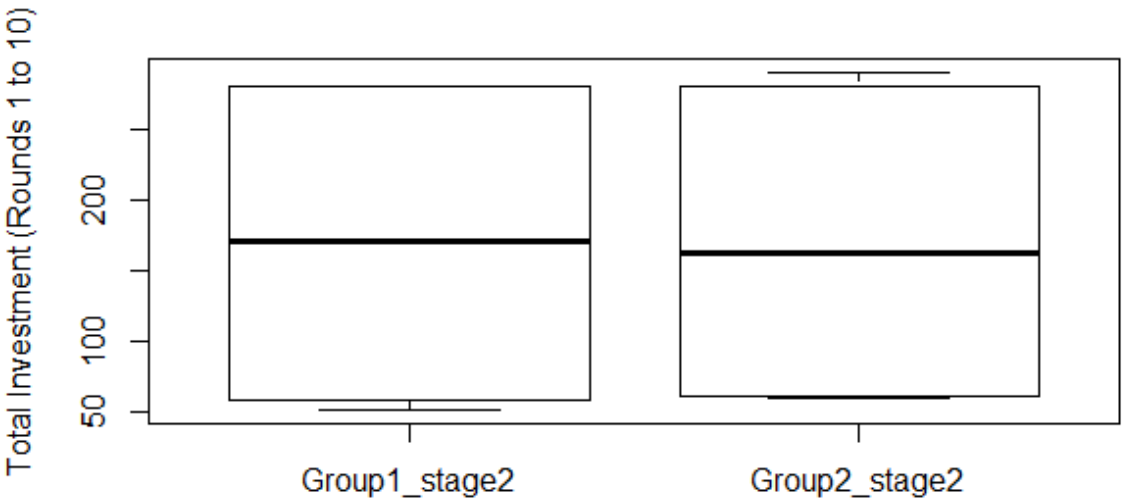
For example, if the highest earner gets a total of 50 electronic currency after the first 10 rounds, he or she will get (50x0.10) = €5 in cash or bank transfer.

Please feel free to ask if you have any question.

Thank you for participating 😊

Appendix B: Experiment data: Comparison of Stage wise total investment of Group 1 and 2




Total Investment (Rounds 1 to 10)
50
100
200
Group1_stage2
Group2_stage2

Appendix C: Descriptive Statistics of Survey Data

Group 1 ID (1-7)

Group 2 ID (8-14)

Defining Agreeable as Score including and less than 3 for all questions

Using Poisson distribution formulas because of discrete nature of the data

	RiskPerception1		**RiskPerception2**		**RiskPerception3**	
	Group 1	**Group2**	**Group 1**	**Group2**	**Group 1**	**Group2**
ANSWERS for survey Questions by Group 1 and Group 2 (1 = Strongly Agree, 5 = Strongly Disagree)	1 4 2 3 1 1 1	2 3 1 3 1 2 3	2 2 4 4 4 1 2	2 5 4 4 2 4 2	5 2 2 3 2 1 1	1 4 3 2 3 2 4
Mean	1.857142 86	2.142857 14	2.714285 71	3.285714 29	2.285714 29	2.714285 71
Standard Deviation	1.214985 79	0.899735 41	1.253566 34	1.253566 34	1.380131 12	1.112697 28
Kurtosis	- 0.056815 8	- 1.816609	- 2.071074 4	- 2.071074 4	 2.3205	- 0.944378 7
Skewness	- 1.146966 82	- 0.353045	- 0.029008 15	- 0.029008 1	 1.423777 77	- 0.248875 5
Minimum	1	1	1	2	1	1
Maximum	4	3	4	5	5	4
Probability of Agreeability	**0.881938**	**0.830469 2**	**0.710940 18**	**0.583496 1**	**0.802245 09**	**0.710940 18**

More Agreeable Groups for each survey	**Group 1**	**Group 1**	**Group 1**

	GovernmentRole1		GovernmentRole4	
	Group 1	**Group2**	**Group 1**	**Group2**
ANSWERS for survey Questions by Group 1 and Group 2 (1 = Strongly Agree, 5 = Strongly Disagree)	2	1	2	2
	3	3	2	2
	4	2	2	1
	4	3	3	3
	2	3	3	3
	5	2	3	2
	4	3	1	3
Mean	3.42857143	2.42857143	2.28571429	2.28571429
Standard Deviation	1.13389342	0.78679579	0.75592895	0.75592895
Kurtosis	-1.2271605	0.27337278	-0.35	-0.35
Skewness	-0.2351779	-1.1145498	-0.595294	-0.595294
Minimum	2	1	1	1
Maximum	5	3	3	3
Probability of Agreeability	**0.55212156**	**0.77273012**	**0.80224509**	**0.80224509**
More Agreeable Groups for each survey	**Group 2**		**SAME AGREEABILITY**	

	GovernmentRole2		GovernmentRole3	
	Group 1	**Group2**	**Group 1**	**Group2**
ANSWERS for survey Questions by Group 1 and Group 2 (1 = Strongly Agree,	5	4	5	2
	2	4	3	1
	3	5	2	5
	3	3	2	1
	4	4	2	3
	4	4	1	2

5 = Strongly Disagree)	2	3	1	2
Mean	3.28571429	3.85714286	2.28571429	2.28571429
Standard Deviation	1.11269728	0.69006556	1.38013112	1.38013112
Kurtosis	-0.9443787	0.336	2.3205	2.3205
Skewness	0.24887549	0.17389652	1.42377777	1.42377777
Minimum	2	3	1	1
Maximum	5	5	5	5
Probability of Agreeability	**0.5834961**	**0.46186543**	**0.80224509**	**0.80224509**
More Agreeable Groups for each survey	**Group 1**		**SAME AGRREEABILITY**	

	EnvironmentalBelief1		**EnvironmentalBelief2**	
	Group 1	**Group2**	**Group 1**	**Group2**
ANSWERS for survey Questions by Group 1 and Group 2 (1 = Strongly Agree, 5 = Strongly Disagree)	2	1	3	5
	4	1	3	5
	1	1	3	4
	2	2	4	5
	2	2	4	5
	1	2	2	4
	5	1	4	5
Mean	2.42857143	1.42857143	3.28571429	4.71428571
Standard Deviation	1.51185789	0.53452248	0.75592895	0.48795004
Kurtosis	-0.196875	-2.8	-0.35	-0.84
Skewness	1.00042471	0.37416574	-0.595294	-1.2296341
Minimum	1	1	2	4
Maximum	5	2	4	5
Probability of Agreeability	**0.77273012**	**0.94300005**	**0.5834961**	**0.30744105**

More Agreeable Groups for each survey	**Group 2**	**Group 1**

Disagreeable IDs	**3, 4, 5, 6**	**8, 10, 11, 12, 13, 14**	**1, 2**	**None**
	HumanRights		**GlobalCooperation**	
	Group 1	**Group2**	**Group 1**	**Group2**
ANSWERS for survey Questions by Group 1 and Group 2 (1 = Strongly Agree, 5 = Strongly Disagree)	2	5	5	1
	2	2	5	1
	5	5	1	1
	4	5	1	1
	4	5	2	1
	5	5	1	1
	2	5	1	1
Mean	3.42857143	4.57142857	2.28571429	1
Standard Deviation	1.39727626	1.13389342	1.88982237	0
Kurtosis	-2.3511005	7	-1.02816	Uniform Distro
Skewness	-0.0523667	-2.6457513	1.08793294	Uniform Distro
Minimum	2	2	1	1
Maximum	5	5	5	1
Probability of Agreeability	**0.55212156**	**0.33038849**	**0.80224509**	**0.98101184**
More Agreeable Groups for each survey	**Group 1**		**Group 2**	