A Model United Nations Experiment on Climate Negotiations

Elisa Hofmann (University of Jena)
Lucas Kyriacou (University of Bern)
Klaus M. Schmidt (LMU Munich)

Discussion Paper No. 266

January 4, 2021

Collaborative Research Center Transregio 190 | www.rationality-and-competition.de
Ludwig-Maximilians-Universität München | Humboldt-Universität zu Berlin
Spokesperson: Prof. Dr. Klaus M. Schmidt, University of Munich, 80539 Munich, Germany
+49 (89) 2180 3405 | info@rationality-and-competition.de

A Model United Nations Experiment on Climate Negotiations*

Elisa Hofmann[a] Lucas Kyriacou[b] Klaus M. Schmidt[c]

University of Jena *University of Bern* *University of Munich, CESifo and CEPR*

January 2, 2021

Abstract

Weitzman (2014) proposed that focusing international climate negotiations on a uniform carbon price is more effective than Paris style negotiations in achieving ambitious climate action. We put this hypothesis to an experimental test by simulating international negotiations on climate change in collaboration with Model United Nations associations. This novel experimental format combines some of the advantages of lab and field experiments. Our results show that negotiating a common commitment on a uniform carbon price yields significantly higher emissions reductions, more participation, and more equal contributions than individual commitments to a non-binding common goal à la Paris.

Keywords: Climate Negotiations; Negotiation Design; Model United Nations, Uniform Carbon Price.

JEL Classification Numbers: C81, C93, F51; H87, Q54

* We would like to thank Friedrich Breyer, Uwe Cantner, Ernst Fehr, Michael Gerfin, Jonas Meier, Axel Ockenfels, Doina Radulescu, Tobias Regner, and Ralph Winkler for helpful comments and suggestions. Financial support by Deutsche Forschungsgemeinschaft through CRC TRR 190 (project number 280092119) is gratefully acknowledged. Tanja Mitric, Timothy Rabozzi, Friederike Reichel, and Gabriel Vollert provided excellent research assistance. Moreover, we would like to thank the following MUN Associations for their support: Model United Nations University of Bern, ETH Model United Nations, MUN Team UZH, Model United Nations TU Munich e.V., MUNAM e.V., Model United Nations Mannheim e.V., Cologne MUN Society e.V., and United Nations Hochschulgruppe Tübingen.

[a] Elisa Hofmann, International Max Planck Research School on "Adapting Behavior in a Fundamentally Uncertain World", Friedrich Schiller University of Jena, Bachstraße 18k, D-07743 Jena, Germany, e-mail: elisa.hofmann@uni-jena.de.

[b] Lucas Kyriacou, Department of Economics, University of Bern, Schanzeneckstraße 1, CH-3001 Bern, Switzerland, e-mail: lucas.kyriacou@vwi.unibe.ch.

[c] Klaus M. Schmidt (corresponding author), Department of Economics, University of Munich, Ludwigstraße 28, D-80539 Munich, Germany, e-mail: klaus.schmidt@LMU.de.

1. Introduction

Climate change can only be mitigated if there is effective international cooperation that is negotiated by sovereign countries. The success of these negotiations depends on how they are structured. In the negotiations on the Paris agreement, countries negotiated a common, non-binding goal by how much to limit global warming. This goal is to be implemented by "nationally determined contributions", i.e. *individual commitments* by the participating countries of how much to contribute to the common good. This negotiation design was very successful in achieving maximum participation (all 197 member nations of the United Nations Framework Convention on Climate Change (UNFCCC) signed the agreement) and an ambitious common goal (limit global warming to less than 2° C), but it did not induce the parties to engage in sufficient climate action to achieve this goal. Because each country has to bear the full cost of its mitigation efforts alone while the benefits are distributed across all nations, it is widely feared that the Paris agreement will fail to limit global warming.[1]

There is a new proposal, advocated by Weitzman (2014, 2017a), Nordhaus (2015, 2019), MacKay et al. (2015), and others, to structure climate negotiations in a radically different way. They argue that negotiations should focus on a uniform minimum price for carbon emissions. This negotiation design strives for a *common commitment* that builds on reciprocity. If a country pushes for a higher carbon price, it knows that this higher price will apply uniformly to all countries. Thus, both the benefits and the costs of this action are borne by all nations. This induces each country to strive for a carbon price that it believes is optimal for the world as a whole, rather than some climate action that it believes is optimal for itself given the mitigation efforts taken by the rest of the world. However, a possible drawback of this design is that it is unlikely to achieve full participation. Some countries may prefer to stay out of the agreement and not to impose any carbon price at all.

Is this new approach likely to be more successful than the Paris approach? In this paper we report on the results of a novel type of field experiment that sheds light on this question. We collaborated with "Model United Nations" (MUN) associations in Germany and Switzerland and simulated "Conferences of the Parties" (COPs) of the United Nations (UN) with student delegates. The conferences followed the actual COP rules of the United Nations. Student

[1] See e.g. Clémençon (2016), Rogelj et al. (2016), Jiang et al. (2019), UNEP (2019).

delegates were supposed to represent the position of the country they were assigned to, they were provided with detailed information, they had to carefully prepare for the event, and they wrote a position paper for their country before the conference started. At each location we held two simultaneous COP conferences on climate action with ten countries each, representing all major regions and the main conflicting interests. Student delegates were assigned randomly to the two COPs and to the countries they represented. One COP negotiated in the format of the Paris agreement, the other one focused the negotiations on a uniform minimum price for carbon. In the "Paris treatment", delegates had to negotiate a resolution specifying a non-binding common goal on how much to reduce worldwide carbon emissions for each of the years 2030, 2040 and 2050 as compared to 2010, and individual commitments of all participating countries on their contributions. In the "Carbon Price treatment", delegates had to negotiate uniform carbon prices for each of these years.

Our study has four main results: First, we find that countries achieve significantly and substantially higher reductions of carbon emissions in 2050 if they negotiate a carbon price. Second, in the Paris treatment, countries are equally ambitious in their non-binding common goals as in the Carbon Price treatment (no significant difference), but the actual individual commitments in the Paris treatment do not live up to these goals. This is why the common commitment to a uniform carbon price is more effective. Third, to our surprise, significantly more countries participate in the resolution if a carbon price is negotiated than in Paris style negotiations. This is partly due to the behavior of countries like Russia and Saudi Arabia. They are opposed to a carbon price not because they suffer a lot if a high carbon price is introduced in their countries, but rather if other countries introduce a high carbon price which reduces demand for their fossil fuel exports. Thus, these countries try to convince other countries to keep the carbon price low in exchange for their participation in the overall agreement. Finally, there are substantial and significant differences in the reduction of emissions between the different countries in the Paris treatment, while countries contribute much more equally to the common good in the Carbon Price treatment. This is partly due to the uniformity of the minimum carbon price, and partly due to the fact that in the Carbon Price treatment more countries participate in the resolution.

Our paper is closely related and complementary in its findings to Schmidt and Ockenfels (2020) who conducted a laboratory experiment comparing the negotiation designs of Paris,

Kyoto, and the new approach striving for a uniform carbon price. In the lab experiment, four subjects faced an asymmetric public good problem and negotiated a binding contract on their contributions to the public good. Negotiations took place through a computer network without personal interaction, the problem was framed in an abstract and neutral fashion (climate change is never mentioned), and subjects were paid for their decisions. Schmidt and Ockenfels (2020) find that negotiations on a uniform minimum contribution to the public good are significantly and substantially more effective than a negotiation design with individual commitments as in Paris and negotiations on a common complex commitment as in Kyoto. This result is driven by two effects. First, negotiating a uniform minimum contribution to the public good induces all parties who participate in the negotiations to contribute almost efficiently (as predicted by the game-theoretic analysis). Second, while the participation rate is somewhat lower when a carbon price is negotiated as compared to Paris style negotiations, the free-riding effect is small. Furthermore, Schmidt and Ockenfels (2020) show that their qualitative results continue to hold even if contracts are non-binding and cannot be enforced.

The advantage of the laboratory experiment of Schmidt and Ockenfels (2020) is its internal validity. The lab allows for a tight control of the environment and for many independent observations. Thus, the experiment can show that negotiation design has a statistically significant (and substantial) causal effect on the negotiation outcome. However, the experiment is highly stylized, negotiations take place anonymously via a computer network, and subjects do not negotiate on climate action but on monetary outcomes of an abstract public good game. Thus, it is difficult to assess whether the experimental results of the lab carry over to the real world.[2] Our study addresses some of these problems. We look at negotiations following the rules of real COP negotiations, negotiations last for an entire day giving rise to complex dynamics (as in the real world), and subjects are intrinsically motivated to represent the best interest of their countries. These simulations are a new form of "field" experiments that complement the more traditional experiments in the lab.

Our paper is related to three strands of the literature. First, there is a small literature on how to structure climate negotiations. In a series of papers, Weitzman (2014, 2015, 2017a, 2017b) compares negotiations on a uniform carbon price to negotiations on a vector of emissions reductions. He argues that negotiating a uniform carbon price provides a salient focal

[2] An interesting discussion of external validity is given by List (2020).

point (as advocated by Schelling (1960), and he shows formally that it aligns self-interest with the common good. MacKay et al. (2015) emphasize that a uniform carbon price is a reciprocal instrument ("I will if you will"). Nordhaus (2015, 2019) proposes a "climate club" that commits to a uniform carbon price for its members and imposes tariffs on the imports of non-members to compensate for the distortion of competition and to induce other countries to join the club. He points to the experience with other international agreements (Barrett, 2003; Battaglini and Harstad, 2016, 2020) showing that treaties tend to be stable only if they penalize free-riders.

Second, there is an experimental literature on the institutional preconditions for successful public good provision. It is well known that many subjects in public good experiments are conditional cooperators (Fischbacher et al., 2001; Chaudhuri, 2011). They are prepared to contribute to the public good if all others do so as well. However, because there are also many selfish subjects, contributions to the public good tend to fall over time if there is no enforcement mechanism. Barrett and Dannenberg (2016) experimentally study the "pledge and review" process of the Paris agreement. They find that pledges do not increase actual contributions over time. Kosfeld et al. (2009) consider a public good game in which subjects can jointly decide on the introduction of a sanctioning institution. They show that subjects often manage to establish such an institution which positively affects cooperation and welfare. Then there is an experimental literature on minimum contributions to public good games (Orzen, 2008). This literature shows that minimum contributions to public goods foster cooperation, no matter whether they are exogenously imposed or chosen by the participants (Kocher et al., 2016; Martinsson and Persson, 2019). This is confirmed by Kesternich et al. (2014, 2018) who analyze the performance of variants of minimum contribution rules in a static and a repeated setting. There is also some empirical evidence, mainly based on case studies on the successful solution of public good problems (Ostrom, 1990; Ostrom et al., 1999), emphasizing the importance of reciprocity and enforcement. These factors play a crucial role in our MUN experiment as well.

Finally, there is a literature in political science and education on simulation games (see, e.g., Boardman, 1969; Lester and Stoil, 1979; Asal, 2005; Kauneckis and Auer, 2013). This literature focuses on simulation games mainly as a pedagogical tool to foster student engagement and learning. A few exceptions are Penetrante (2012) and Matzner and Herrenbrück (2017). Penetrante (2012) used MUN simulation games as "case studies" to find stumbling blocks in negotiations and to analyze coalition building. Similarly, Matzner and

Herrenbrück (2017) conducted three MUN conferences as experimental sessions to explore the conflicts that may arise when countries negotiate on climate engineering. However, none of these papers allows for statistical hypothesis testing. A methodological novel feature of our paper is the use of MUN simulations as a randomized controlled field experiment. This is related to Schwardmann et al. (2019) who used international debating competitions as a "field experiment" to study whether people persuade themselves about the moral and factual superiority of their position to better convince others.

The rest of the paper is structured as follows: Section 2 discusses the motivation and the background of our study in more detail. Section 3 describes the setup of the MUN experiment. Section 4 derives the hypotheses that we want to test. Section 5 summarizes the experimental procedures and Section 6 reports the results. Section 7 concludes with a discussion of our new experimental method and our main results. A detailed documentation of the MUN experiment is provided in the Appendix.

2. Motivation and Background

The fight against climate change is a *global* public good problem. Greenhouse gases (GHG) have the same effect on global warming independently of where they are emitted. If a country reduces its greenhouse gas emissions such as carbon dioxide (CO_2)[3], it has to bear all the economic costs of this policy alone while the benefits accrue to all other nations as well. Hence, for each country, the economic incentives to invest in climate protection are inefficiently small. *Local* public good problems can often be solved by government interventions that regulate or tax activities that have positive or negative external effects within the country. At the global level, however, there is no supranational government that could impose and enforce such policies. Thus, to solve the global public good problem, international cooperation of sovereign nations is necessary.

In the Paris agreement of 2015, 197 countries, every nation on earth, agreed to the common goal of limiting global warming to well below 2° C and pursuing efforts to limit it to 1.5° C. Each country promised to contribute to this common goal by voluntarily limiting its own greenhouse gas emissions, and to list these "intended, nationally determined contributions"

[3] Other greenhouse gases are methane, nitrous oxide, hydrofluorocarbons, and others. Because CO_2 is by far the most important GHG, other emissions are typically expressed in CO_2 equivalents. In this paper we use the terms "greenhouse gases" and "CO_2 emissions" synonymously.

in the Annex to the agreement. It is often difficult to compare the contributions listed in the Annex because each country has some discretion which measures to list and how to count them. However, all observers agree that taken together, the intended nationally determined contributions listed in the Annex are insufficient to achieve the 2° goal, let alone to get close to 1.5° C, and that we are rather on a path to a temperature increase of 3° C or more (Rogelj et al., 2016, IPCC, 2018).

Proponents of the Paris agreement point to the annual follow-up conferences that took place in Marrakesh, Bonn, Katowice, and Madrid, and will continue in Glasgow and other places. These conferences are supposed to lead to a process of "ratcheting up", so that each country makes stronger commitments over time and induces other countries to do so as well. However, not much has been achieved so far. On the contrary, the USA announced that it will withdraw from the Paris agreement in November 2020, arguing that it is unfair that other countries are contributing less than their fair share. Other countries are discussing to follow suit. The experimental evidence on repeated public good games suggests that ratcheting up is unlikely to occur. If there is no punishment mechanism, contributions go down over time because each player takes the insufficient contributions of the other players as an excuse to also contribute less.[4]

A possible explanation for the failure of the Paris agreement to effectively limit GHG emissions is that it relies on individual commitments rather than on a common commitment. The 2° C goal is not a commitment but a non-binding agreement, and no country can be held responsible if this goal is not achieved. Countries commit to nationally determined contributions, but these are individual commitments. Thus, because of the public good nature of the problem, there is a strong economic incentive to contribute too little. The international community tried to achieve a common commitment in the Kyoto protocol of 1997.[5] However, it turned out to be impossible to find a general rule on how much each country should reduce its GHG emissions. In the end, the Kyoto protocol just listed how much each of the participating countries was willing to commit to voluntarily for the period 2008-2012. The USA did not ratify the Kyoto protocol, Canada withdrew its participation, and several countries did not live up to their commitments. A planned follow-up agreement was never ratified. This is why for the Paris negotiations the international community gave up on a common commitment.

[4] See, e.g. Fehr and Gächter (2000).
[5] See, e.g. Grubb et al. (1999).

Recently, a new idea for achieving a common commitment has been proposed by Weitzman (2014, 2017a), Nordhaus (2015, 2019), MacKay et al. (2015), and others. Rather than negotiating a non-binding goal with individual commitments as in Paris or a complex common commitment as in Kyoto, these authors propose to focus negotiations on one number, a uniform minimum price for carbon emissions as a common commitment that applies to all participants equally.

The idea of putting a price on pollution (such as carbon emissions) is not new and goes back at least to the work of Pigou (1920). Economists advocate a uniform carbon price as an instrument to implement the reduction of carbon emissions most efficiently, i.e. at the lowest possible cost. This is an important economic advantage, but the main argument for the new proposal is different and unrelated to cost efficiency. The argument is that a negotiation protocol that focuses international negotiations on a uniform minimum price for carbon *facilitates international cooperation* and makes it more likely that an effective agreement is reached.

This has been formalized by Weitzman (2014) and Schmidt and Ockenfels (2020). They model the fight against climate change as an asymmetric public good problem. All countries want to mitigate global warming, but some countries are more affected by climate change or have lower costs of introducing a carbon price than others and therefore want to implement more stringent policies. Thus, for each country, there is a most preferred carbon price that it wants to be applied to the world. Weitzman (2014) assumes that an international assembly decides by majority voting on how high the carbon price should be, and that this price will then become binding for everybody. If the preferences of all countries are single-peaked, the median voter theorem implies that the median most preferred carbon price will be selected. This need not be efficient, because the median optimal carbon price may differ from the (weighted) mean optimal carbon price that would be welfare maximizing from a global perspective. However, if median and mean are not too different, it would get at least close to the optimum.

A strong assumption in Weitzman (2014) is majority voting. After all, nations are sovereign, and no nation can be forced to participate in carbon pricing. Each nation has to participate voluntarily. Schmidt and Ockenfels (2020) assume instead that each country can veto the decision, i.e. the decision has to be taken unanimously. They consider a negotiation protocol where each country can propose its most preferred uniform carbon price and the minimum of the proposed carbon prices becomes a binding commitment. Thus, no country is forced to accept a higher carbon price than the one that it is willing to impose itself.

Furthermore, no country must be worried that it has to impose a higher carbon price than any other country. Schmidt and Ockenfels (2020) show that this mechanism is strategy-proof, so for each country it is a weakly dominant strategy to propose the carbon price that would be optimal from its own perspective, if it was imposed by all other countries as well. The lowest of these carbon prices will become a common commitment. Again, this mechanism does not implement the efficient carbon price from a global perspective, but it (partially) solves the free-rider problem. Schmidt and Ockenfels (2020) show in a lab experiment that it yields a much more efficient outcome than individual commitments.

There are several other arguments for why it might be a good idea to focus international negotiations on a uniform minimum carbon price.

1. Simplicity: Negotiations are focused on one number, the minimum price of carbon. This is much simpler than negotiating a complex vector of contributions of many different countries.
2. Reciprocity: Each country imposes its carbon price under the condition that all other countries do the same. If the countries agree to raise the uniform carbon price, the price is raised for all countries. No country can blame any other country for contributing less, because all countries face the same price.
3. Flexibility: Each country is free how to implement carbon pricing in its economy, whether by imposing a carbon tax, by introducing an emissions market or by using hybrid instruments. Thus, each country can build on its existing pricing schemes. However, it has to commit that the price imposed on average on all domestic carbon emissions must be at least as high as the internationally agreed uniform price for carbon.
4. Transparency: Monitoring whether a country honors its commitment is relatively easy. Simply divide total revenues from carbon pricing by total emissions. Of course, strict rules and international monitoring are required to prevent cheating, but this is arguably easier to do this with carbon pricing than with the complex individual commitments of the Paris agreement that are more difficult to verify and to enforce.
5. No international transfers: Each country keeps the revenues from carbon pricing and can use them at will, e.g. to reduce other (distortive) taxes or to support those parts of the population that are most severely affected by the increased carbon price. In contrast, the Kyoto protocol relied on international emissions trading. Thus, if a country did not reduce

emissions as planned, it had to buy emission rights from other countries which led to large international payment streams. When it became clear that the USA, Canada, and Australia would have to buy emission rights from other countries for billions of Dollars in order to honor their commitments, these countries quickly abandoned the Kyoto protocol.

But there are also problems with this new approach. One problem is participation. Some countries could decide not to participate in the negotiations and to free-ride on the emissions reductions of others. This problem arises with any international agreement and has to be taken seriously. A second and related problem is carbon leakage. If some countries do not participate in carbon pricing, their firms have a competitive advantage because of lower energy costs. Thus, production of carbon intensive goods could be shifted to these countries, damaging the economies of the other countries and increasing carbon emissions. A third problem is that the cost of introducing a uniform carbon price may be different for different countries. Many developing countries are currently subsidizing fossil fuels. If these subsidies are turned into carbon taxes, large parts of the population may be severely affected which may yield political unrest. Furthermore, developing countries may argue that it is unfair that they are expected to impose the same price on carbon emissions as developed countries, even though the developed countries have been emitting for more than a hundred years and are largely responsible for the current climate crisis.

Nordhaus (2015) argues that a solution to these problems could be a “climate club” to be formed by the most important industrialized countries, such as the USA, the European Union, China, and Japan. These countries are located roughly on the same latitude and are similarly affected by climate change. If they agree on a uniform carbon price among themselves, most of worldwide production and world trade would be covered. Furthermore, the club could impose a border adjustment tax on all countries that do not impose at least the minimum carbon price. The border adjustment tax eliminates the competitive advantage that countries outside the club would otherwise have, and it gives an incentive to join the club to avoid the hassle of going through the border adjustment. Furthermore, developing countries could be motivated to join the club by the carrot of compensation and support through a “Green Fund” that could be financed by a fraction of the revenues from carbon pricing.

How do we know that the new approach will be more successful than the approaches of Paris and Kyoto? There is no direct empirical evidence to support it.[6] Ideally, we would like to run a randomized controlled field experiment in many parallel worlds that are randomly assigned to two different treatments, one in which countries negotiate a uniform minimum carbon price and one in which they negotiate according to the current rules of the Paris agreement. We would then see whether there is a statistically significant difference in carbon emissions, leading to differences in global warming between the worlds that negotiated a carbon price and the worlds that did not. But, of course, as there is only one world, such an experiment is impossible. Alternatively, one could run a laboratory experiment. This is the approach of Schmidt and Ockenfels (2020). In an abstract setting of an asymmetric, linear public good problem, they show that that the negotiation design has a statistically highly significant causal effect on the contributions to the public good. Negotiating a carbon price yields a much more efficient outcome in the lab. But the experiment is highly stylized, climate change is never mentioned, and negotiations take place anonymously via a computer network. Thus, external validity is a serious problem.

In this study we run a field experiment with Model United Nations associations comparing two negotiation protocols of COPs: Negotiations on a common commitment to a uniform carbon price ("Carbon Price treatment") vs. negotiations on a non-binding common goal with individually determined national contributions as in Paris ("Paris treatment"). This is closer to real negotiations and addresses some of the problems of external validity.

3. The MUN Experiment: Design

For the experiment we collaborated with Model United Nations (MUN) associations at six universities across Germany and Switzerland. The idea of MUN goes back to the League of Nations simulations in Oxford and Harvard in the 1920s (Muldoon, 1995). Today, MUN associations exist at hundreds of universities and high schools in most countries of the world. They are student organized and engage in extracurricular activities to prepare for simulated

[6] There are a few other global public good problems that have been solved more or less successfully. For example, the World Trade Organization (WTO) managed to extend the public good of (relatively) free trade to large parts of the world. Two basic principles of the WTO are reciprocity and non-discrimination, in particular the "most favored nations" rule that requires each WTO member to offer the lowest tariff it offers to any country uniformly to all other countries as well. This is similar in structure to a uniform carbon price. But, of course, there are also many differences.

United Nations conferences. They teach their members debating and writing skills as well as critical thinking and leadership abilities, they organize local MUN events and send delegations to national and international MUN conferences.

A MUN conference simulates real United Nations conferences. Participants in a MUN conference ("delegates") are assigned countries to represent. They have to conduct research on their country, formulate positions and come up with policy proposals that they will then debate with their fellow delegates in the conference, staying true to the actual position of the member they represent. During the conference, delegates have to adhere to the formal rules similar to those of real UN conferences. At the end of the conference delegates vote on written policies, called "resolutions" with the goal of passing them with a majority vote. The best performing delegates are often recognized with awards.

At each of the six universities we organized a one-day MUN conference on climate policy[7] with two separate committees (treatments) consisting of ten delegates and two chairs each. Delegates and chairs are allocated randomly to the two committees and to the countries they represent. There are ten nations, kept constant across all conferences, that are supposed to represent the world: Australia, Canada, China, European Union (EU), India, Japan, Russia, Saudi Arabia, South Africa, and the United States of America (USA)[8]. These include the major CO_2 emitters (USA, China, EU, Japan), the major producers of fossil fuels (Saudi Arabia, Russia, USA, Australia), and countries from the developing world (India, South Africa). The two chairs are supposed to strictly enforce the rules of the conference, but not to influence the negotiations otherwise.

Two weeks before the conference all participants receive the same "study guide" (available in the Appendix) which offers general information on the causes and consequences of climate change and a summary of the forecasted scenarios of the 5th Assessment Report of the Intergovernmental Panel on Climate Change (IPCC). It also discusses different policy

[7] The MUN conference is modelled after a „Conference of the Parties" (COP). The COP is the main body of the United Nations Framework Convention on Climate Change (UNFCCC), which represents the framework of United Nations climate change activities. At the COP, all United Nations Member States meet once a year to negotiate and adopt international climate change agreements. For instance, the Kyoto protocol has been negotiated upon at COP3 in 1997, and the Paris agreement has been adopted at COP21 in 2015. Thus, COP is a natural candidate being simulated at a MUN conference when investigating international climate change negotiations.

[8] We are aware that the European Union is not a country but represents all member countries of the European Union. This was explicitly stated in the study guide. We nevertheless included the European Union as "one country" because the European countries closely coordinate their climate policies at the European level.

options to combat climate change and their estimated costs.[9] Participants are supposed to research the position of the country they represent and to write and hand in a position paper before the conference starts.

The position paper has to include (1) a statement on how the represented country will be affected by climate change, (2) what the country's general position on climate action is, (3) a suggestion by how much the world as a whole should reduce CO_2 emissions until 2030, 2040, and 2050 (as compared to 2010), (4) a suggestion by how much the respective country should reduce its own CO_2 emissions until 2030, 2040, and 2050 (as compared to 2010), and (5) a short discussion of the advantages and disadvantages of carbon pricing from the perspective of the represented country. We incentivize the delegates to stay in character of their nation by publicly awarding a "Position Paper Award" (cinema voucher of about 10 Euros) to the best written and most authentic position paper at the end of the conference. Furthermore, we proofread position papers and remind delegates whose position papers do not answer all five questions to think about the unanswered questions. The position papers are distributed among the delegates and chairs in each Committee. All participants are asked not to communicate about the conference before the conference starts.

Before the conference, the two committees receive a document called "Questions A Resolution Must Answer" (QARMA, available in the Appendix). This document is the only difference between the two committees. It sets up different negotiation frameworks. Committee 1 (C1; Paris treatment) is instructed to get to a Resolution that specifies goals for the reduction of worldwide CO_2 emissions in 2030, 2040, and 2050.[10] Importantly, these goals are non-binding declarations. However, after the resolution has been passed, each country supporting the resolution has to specify in an Annex how much it will reduce its own emissions by 2030, 2040, and 2050, and indicate how it wants to achieve this (e.g. via carbon pricing, subsidizing green energy, imposing restrictions and regulations on CO_2 emissions, etc.). Participants are

[9] The study guide also offers some statistical information on the ten participating countries, such as population, GDP/person, share of worldwide CO_2 emissions, and emissions per person in 2010, etc. Finally, it provides references and links to research further information. In addition, participants receive the "MUN Rules of Procedures", which setup the formal rules for the debate (available in the Appendix). Furthermore, participants are provided with a document entitled "Model United Nations for Beginners". It reminds the delegates about the commonly used documents during MUN conferences (such as Working Papers, Draft Resolutions, and Resolutions), a short introduction to MUN Rules of Procedures (e.g. rules on debating, on speeches, and on diplomatic conduct) and a summary of voting rules. Finally, delegates are provided with an Excel Sheet that could be used to compute the effects of different policy measures in different countries on worldwide CO_2 emissions.

[10] Reductions or increases in CO_2 emissions are always relative to the emission levels of 2010.

told that these country-specific goals are binding commitments according to international law.[11] Note that the country-specific goals are "nationally determined" by each country alone after the resolution has been passed. This negotiation protocol is similar to the negotiation protocol that led to the Paris agreement.

In Committee 2 (C2; Carbon Price treatment) the negotiation rules are different. Delegates are informed that there has been a previous agreement to introduce a uniform minimum price for CO_2 emissions (a minimum "carbon price"). They are instructed to get to a resolution that specifies how high this uniform minimum carbon price should be in 2030, 2040, and 2050. Each country is free how to implement the carbon price (by a carbon tax, an emissions trading system, or some hybrid system) and how to spend the revenues from carbon pricing. However, for all countries supporting the resolution the minimum price is binding according to international law. Countries that do not vote for the resolution are not bound by it and can continue to do "business as usual". Delegates are also informed that a carbon adjustment tax (equivalent to the carbon price) will be imposed on exports from those countries not supporting the resolution in order to prevent a competitive disadvantage, and that this is in accordance with WTO rules. Delegates are instructed that the carbon price has to be uniform (i.e. the same for all countries supporting the resolution) and that the resolution cannot include any additional measures to mitigate climate change.

In both committees a resolution needs at least five votes to be passed.[12] Countries that do not support the resolution are assumed to pursue "business as usual" which results in an increase of CO_2 emissions of 40 percent of this country. Furthermore, in both committees, delegates are instructed not to discuss compensation payments for low income countries because there will be another UNFCCC conference on the introduction of a "Green Fund" that will deal with this issue separately.[13]

[11] The instructions mention that if a country does not adhere to its legally binding commitment, it can be sued in an international court and sentenced to pay penalties. Note that this is not the case for the actual Paris agreement. However, we wanted to have equally strong commitments in both treatments. We did not discuss whether these legal obligations are enforceable.

[12] We are aware that this voting procedure is different from the one applied at the COP21 in which the Paris Agreement has been negotiated (consensus or two-third majority) (UNFCCC Secretariat (2015)). We decided for this procedure to keep the experiment manageable with only ten nations.

[13] We added this statement to the instructions after the first conference in Bern. In Bern delegates spent some time discussing this issue and decided in the end not to deal with it (in both committees). We wanted to focus the attention of the delegates on the measures against climate change, so we added this statement. It does not seem that the resolutions were affected by these discussions. All our results remain valid if we exclude Bern from the analysis (see Appendix).

The two committees are two experimental treatments that differ in only one respect, the design of the negotiations. We refer to the two committees/treatments often as "Paris treatment" (Committee 1, C1) and "Carbon Price treatment" (Committee 2, C2). It is crucial for our experiment that the climate effects of the negotiation outcomes can be compared with each other. In the study guide we provide a table that informs delegates that there is a linear relationship between the reduction of CO_2 emissions and the carbon price. For example, a carbon price of USD 0 yields an increase of emissions of 40 percent, a carbon price of USD 60 yields an increase of emissions of 0 percent, a carbon price of USD 120 yields a reduction of emissions of 40 percent and a carbon price of USD 180 yields a reduction of emissions of 80 percent. This linear relationship applies to all countries and to the world as a whole. It is clearly a simplification, but it corresponds roughly to estimates that have been reported by the IPCC AR5 (Edenhofer, 2014, Chapter 6) and the Report of the High-Level Commission on Carbon Prices (Stiglitz et al., 2017). All delegates are instructed to take these numbers at face value.

Note that the delegates in Committee 1 can choose to adopt a carbon price as well. However, in Committee 1 each country has to do this independently, while in Committee 2 all countries supporting the resolution have to commit to a common carbon price.

4. Hypotheses

The main question of our study is which negotiation protocol is more successful in achieving an effective agreement. Following the literature discussed in Section 2 we predict that negotiations on a uniform carbon price are more successful than Paris style negotiations:

> **Hypothesis 1:** Negotiations in the Carbon Price treatment achieve significantly higher reductions in CO_2 emissions than negotiations in the Paris treatment.

An important difference between the two negotiation protocols is that the uniform carbon price aims for a common commitment, while the Paris style negotiations aim for a non-binding common goal that is implemented via nationally determined contributions, i.e. individual commitments. Thus, countries that sign a resolution on the carbon price are bound by it, while parties that sign a non-binding resolution on global emissions reductions are not. Hence, with Paris style negotiations there could be a difference between the non-binding global goal and the individual commitments.

Hypothesis 2: In the Paris treatment the proclaimed goal in the resolution is significantly higher than the nationally determined contributions specified by each country in the Annex to the Resolution.

How many countries will participate in signing the resolution? The Paris agreement was signed by all 197 nations on the planet, possibly because each nation was free how much to contribute to the commonly declared goal. But universal participation is not guaranteed. The USA is going to withdraw from the agreement, and other countries are discussing to follow suit. On the other hand, a uniform carbon price is a much stronger commitment. Without a border adjustment tax there is a strong incentive to free-ride and benefit from carbon leakage by not participating. With a border adjustment tax, the incentive to free-ride is reduced, but it is still there.

Hypothesis 3: Participation in the resolution is significantly higher in the Paris treatment than in the Carbon Price treatment.

A related question concerns the differences across countries in their contributions. The uniform carbon price forces all countries that participate in the resolution to impose the same price, so they are all contributing similarly to the common good. With Paris style negotiations, each country decides on its own how much to contribute. Some countries (like the EU or Japan) may behave altruistically, others (like the USA or Russia) may put their own interests first. Thus, the differences in contributions are likely to be larger.

Hypothesis 4: In the Paris treatment there will be large differences in the contributions of the different countries. In the Carbon Price treatment, emissions reductions will be less unequal.

5. Experimental Procedures

The experiment was conducted in late 2018 and 2019. We held six MUN conferences in Germany and Switzerland lasting about seven hours (10:00 a.m. until 5:00 p.m.) each. Altogether we collected data from 144 participants (120 delegates and 24 chairs, see Table 1).[14]

[14] In our statistical analysis we are interested in the behavior of the delegates only (n = 120).

Session Date	Session Location	Participants		
		Committee 1	Committee 2	*Total*
15.12.2018	Bern (Switzerland)	12	12	24
23.03.2019	Munich (Germany)	12	12	24
18.05.2019	Zurich (Switzerland)	12	12	24
19.10.2019	Mannheim (Germany)	12	12	24
09.11.2019	Cologne (Germany)	12	12	24
30.11.2019	Tübingen (Germany)	12	12	24
	Total	*72*	*72*	*144*

Table 1: Overview of experimental sessions and participants.

The communication language of the conference was English. Subjects received a flat payment of 20€ in Germany and 20CHF in Switzerland for their participation. Participants knew that the conference was part of an experiment, but they did not know what the experiment was about, nor did they know that the other committee negotiated under a different negotiation protocol. We separated the two committees from the very beginning and instructed the participants not to interact with members of the other committee before and during the conference. After a short introduction given in each committee by an experimenter, the conference was run by the chairs. One experimenter was sitting in the back of each room taking notes.

Table 2 provides summary statistics of the participants (delegates only).[15] On average, participants were 22.07 years old. 48 percent of participants were female. Subjects studied on average in their 4th semester. On average participants had participated in 3.25 MUN conferences before and prepared 167.78 minutes for the conference. Subjects evaluated the realism of the resolution as 'rather realistic' (4.24 on a seven-point-Likert-Scale ranging from 1 ("not realistic at all") to 7 ("very realistic")) and they were 'rather satisfied' (4.71 on a seven-point-Likert-Scale ranging from 1 ("not satisfied at all") to 7 ("very satisfied")) with the resolution. The participants stated being very interested in the topic already before the conference but indicated an even (significantly) higher interest in the topic after the conference (one-sided Wilcoxon signed-rank test, $z = 4.55$, $p < .001$).[16]

[15] Missing observations are due to not obligatory responses in the ex-post questionnaire.
[16] This result confirms previous studies that have shown that simulations tend to increase the participants' interest in the topic, see e.g. Boardman (1969) and Rooney-Varga et al. (2018).

Variable	Mean	Std. Dev.	N	Min.	Max.
Age	22.07	2.74	119	16	29
Gender *(female = 1)*	0.48	0.50	120	0	1
Semester	4.33	2.64	98	1	12
MUN participations	3.25	3.14	116	0	20
Preparation time (in minutes)	167.78	189.57	114	0	1080
Evaluation: Realism resolution	4.24	1.45	119	1	7
Satisfaction with resolution	4.71	1.63	119	1	7
Interest in topic before conference	5.55	1.27	119	1	7
Interest in topic after conference	5.98	1.13	119	2	7

Table 2: Summary descriptive statistics for delegates across all six experimental sessions.

Participants came from a broad variety of disciplines. Most of them studied economics (28%), Law (22%) and other social sciences (21%). The participants did not differ regarding age, gender, semester, and preparation time for the conference between the two committees in each experimental session (see balance Table A.1 in the Appendix).[17]

6. Results

Figure 1 compares the average actual worldwide reductions of emissions in percent as compared to 2010 in Committee 1 (C1; Paris treatment) and Committee 2 (C2; Carbon Price treatment) across the six COP meetings.[18] Note that positive values indicate emission reductions while negative values indicate increases in emissions.

[17] In Tübingen, subjects in Committee 1 and in Committee 2 differed statistically significantly regarding their MUN participations (two-sided Wilcoxon signed-rank test, $z = 2.27$, $p = .023$). In Zurich, subjects in Committee 1 and Committee 2 differed statistically significantly regarding their evaluation of the realism of the Resolution (two-sided Wilcoxon signed-rank test, $z = 2.04$, $p = .041$).

[18] The emissions reductions for each experimental session are provided in Table A.2 in the Appendix.

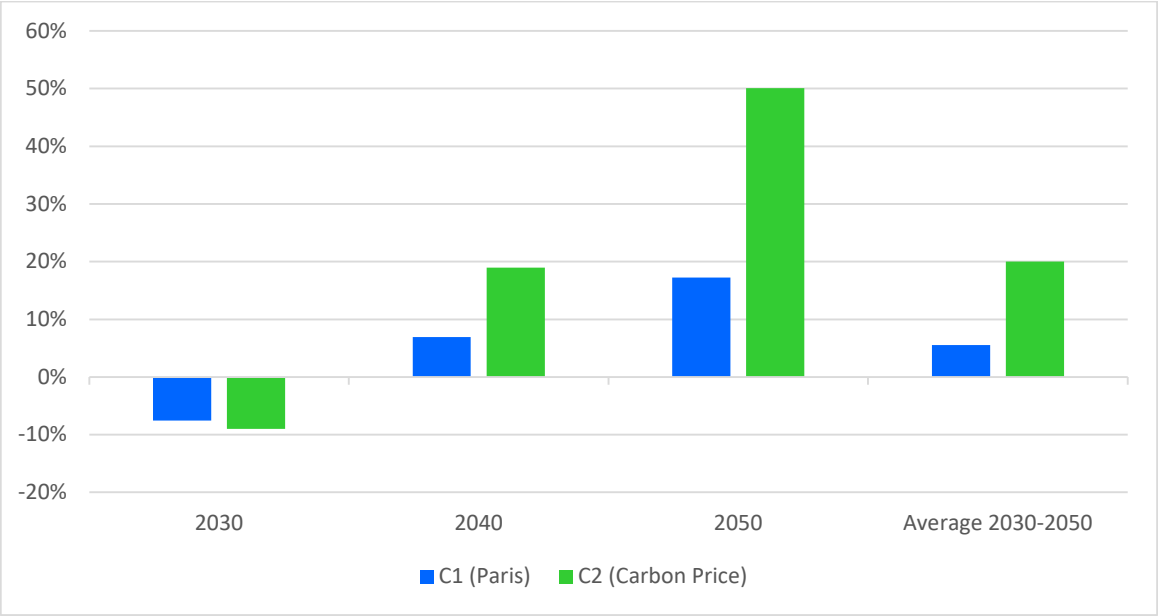

Figure 1: Actual worldwide reductions of emissions (weighted average over all countries) in Committee 1 versus Committee 2 averaged over all COP meetings.

There are two main differences between the outcomes of treatments C1 and C2. First, average emissions reductions of the years 2030-2050 are substantially higher in C2 (Carbon Price, about 20 percent) than in C1 (Paris, about 5 percent). Second, the time path of emissions reductions in C2 is significantly steeper than in C1. Both start with a similar reduction of emissions in 2030 of about -8 percent (i.e. an increase of emissions by +8 percent). However, in 2040 and in particular in 2050, the negotiation outcome in C2 is much more ambitious as compared to C1. In 2050 this difference is statistically significant.[19]

Result 1: In 2050 the actual emissions reductions of the ten countries are significantly higher in C2 than in C1. Furthermore, the time path of actual average reductions is significantly steeper in C2 than in C1.

Result 1 confirms Hypothesis 1 in 2050. It is supported by a one-sided Wilcoxon signed-rank test ($z = 2.071$, $p = .019$) comparing the actual CO_2 emissions reductions of the ten

[19] In fact, in C2, the average worldwide reduction of emissions is about 50 percent in 2050 while it is less than 20 percent in C1. Thus, if the experiment and the underlying assumptions are taken literally, then the reduction of emissions through a uniform minimum price of carbon would just be sufficient to reach the two-degree-goal, while the reductions achieved via Paris style negotiations would be far too small to achieve this.

countries in Committee C1 (as stated in the Annex if they support the resolution and "business as usual" otherwise) with the actual CO_2 emissions reductions of the ten countries in Committee C2 (again depending on voting behavior on the resolution) for the year 2050 in all experimental sessions.

Result 1 is further backed up by mixed effects regressions (see Table 3). Here we compare the actual *average* worldwide abatement levels over 2030-2050 between the two treatments. In all three models, the dependent variable is the actual average CO_2 emissions reduction in the years 2030, 2040 and 2050. Because observations at the same location need not be independent, we include a random effect of the location as a matching group variable. In Model 1, we further add a random effect of time to account for possible dependencies of the three responses (2030, 2040, and 2050) of one committee.[20] The treatment itself increases actual worldwide reductions of emissions, but the effect is statistically not significant (Model 1, coefficient = 14.48, $p = .163$). However, reductions of emissions significantly increase over time (Model 2, coefficient = 20.98, $p < .001$). Furthermore, we find a (marginally) significant interaction between treatment and time (Model 3, coefficient = 17.12, $p = .080$).[21]

[20] We ran experimental sessions at six locations with two treatments each, resulting in 12 group observations being matched at the location level. Due to the three responses per observation (2030, 2040, and 2050), we include 36 observations in our regression analysis.

[21] As a robustness check we ran a similar regression with time dummy variables (see Appendix, Table A.3) confirming these results.

	(1)	(2)	(3)
(Intercept)	5.54 (6.46)	-36.41*** (9.03)	-19.29*** (6.36)
Carbon Price Treatment	14.48 (10.39)	14.48 (10.39)	-19.76 (12.02)
Year		20.98*** (3.75)	12.42*** (2.20)
Carbon Price Treatment x Year			17.12* (9.79)
Akaike Inf. Criterion	355.08	336.97	333.93
Bayesian Inf. Criterion	363.00	344.89	343.43
Log Likelihood	-172.54	-163.49	-160.97
Observations	36	36	36

Notes: *** p < .01, ** p < .05, * p < .1; Regression results from mixed effects models; Abatement levels of carbon emissions was the dependent variable in all three Models; Random intercepts are associated with location in all three Models and additionally with time in Model 1. Robust standard errors are provided in parentheses.

Table 3: Determinants of actual average CO_2 emissions reductions 2030-2050 grouped on experimental session level.

What drives the difference in emissions reductions between the two treatments? If we look at the resolutions that are passed by the committees, then the Paris style negotiations in C1 are on average more ambitious than the C2 resolutions, in particular in 2030. However, there is a large and statistically significant difference between the resolution and the actual reduction of emissions in treatment C1, but not in treatment C2. This is shown in Figure 2:

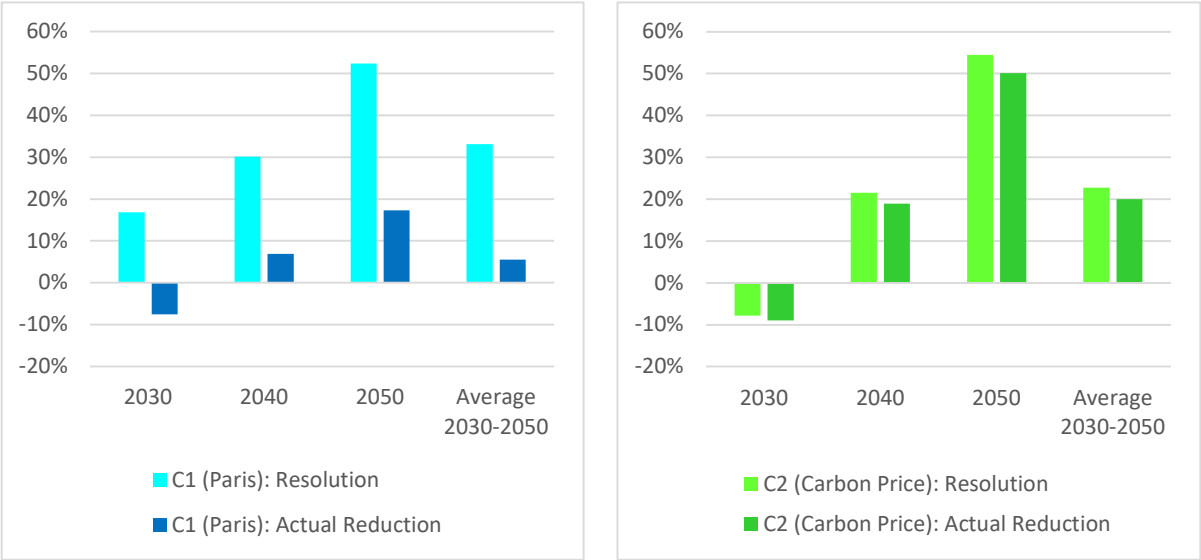

Figure 2: Resolutions vs. actual reductions. The left bars depict the reductions of emissions as announced in the resolutions, the right bars the actual reductions of emissions in all countries (national commitments weighted by country size).

Result 2: There is no significant difference in the resolutions passed in C1 and C2. However, the emissions reductions in the resolutions are substantial and statistically significantly higher than the actual reductions of emissions for 2030, 2040, and 2050 in C1, but small and not significantly different in C2.

Result 2 confirms Hypothesis 2. It is supported by Wilcoxon signed-rank tests (two-sided test, $z = -1.614$, $p = .107$), indicating that the resolutions passed are not statistically significantly different between C1 and C2. Furthermore, the emissions reductions as announced in the resolutions are statistically significantly higher than the actual average emissions reductions for 2030, 2040, and 2050 in C1 (one-sided tests, $z = 2.201$, $p = .014$), while they do not differ in C2 (two-sided tests, $z = 1.408$, $p = .159$).

There are two reasons for Result 2. First, in C2 the minimum price for carbon is binding for all countries that passed the resolution. In contrast, in the C1 negotiations, the actual reductions of emissions are not determined by the non-binding resolution but rather by nationally determined contributions. In fact, while some countries reduce their emissions by more than required by the resolution, most countries reduce substantially less and do not live up to the resolution that they passed. This is illustrated in Figure 3 that considers only

negotiations in C1 and looks only at those cases where a country voted in favor of a resolution. As can be seen from the figure, while the EU, Japan, Canada and Australia reduced their emissions by more than required by the resolutions, India, South Africa, Russia, and China reduced their emissions much less. The USA did not reduce them at all, and Saudi Arabia even increased their emissions on average in the years 2030-2050.

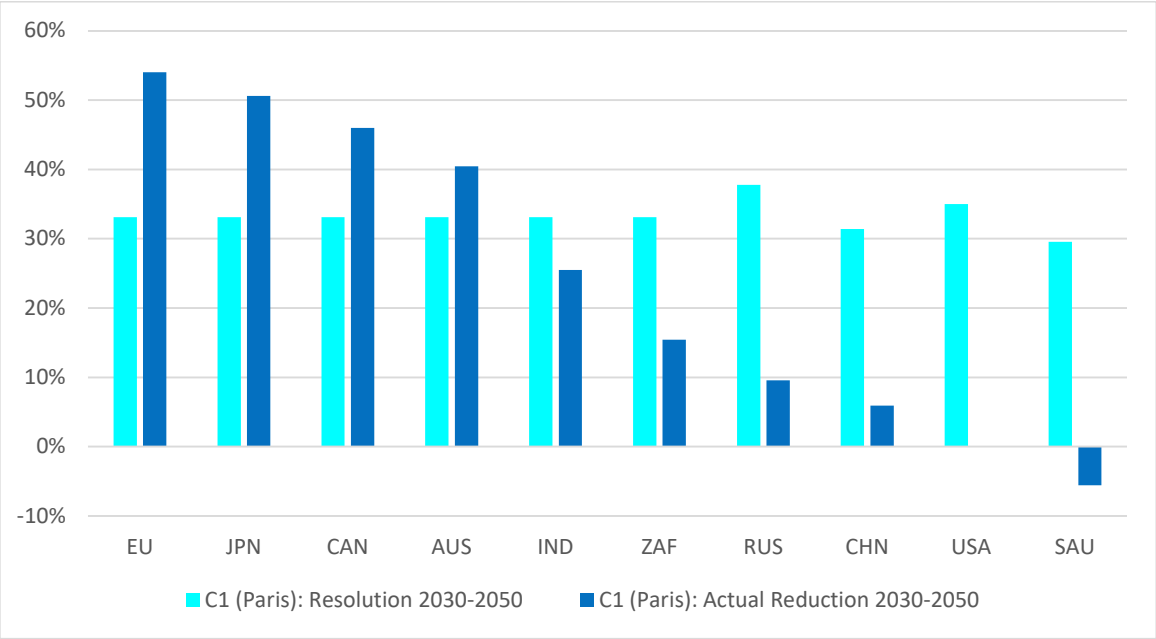

Figure 3: Resolution vs. actual reductions of each country in C1. The left bars depict the average announced reduction in those resolutions that the country voted for, the right bars depict the average actual reductions in all cases in which the country voted for the resolution.

The second reason is that resolutions are supported by fewer countries in C1 negotiations than in C2 negotiations. This is shown in Figure 4. While in C1 the resolution was passed on average by 80 percent of all countries, it was accepted by 93 percent in C2.

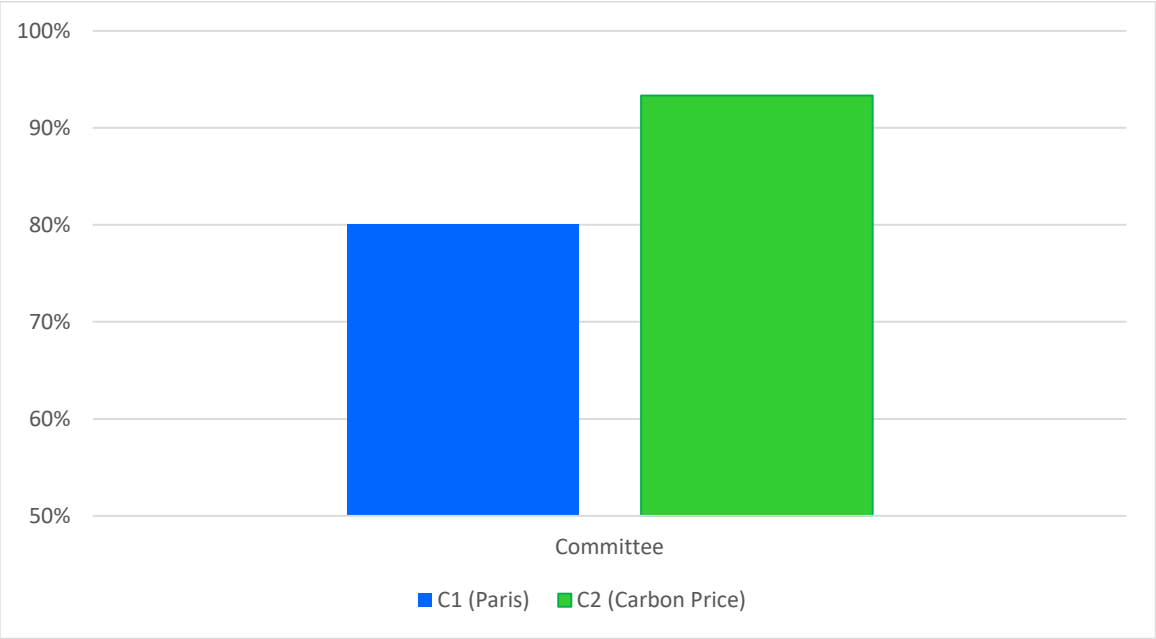

Figure 4: Fraction of countries that voted in favor of the resolution in Committee 1 and Committee 2 (averaged over all COP meetings).

Result 3: In C2 significantly more countries support the resolution than in C1.

Result 3 is supported by a Fisher's Exact test, which shows that a nation is statistically significantly more likely to vote in favor of the resolution if it is in C2 than if it is in C1 (p = .029). We further run a binary logistic regression, including the voting behavior as dependent variable and the treatment as predictor variable. Being in C2 significantly increases the probability of voting *Yes* versus voting *No* (coefficient = 1.25, p = .041, odds ratio = 3.5).

Result 3 clearly refutes Hypothesis 3. This may be surprising at first glance. After all, in C1 the resolution is non-binding and each country is free to choose its nationally determined contribution. Thus, each country could simply vote for the resolution and then choose a much smaller reduction of its emissions than required by the resolution. In fact, this is what many countries did. However, some countries voted against the resolution, in particular the US (5 times), Russia (3 times) and Saudi Arabia (3 times), often because they wanted to make the point that the fight against climate change is harmful to their national interests. This reflects the fact that the Paris agreement is seen more critically in these countries today as in 2015 when the Paris agreement was signed.

On the other hand, in C2, the agreed upon carbon price is binding for all countries that supported the resolution. Thus, a country can free-ride only by rejecting the resolution. This suggests a lower acceptance rate in C2 than in C1. However, in the discussions and actual negotiations during the MUN conferences we frequently observed that countries opposed to carbon pricing used their participation in the resolution as a bargaining chip. The delegates of Russia and Saudi Arabia (and less frequently of the USA) argued that a high carbon price of the other countries (combined with a border adjustment tax) is a major threat to their interests as exporters of fossil fuels. At the same time, they recognized that the majority of nations is determined to introduce carbon pricing to mitigate climate change. Thus, they tried to keep the carbon price as low as possible by leveraging their vote for the overall resolution. They promised to vote for the resolution, if the other countries agreed to carbon prices that were not too high.[22] This strategy often proved successful. Our observation of the actual negotiations indicate that the other countries probably would have adopted substantially higher carbon prices, in particular in 2030, if countries like Russia, Saudi Arabia and the USA had stayed out.

The developing countries, in particular India, South Africa, and to a lesser degree China, sometimes objected to the idea that they should impose the same carbon price as the developed countries. Two main arguments convinced them to participate. First, they realized that they will suffer most from climate change and thus have a strong interest to induce the other countries to mitigate it. Thus, they leveraged their vote by pressing for a higher carbon price. Second, the prospect of the Green Fund played a role in all negotiations, even though this was not part of the official agenda. Developing countries speculated that they will succeed in a later conference to convince all other countries to devote a small fraction of the revenues from global carbon pricing to the Green Fund, which would generate a sizable amount that could be used to support developing countries in their efforts to combat climate change.

Another interesting finding is that the reductions of emissions are much more evenly distributed across countries in C2 than in C1. Figure 5 shows that the average reductions in each country for 2030-2050 are all between 12 and 22 percent if they negotiate a carbon price, while they fluctuate widely between almost 55 percent and minus 33 percent if parties rely on nationally determined contributions. In sum, this leads to an overall lower actual average reduction over 2030-2050 in Committee 1 (about 5 percent) compared to a high reduction in

[22] An often-heard argument by the delegates of Russia and Saudi Arabia was that the lower prices in 2030 would provide them with more time to adapt and hence also increase their willingness to accept the higher prices in the future.

Committee 2 (about 20 percent). Thus, despite the large contributions by four countries in C1, the carbon emissions reductions are still below the reductions in C2.

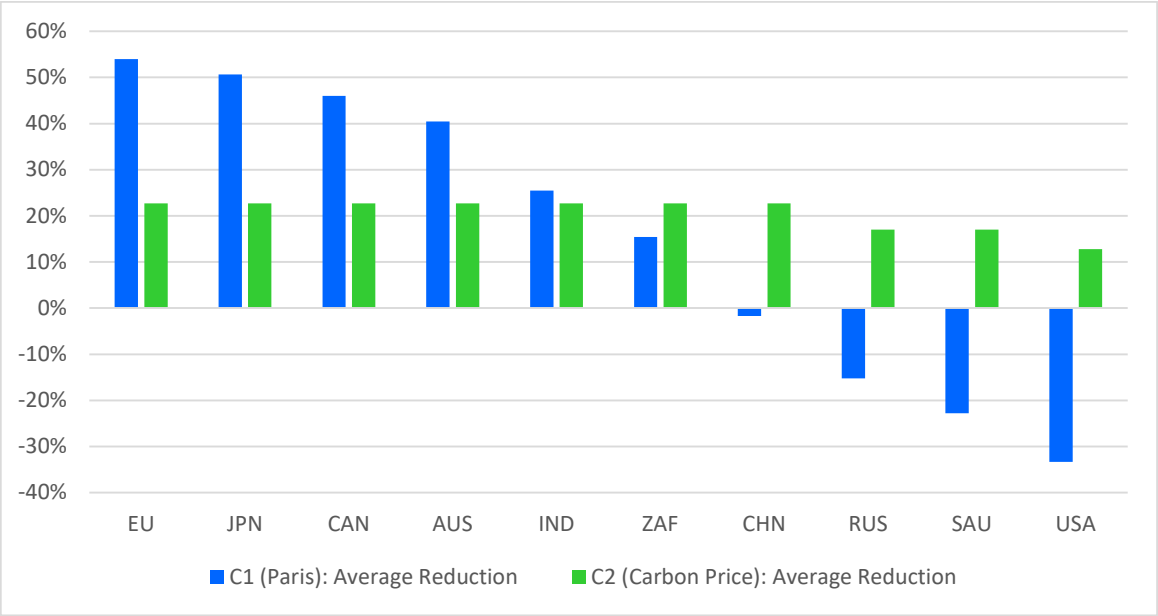

Figure 5: Reduction of emissions of each country in Committee 1 and Committee 2 in 2030-2050 (averaged over all COP meetings).

Result 4: There are substantial and highly significant differences in the reductions of emissions for 2030-2050 between countries in C1, while these differences are much smaller and statistically not significant in C2.

Result 4 confirms Hypothesis 4. It is supported by nonparametric Kruskal-Wallis tests, which indicate significant differences of emissions reductions between the countries in C1 ($H(9) = 103.15$, $p < .001$), but not in C2 ($H(9) = 1.53$, $p = .997$). We further analyze the differences for each country separately. In a first step, we compare the differences in 2030-2050 between C1 and C2 for each country. Supported by two-sided Wilcoxon signed-rank tests, we find that CO_2 emission reductions goals are significantly different between C1 and C2 for all countries, except India and South Africa. In a second step, we run one-sided tests to further explore those eight countries showing significant differences. One-sided Wilcoxon signed-rank tests reveal that for the EU, Japan, Canada, and Australia, CO_2 emission reductions goals are significantly higher in C1 than in C2. On the contrary, the CO_2 emission reductions goals for China, Russia, Saudi Arabia, and the USA are significantly higher in C2 than in C1.

Result 4 is partially imposed by the negotiation design. In C2, countries have to agree to a uniform minimum price for carbon, so all countries that agree to the resolution automatically impose the same carbon price that yields the same reduction of emissions. During the negotiations in C2, some countries like the EU and Japan announced that they were willing to voluntarily impose a higher carbon price than the minimum carbon price agreed upon in the Resolution, but this was not accounted for in the actual emissions reductions. If the negotiation protocol would have allowed for voluntary higher commitments in C2, this would have led to a less equal distribution of reductions and it might have further increased overall emissions in C2.[23]

7. Conclusions

MUN simulations are a novel experimental method that combines some of the advantages of laboratory and field experiments. They provide a formally structured framework that makes it possible to observe the outcomes of many simulated COP conferences on the same topic that were held under the exact same rules, with tight control over the preparation and the information provided to the participants. Thus, MUN conferences allow the experimenter to apply similarly high standards of replicability as in lab experiments, while at the same time enriching the experimental context and making the negotiations much more realistic. This increases external validity. MUN simulations do not use monetary incentives but rely on the intrinsic motivation of the participants to engage with a complex topic and to represent "their" nation as genuinely as possible. This may be closer to the motivation of real delegates than paying the subjects small amounts of money for their (difficult to measure) performance. The lively and dynamic debating process allows researchers to account for the complexity of negotiation processes and to collect data on a variety of interesting variables, as for instance which arguments are used, which coalitions are formed (and abandoned), and which strategies are employed. These observations are insightful, but it is sometimes difficult to draw statistically validated conclusions from them.

Of course, the new method also has its drawbacks. Like many other field experiments they require a large organizational effort which limits the number of observations. Furthermore,

[23] However, this could also reduce overall reductions, because countries that want a lower carbon price could argue that the minimum price should be kept low because those countries that want a higher price can have it on a voluntary basis.

the increase of external validity goes along with less control and thereby less internal validity of the experiment as compared to the lab. Finally, it is possible that the different locations and/or the different times at which the conferences took place affected behavior. However, because we always had both treatments at the same location at the same time, and because we randomized the assignment of the participants to the committee and their represented country this does not affect the statistical validity of the approach.

Despite these drawbacks, MUN simulations can provide valuable empirical information in addition to lab experiments and case studies. Result 1 shows that negotiating a common commitment on a uniform carbon price is more successful in reducing carbon emissions in the long run than negotiating a non-binding common goal that has to be achieved by individual commitments, confirming the lab experiment of Schmidt and Ockenfels (2020). Thus, our experiment provides causal evidence that the negotiation setup affects the reductions of carbon emissions.

There are several other results that have important implications. First, Result 2 shows that the individual commitments of Paris style negotiations do not live up to the non-binding common goal that the parties agreed upon. This is directly in line with projections of the Paris agreement (e.g. Clémençon 2016, Rogelj et al. 2016, Jiang et al. 2019, UNEP 2019) showing that the intended nationally determined pledged CO_2 emissions reductions are not sufficient to reach the two-degree-goal.

Result 3 shows that participation in the agreement is higher if a uniform carbon price is negotiated. This result is surprising as it is less costly for the nations to join a non-binding agreement, such as the Paris Agreement, as compared to a binding agreement, such as on a uniform global carbon price.

Our final Result 4 shows that in the Paris treatment (C1) some countries (e.g. EU, Japan, Canada, and Australia) frequently reduced their emissions by more than the common goal, while other countries (e.g. Russia, Saudi Arabia, and the USA) contributed very little. The uniform carbon price in the Carbon Price treatment (C2) forced all participating countries to contribute the same. Countries were not allowed to register additional voluntary climate action in the resolution. The discussions in C2 and the results of C1 showed, however, that some countries would have been prepared to do much more. This might have further increased the effectiveness of the carbon price negotiations.

Taken together our results suggest that focusing international climate negotiations on a uniform carbon price is a promising proposal. Additional research is required to study how to best negotiate a Green Fund that is necessary to support developing countries in their efforts to combat and deal with climate change, and how to optimally design border adjustment taxes that prevent carbon leakage. These problems have been left aside in our study. If it turns out that the Paris agreement does not lead to an upward spiral of nationally determined contributions, the international community should thus consider to change the negotiation format in the direction of a uniform common commitment such as a uniform carbon price, possibly first within a climate club.

References

Asal, V., 2005. Playing Games with International Relations. International Studies Perspectives 6, 359–373.

Barrett, S., 2003. Environment and Statecraft: The Strategy of Environmental Treaty-Making, 1st ed. Oxford University Press, Oxford, 437 pp.

Barrett, S., Dannenberg, A., 2016. An Experimental Investigation into 'Pledge and Review' in Climate Negotiations. Climatic Change 138, 339–351.

Battaglini, M., Harstad, B., 2016. Participation and Duration of Environmental Agreements. Journal of Political Economy 124, 160–204.

Battaglini, M., Harstad, B., 2020. The Political Economy of Weak Treaties. Journal of Political Economy 128, 544–590.

Boardman, R., 1969. The Theory and Practice of Educational Simulation. Educational Research 11, 179–184.

Chaudhuri, A., 2011. Sustaining Cooperation in Laboratory Public Goods Experiments: A selective survey of the literature. Experimental Economics 14, 47–83.

Clémençon, R., 2016. The Two Sides of the Paris Climate Agreement. Journal of Environment and Development 25, 3–24.

Edenhofer, O. (Ed.), 2014. Climate change 2014: Mitigation of climate change: Working Group III contribution to the Fifth assessment report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge.

Fehr, E., Gächter, S., 2000. Cooperation and punishment in public goods experiments. Am. Econ. Rev. 90, 980–994.

Fischbacher, U., Gächter, S., Fehr, E., 2001. Are People Conditionally Cooperative? Evidence from a Public Goods Experiment. Economics Letters 71, 397–404.

Grubb, M., Vrolijk, C., Brack, D., Forsyth, T., Lanchbery, J., Missfeldt, F., 1999. The Kyoto Protocol: A Guide and Assessment. Earthscan Publications, London, UK.

IPCC, 2018. Global Warming of 1.5 °C: Special Repprt. https://www.ipcc.ch/report/sr15/.

Jiang, X., Peters, G.P., Green, C., 2019. Global Rules Mask the Mitigation Challenge Facing Developing Countries. Earth's Future 7, 428–432.

Kauneckis, D.L., Auer, M.R., 2013. A Simulation of International Climate Regime Formation. Simulation and Gaming 44, 302–327.

Kesternich, M., Lange, A., Sturm, B., 2014. The impact of burden sharing rules on the

voluntary provision of public goods. Journal of Economic Behavior & Organization 105, 107–123.

Kesternich, M., Lange, A., Sturm, B., 2018. On the performance of rule-based contribution schemes under endowment heterogeneity. Exp Econ 21, 180–204.

Kocher, M.G., Martinsson, P., Persson, E., Wang, X., 2016. Is there a hidden cost of imposing a minimum contribution level for public good contributions? Journal of Economic Psychology 56, 74–84.

Kosfeld, M., Okada, A., Riedl, A., 2009. Institution formation in public goods games. Am. Econ. Rev. 99, 1335–1355.

Lester, J.P., Stoil, M.J., 1979. Evaluating a Role-Specific Simulation. Simulation and Games 10, 167–181.

List, J., 2020. Non est disputandum de generalizability? A glimpse into the external validity trial. NBER Working Paper 27535.

MacKay, D.J.C., Cramton, P., Ockenfels, A., Stoft, S., 2015. Price Carbon - I Will if You Will. Nature 526, 315–316.

Martinsson, P., Persson, E., 2019. Public Goods and Minimum Provision Levels: Does the Institutional Formation Affect Cooperation?*. Scand. J. of Economics 121, 1473–1499.

Matzner, N., Herrenbrück, R., 2017. Simulating a Climate Engineering Crisis. Simulation and Gaming 48, 268–290.

Muldoon, J.P., 1995. The Model United Nations Revisited. Simulation and Gaming 26.

Nordhaus, W., 2015. Climate Clubs: Overcoming Free-riding in International Climate Policy. American Economic Review 105, 1339–1370.

Nordhaus, W., 2019. Climate Change: The Ultimate Challenge for Economics. American Economic Review 109, 1991–2014.

Orzen, H., 2008. Fundraising through Competition: Evidence from the Lab. CeDEx Discussion Paper 2008-11, Nottingham. http://hdl.handle.net/10419/49659.

Ostrom, E., 1990. Governing the Commons: The Evolution of Institutions for Collective Action. Cambridge University Press, Cambridge, 280 pp.

Ostrom, E., Burger, J., Field, C.B., Norgaard, R.B., Policansky, D., 1999. Revisiting the Commons: Local Lessons, Global Challenges. Science 284, 278–282.

Penetrante, A.M., 2012. Simulating Climate Change Negotiations: Lessons from Modeled Experience. Negotiation Journal 28, 279–314.

Pigou, A.C., 1920. The Economics of Welfare. MacMillan and Co., London.

Rogelj, J., den Elzen, M., Höhne, N., Fransen, T., Fekete, H., Winkler, H., Schaeffer, R., Sha, F., Riahi, K., Meinshausen, M., 2016. Paris agreement climate proposals need a boost to keep warming well below 2 °C. Nature 534, 631 EP -.

Rooney-Varga, J.N., Sterman, J.D., Fracassi, E., Franck, T., Kapmeier, F., Kurker, V., Johnston, E., Jones, A.P., Rath, K., 2018. Combining role-play with interactive simulation to motivate informed climate action: Evidence from the World Climate simulation. PloS one 13, e0202877.

Schelling, T.C., 1960. The Strategy of Conflict. Harvard University Presss, Cambridge, Mass., 309 pp.

Schmidt, K.M., Ockenfels, A., 2020. Focusing Climate Negotiations on a Uniform Common Commitment Can Promote Cooperation. CRC TRR Discussion Paper No. 267.

Schwardmann, P., Tripodi, E., Van der Weele, Joël J., 2019. Self-Persuasion: Evidence from Field Experiments at Two International Debating Competitions. CESifo Working Papers 7946.

Stiglitz, J.E., Stern, N., Duan, M., Edenhofer, O., Giraud, G., Heal, G.M., La Rovere, E.L., Morris, A., Moyer, E., Pangestu, M., Shukla, P.R., Sokona, Y., Winkler, H., 2017. Report of the High-Level Commission on Carbon Prices, New York.

UNEP, 2019. Emissions Gap Report 2019. United Nations Environment Programme, Nairobi. https://www.unenvironment.org/resources/emissions-gap-report-2019.

UNFCCC Secretariat, 2015. Synthesis Report on the Aggregate Effect of the Intended Nationally Determined Contributions. https://unfccc.int/resource/docs/2015/cop21/eng/07.pdf.

Weitzman, M.L., 2014. Can Negotiating a Uniform Carbon Price Help to Internalize the Global Warming Externality? Journal of the Association of Environmental and Resource Economists 1, 29–49.

Weitzman, M.L., 2015. Internalizing the Climate Externality: Can a Uniform Price Commitment Help? Economics of Energy and Environmental Policy 4, 37–50.

Weitzman, M.L., 2017a. On a world climate assembly and the social cost of carbon. Economica 84, 559–586.

Weitzman, M.L., 2017b. Voting on Prices vs . Voting on Quantities in a World Climate Assembly. Research in Economics 71, 199–211.