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A Model United Nations Experiment on Climate Negotiations

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Abstract: Weitzman, M.L. (2014. Can negotiating a uniform carbon price help to internalize the global warming externality? *J. Assoc. Environ. Resour. Econ.* 1: 29–49) proposed that focusing international climate negotiations on a uniform common commitment (such as a uniform carbon price) is more effective than negotiations on individual commitments (as in the Paris agreement) 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 offer support for Weitzman's hypothesis and indicate that negotiating a common commitment on a uniform carbon price may yield higher emission reductions in the long run and more participation than individual commitments à la Paris.

Keywords: climate negotiations, negotiation design, model united nations, uniform carbon price

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1 Introduction

Mitigating CO₂ emissions is a global public good problem. To solve it, effective international cooperation is required that needs to be 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, nonbinding 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 sufficiently 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 price for carbon emissions. This negotiation design strives for a *uniform 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 some countries may prefer to stay out of the agreement and not to impose any carbon price at all.

Is this new approach, focusing on a uniform common commitment, likely to be more successful than negotiating individual commitments, as in 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

¹ See e.g. Cléménçon (2016), Rogelj et al. (2016), Jiang et al. (2019), UNEP (2019).

conferences followed the actual COP rules of the United Nations. Student 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.

Both COPs had to pass resolutions specifying the reductions of carbon emissions in the years 2030, 2040, and 2050. In committee C1, these reductions were achieved by binding individual commitments to emission reductions of the participating countries in these years, combined with a nonbinding common goal on how much to reduce worldwide emissions. In committee C2, the parties that passed the resolution agreed to a binding commitment on a uniform carbon price for each of these years. Thus, C1 negotiated *individual commitments* (as in Paris), while C2 focused the negotiations on a *uniform common commitment* (a uniform carbon price).

Our study has four main results: First, we find that countries achieve significantly and substantially higher reductions of carbon emissions in 2050 in C2 where they negotiate a uniform carbon price. Second, in C1 countries are equally ambitious in their nonbinding common goals as in C2 (no significant difference), but the actual individual commitments in C1 do not live up to these goals. Third, to our surprise, significantly more countries participate in the resolution if a uniform common commitment is negotiated than if negotiations are focused on individual commitments. 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 C1, while countries contribute more equally to the common good in C2. This is partly due to the uniformity of the carbon price, and partly due to the fact that in C2 more countries participate in the resolution.

Our paper is closely related and complementary to Schmidt and Ockenfels (2021) 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 (2021) 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 (2021) show that their qualitative results continue to hold even if contracts are nonbinding and cannot be enforced.

The advantage of the laboratory experiment of Schmidt and Ockenfels (2021) 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 highly significant (and substantial) causal effect on the negotiation outcome. However, the experiment is very 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 have a richer and more realistic context, they last for an entire day, and subjects are intrinsically motivated to represent the best interest of their countries. Following the taxonomy of Harrison and List (2004), our experiment is close to what they call a framed field experiment, because the experimental framework of climate change negotiations represents field context. However, our design differs from a framed field experiment as we use a standard subject pool of students. These subjects simulate negotiations in a field setting, an experimental design that is not quite captured in the taxonomy of Harrison and List (2004).

Our paper is related to several strands of the literature. First, there is a large literature on international environmental agreements going back to the canonical paper by Barrett (1994) and surveyed by Barrett (2005). This literature offers many important insights in the incentives to join international agreements and how to make them self-enforcing. However, it does not discuss the design of the negotiation process.

Second, 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

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

uniform carbon price to negotiations on a vector of emission reductions. He argues that negotiating a uniform carbon price provides a salient focal point (as advocated by Schelling (1960)), and he shows formally that it aligns self-interest with the common good. This argument has been formalized by Weitzman (2014) and Schmidt and Ockenfels (2021). 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. Schmidt and Ockenfels (2021) 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. MacKay et al. (2015) furthermore 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.

Third, there is an experimental literature on the endogenous formation of institutions for successful public good provision. Dannenberg and Gallier (2020) offer an excellent survey of this literature. According to their classification our paper considers the case of a global public good (carbon emissions affect everybody) and an exclusive institution (the uniform carbon price applies to only those countries that support it). A closely related paper in this class is Kosfeld et al. (2009) who consider a public good game in which subjects can vote on the introduction of an institution that forces all members to contribute the full amount to the public good, while those who stay out are free how much to contribute. They find that institutions form in about half of all cases, and in most of them there is full participation. In contrast, in our setup countries are not forced to raise the carbon price to the efficient level. The minimum mechanism allows them to react to those countries that did not participate in the uniform carbon price. Several other papers explore the minimum contribution mechanism. Dannenberg et al. (2014) consider a repeated public good experiment in which all players are forced to participate (inclusive institution). They find that about 60 percent of the groups have an increasing minimum contribution level over time that approaches the social optimum at the end, while the other 40 percent implement a low level throughout the game. This may be explained by the fact that participation was not voluntary. A subject that was forced to participate can choose a very low contribution level

which implies that all other contributions are equally low. In contrast, participation was voluntary in our setup. In Kocher et al. (2016) as well as in Martinsson and Persson (2019) the minimum contribution level was prespecified but lower than the efficient level. Both papers find that the large majority of subjects vote in favor of this mechanism. Almost all of the lab experiments in this literature do not allow subjects to communicate, while in our Model United Nations experiment parties had ample time to discuss and negotiate their actions. While almost all of the lab experiments take place in an abstract setting, there is one interesting experiment by Barrett and Dannenberg (2016) on climate negotiations. They study the “pledge and review” process of the Paris agreement in a lab experiment and show that pledges do not increase actual contributions over time.

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. (2022) 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 describes the setup of the MUN experiment. Section 3 derives the hypotheses that we want to test. Section 4 summarizes the experimental procedures and Section 5 reports the results. Section 6 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 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 extra-curricular activities to prepare for simulated 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 at 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 policy³ 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).⁴ These include the major CO₂ emitters (USA, China, EU, and Japan), the major producers of fossil fuels (Saudi Arabia, Russia, USA, and Australia), and countries from the developing world (India and 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

³ 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.

⁴ 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.

5th Assessment Report of the Intergovernmental Panel on Climate Change (IPCC). It also discusses different policy options to combat climate change and their estimated costs.⁵ 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 CO₂ emissions until 2030, 2040, and 2050 (as compared to 2010), (4) a suggestion by how much the respective country should reduce its own CO₂ 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.⁶ 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) is instructed to get to a resolution that specifies goals for the reduction of worldwide CO₂ emissions in 2030, 2040, and

⁵ The study guide also offers some statistical information on the ten participating countries, such as population, GDP/person, share of worldwide CO₂ 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 CO₂ emissions.

⁶ We selected the best position paper based on whether it took a credible and realistic stance on the aforementioned five points from the perspective of the represented country and how well written the position paper was in terms of structure, information content and clarity. These award-winning position papers (from both committees and all experimental sessions) are available in the Appendix.

2050, but these goals are nonbinding.⁷ Actual reductions are achieved by nationally determined contributions, i.e. *individual commitments* of all countries supporting the resolution on how much they will reduce their own emissions by 2030, 2040, and 2050. Parties are also asked to indicate in the Annex how they plan to achieve these reductions (e.g. via carbon pricing, subsidizing green energy, imposing restrictions and regulations on CO₂ emissions, etc.) Participants are told that these country-specific goals are *binding commitments* according to international law.⁸ Note that the country-specific goals are “nationally determined” by each country alone after the resolution has been passed. This negotiation protocol shares key features of the negotiation protocol that led to the Paris agreement.

In Committee 2 (C2) the negotiation rules are different. Delegates are informed that there has been a previous agreement to introduce a *common commitment* via a uniform price for CO₂ emissions (a “carbon price”). They are instructed to get to a resolution that specifies how high this uniform carbon price should be in 2030, 2040, and 2050. Each country is free how to implement the carbon price (by a carbon tax, emissions trading system, or some hybrid system) and how to spend the revenues from carbon pricing. However, for all countries supporting the resolution, the carbon price is binding. Again, participants are told that this agreement is a *binding commitment* according to international law. Countries that do not vote for the resolution are not bound by it. Delegates are informed that the common carbon price is accompanied by a carbon border adjustment tax to prevent carbon leakage.⁹ They 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.¹⁰ Countries that do not support the resolution are assumed to pursue “business as

⁷ Reductions or increases in CO₂ emissions are always relative to the emission levels of 2010.

⁸ The instructions mention that if a country does not adhere to its legally binding commitment, it can be sued and sentenced to pay penalties. Note that the legal status of the actual Paris agreement is less clear. While some countries have been successfully sued by their citizens to fulfill their obligations, this is not possible in other countries. However, we wanted to have equally strong commitments in both treatments. We did not discuss whether these legal obligations are enforceable.

⁹ The idea of a climate club with a uniform carbon price is closely linked to a carbon border adjustment mechanism, see e.g. Weitzman (2014, p. 47) and Nordhaus (2019, p. 2011). For this reason, we presented these two ideas together in Committee 2. A carbon border adjustment mechanism is much more problematic if employed by a single country. Hence, we did not refer to it in the instructions of Committee 1.

¹⁰ This voting procedure is less demanding than the one applied at the COP21 in which the Paris Agreement has been negotiated (which required a two-third majority and for some decisions a consensus, see UNFCCC Secretariat (2015)). Out of 12 voting results from both committees, we observed 4 instances where the resolution was adopted unanimously, 7 instances where it was

usual” which results in an increase of CO₂ emissions by 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.¹¹

It is crucial for the 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 CO₂ 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) and the Report of the High-Level Commission on Carbon Prices (Stiglitz et al. 2017).¹² All delegates are instructed to take these numbers at face value.

The two committees are two experimental treatments that differ in only one respect: In Committee C1, individual commitments are negotiated, while in Committee C2 negotiations aim at a uniform common commitment. Note that carbon pricing is not restricted to Committee 2. The delegates in Committee 1 can also choose to adopt carbon prices. However, in C1 each country has to do this independently, while in C2 all countries supporting the resolution have to commit to a common uniform carbon price.

adopted with a two-thirds majority and one instance where it was adopted with a simple majority (in this case the resolution passed with 6 Yes votes). On average, 8 out of 10 countries voted in favor of the resolution in C1. In C2 the average was 9.3. See the discussion of Result 3 and Figure 4 for more details.

11 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).

12 The linear relationship reflects the short- and medium-term effects of a carbon price. The long-term effects are predicted to be significantly larger because of technological innovation. For example, the cost of producing green hydrogen and the cost of carbon capture and storage are predicted to decrease significantly over time and will become economical at much lower carbon prices. If this prediction is correct, it strengthens the effects of carbon pricing (and thereby our results) significantly.

3 Hypotheses

The main question of our study is which negotiation protocol is more successful in achieving an effective agreement.¹³ Following the literature discussed in the Introduction we predict that negotiations on a uniform carbon price are more successful than negotiations on individual commitments.

Hypothesis 1: Negotiations in C2 achieve significantly higher reductions in CO₂ emissions than negotiations in C1.

In C1, parties did not only state their nationally determined contributions, they also proclaimed a non-binding common goal, namely by how much they want to reduce global CO₂ emissions. Because this common goal is nonbinding and nobody can be held responsible for not achieving it, we hypothesize that the individual commitments fail to achieve the stated common goal.

Hypothesis 2: In C1 the proclaimed nonbinding common goal is significantly higher than the sum of the nationally determined contributions specified by each country individually.

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 was going to withdraw from the agreement while our experiments took place and some other countries were also on the fence. Thus, in C1 we expect most (but not necessarily all) countries to participate. In C2, a uniform carbon price is a much stronger commitment. Each party has an incentive not to participate but to free-ride on the efforts of the other parties.

Hypothesis 3: Participation in the resolution is significantly higher in C1 than in C2.

A related question concerns the differences across countries in their contributions. In C2 the uniform carbon price forces all countries that participate in the resolution to impose the same price. Only those countries that do not participate have a carbon price of 0 and therefore higher emissions. In contrast, in C1 each country decides on its own how much to contribute. Some countries (like the EU or Japan)

13 We (pre-)registered the trial with a Pre-Analysis Plan in the AEA RCT Registry: Hofmann, Elisa, Lucas Kyriacou and Klaus Schmidt 2019. "A Model United Nations experiment on climate change negotiations." AEA RCT Registry. October 23. <https://doi.org/10.1257/rct.4834-1.1>. However, we did so only after the first sessions had been completed.

may behave altruistically; others (like the USA or Russia) may put their own interests first. Therefore, we hypothesize that the differences in contributions are likely to be larger in C1.

Hypothesis 4: In C1 there will be large differences in the contributions of the different countries. In C2, emission reductions will be less unequal.

4 Experimental Procedures

The experiment was conducted in late 2018 and 2019. We held six MUN conferences in Germany and Switzerland lasting about 7 h (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

Table 1: Overview of experimental sessions and participants.

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

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 and kept a log.

Table 2 provides summary statistics of the participants (delegates only)¹⁵ and survey evidence on how they evaluated the conference. On average, participants

¹⁴ In our statistical analysis we ignore the chairs and are interested in the behavior of the delegates only ($n = 120$).

¹⁵ Missing observations are due to not obligatory responses in the ex-post questionnaire.

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

Variable	Mean	Std. dev.	N	Min.	Max.
Age	22.07	2.74	119	16	29
Gender (<i>female</i> = 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)	467.22	330.78	116	50	2040
Evaluation: realism position paper	5.32	1.25	119	1	7
Evaluation: realism own performance	4.82	1.21	119	1	7
Evaluation: realism other's performance	4.92	1.14	119	2	7
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

were 22.07 years old. 48 percent of them were female. Subjects studied on average in their 4th semester. On average participants had participated in 3.25 MUN conferences before and prepared on average 467.22 min (almost 8 h) for the conference. They rated the realism of their position paper at 5.32 on a seven-point Likert-scale ranging from 1 (“not realistic at all”) to 7 (“very realistic”). They evaluated their own performance at 4.82 (on the same scale), similar to the performance of the other participants (4.92). Furthermore, subjects evaluated the realism of the resolution at 4.24 and they were ‘rather satisfied’ with the resolution (4.71 on a seven-point-Likert-Scale ranging from 1 (“not satisfied at all”) to 7 (“very satisfied”)). 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, $z = 4.55$, $p < 0.001$).¹⁶ This survey evidence indicates that the MUN conferences succeeded in providing a fairly realistic framework for our simulation experiment.

Participants came from a broad variety of disciplines. Most of them studied economics (28%), law (22%) and other social sciences (21%). The balance Table A.1 in the Appendix shows that the differences among participants across treatments and experimental session are small.

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). In our study we mainly rely our statistical analysis on nonparametric tests (Wilcoxon signed-rank test, Kruskal–Wallis test, Fisher’s exact test) due to our small sample size and the potentially non-normality of distributions. We complement these nonparametric analyses by parametric analyses (linear mixed effects regressions for Result 1 and binary logistic regression for Result 3).

5 Results

Figure 1 compares the average actual worldwide reductions of emissions in percent as compared to 2010 in C1 (individual commitments) and C2 (uniform common commitment) across the six COP meetings.¹⁷ Note that positive values indicate emission reductions while negative values indicate increases in emissions.

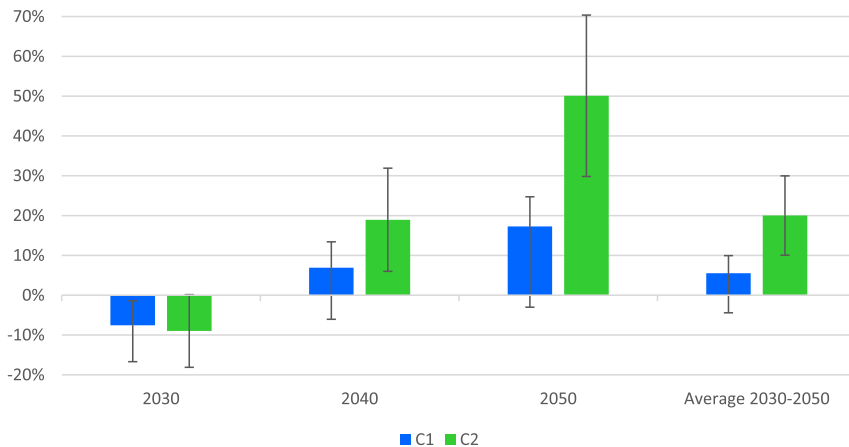


Figure 1: Actual worldwide reductions of emissions (weighted average over all countries) in Committee C1 versus Committee C2 averaged over all COP meetings.

There are two main differences between the outcomes of treatments C1 and C2. First, average emission reductions of the years 2030–2050 are substantially higher in C2 (about 20 percent) than in C1 (about 5 percent). Second, the time path of emission 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.¹⁸

¹⁷ The emission reductions for each experimental session are provided in Table A.2 in the Appendix.

¹⁸ 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.

Result 1: In 2050 the actual emission 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 ($z = 2.071$, $p = 0.019$) comparing the actual CO₂ emission reductions of the ten countries in Committee C1 (as stated in the Annex if they support the resolution and “business as usual” otherwise) with the actual CO₂ emission reductions of the ten countries in Committee C2 (again depending on voting behavior on the resolution) for the year 2050 in all experimental sessions.¹⁹

Result 1 is further backed up by linear mixed effects regressions (see Table 3). Here we compare the actual *average* worldwide abatement levels over 2030–2050 between the two treatments and for the different years. In all three models, the dependent variable is the actual average CO₂ emissions reduction in the years 2030, 2040, and 2050. We include a random effect of the location as a matching group variable in all three Models. 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 (repeated observations) and hence to account for the nested structure of our data.²⁰

Table 3: Determinants of actual average CO₂ emission reductions 2030–2050 grouped on experimental session level.

	(1)	(2)	(3)
(Intercept)	5.54 (6.46)	−36.41 ^a (9.03)	−19.29 ^a (6.36)
C2 treatment	14.48 (10.39)	14.48 (10.39)	−19.76 (12.02)
Year		20.98 ^a (3.75)	12.42 ^a (2.20)
C2 treatment x year			17.12 ^b (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

^a $p < 0.01$, ^b $p < 0.1$. 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 adjusted for six location clusters are provided in parentheses.

19 We use a one-sided test here (and in some of the following results) to test directed predictions, while two-sided tests are used for undirected predictions.

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 (repeated) responses per observation (2030, 2040, and 2050), we include 36 observations in our regression analysis. As a robustness check we ran a similar regression including a random effect of the group (clustering the standard errors at the 12 group levels; see Appendix, Table A.3). When excluding the data from Bern, the regression results are similar (see Appendix).

The treatment itself increases actual worldwide reductions of emissions, but the effect is statistically not significant (Model 1, coefficient = 14.48, $p = 0.163$). However, reductions of emissions significantly increase over time (Model 2, coefficient = 20.98, $p < 0.001$). Furthermore, we find a (marginally) significant interaction between treatment and time (Model 3, coefficient = 17.12, $p = 0.080$).²¹

What drives the difference in emission reductions between the two treatments? If we look at the resolutions that are passed by the committees, then the 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:

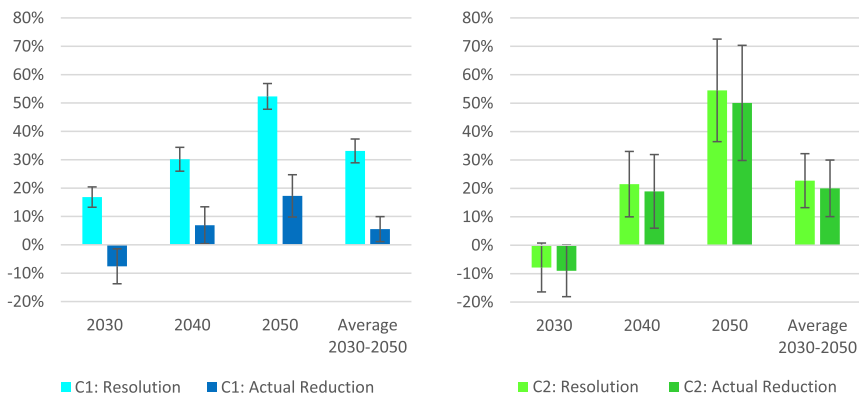


Figure 2: Resolutions versus actual reductions. The left bars depict the reductions of emissions as announced in the resolutions, the right bars the actual reductions of emissions in all countries (national commitments weighted by country size).

Result 2: There is no significant difference in the resolutions passed in C1 and C2. However, the emission 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, $z = -1.614$, $p = 0.107$), indicating that the resolutions passed are not statistically significantly different between C1 and C2. Furthermore, the emission reductions as announced in the resolutions are statistically significantly higher than the actual average emission reductions for 2030, 2040, and 2050 in C1 (one-

²¹ As a robustness check we ran a similar regression with time dummy variables (see Appendix, Table A.4) confirming these results.

sided tests, $z = 2.201$, $p = 0.014$), while they do not differ in C2 (two-sided tests, $z = 1.408$, $p = 0.159$).

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 determined by nationally determined contributions while the non-binding goal of worldwide emission reductions is just cheap talk. In fact, while some countries reduce their emissions by more than the goal of the resolution, most countries reduce substantially less and do not live up to the proclaimed goal in 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.

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.

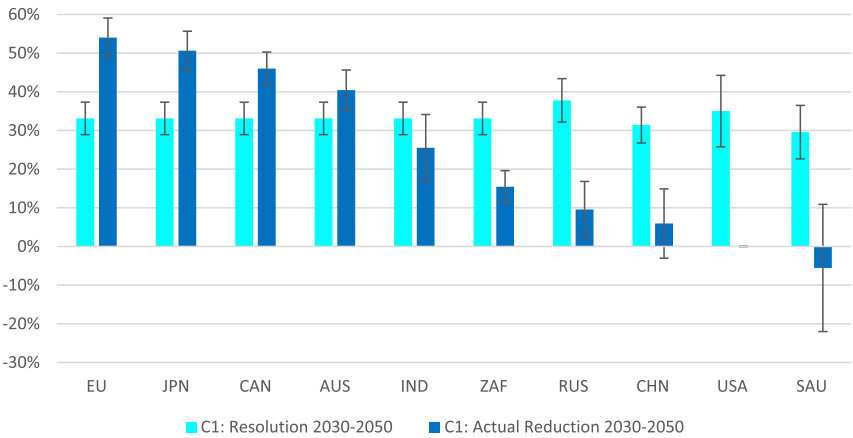


Figure 3: Proclaimed goal versus actual reductions of each country in C1. The left bars depict the average announced reduction in those resolutions that the country voted for, the right bars depict the average actual reductions in all cases in which the country voted for the resolution.

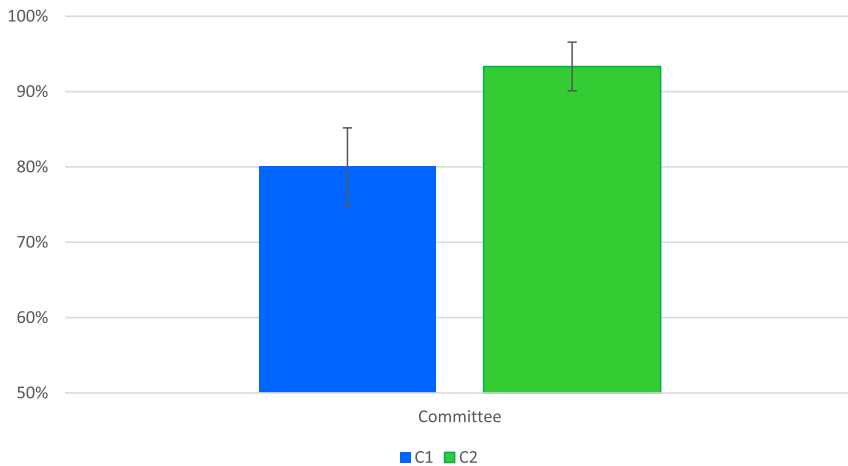


Figure 4: Fraction of countries that voted in favor of the resolution in Committee C1 and Committee C2 (averaged over all COP meetings).

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 ($p = 0.029$). 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, $p = 0.041$, odds ratio = 3.5).

Result 3 clearly refutes Hypothesis 3. This may be surprising at first glance. After all, in C1 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 was seen more critically in these countries at the time of the experiments than in 2015 when the Paris agreement was signed.

On the other hand, in C2, the agreed upon common 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 (both C1 and C2), even though this was not part of the official agenda. Developing countries speculated that they will succeed in a later conference to convince richer countries to contribute to a Green Fund aiming 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 Committee 2 (about 20 percent). Thus, despite the large contributions by four countries in C1, the carbon emission reductions are still below the reductions in C2.

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.

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.

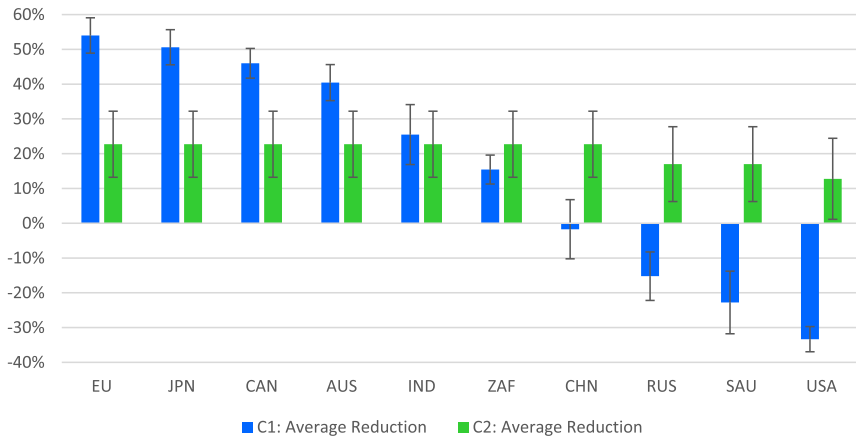


Figure 5: Reduction of emissions of each country in Committee C1 and Committee C2 in 2030–2050 (averaged over all COP meetings).

Result 4 confirms Hypothesis 4. It is supported by nonparametric Kruskal–Wallis tests, which indicate significant differences of emission reductions between the countries in C1 ($H(9) = 103.15$, $p < 0.001$), but not in C2 ($H(9) = 1.53$, $p = 0.997$). 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 reduction 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 reduction goals are significantly higher in C1 than in C2. On the contrary, the CO_2 emission reduction 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 emission 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

It is interesting to compare the experimental outcomes for the different countries to the real nationally determined contributions listed by these countries in the Annexes to the Paris agreement. However, countries have lot discretion how to list and count their contributions, and not all countries submitted their NDC. Climate Action Tracker (CAT)²⁴ is an independent scientific analysis platform that tracks government climate action over time. Through its analyses and estimates, CAT helps to compare officially submitted NDCs. In the Appendix, we compare the real NDCs of the Paris Agreement available at the time of our experiments (as measured by CAT) to the average behavior in C1 for 2030 and 2050. As can be seen in Table A.6, the large majority of the pledges in C1 are very close to the NDC counterparts. This confirms that the subjects took their roles in the simulated negotiations seriously.

6 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 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 a narrowly defined performance.²⁵ 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

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.

24 See <https://climateactiontracker.org/about/>.

25 See Voslinsky and Azar (2021) for a recent survey showing that experiments without financial incentives may be preferable to narrowly incentivized experiments.

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. It requires a large organizational effort which limits the number of observations. Furthermore, the increase of external validity goes along with less control and thereby less internal validity of the experiment as compared to the lab.

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 (2021). 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 (as in 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. Cléménçon 2016, Rogelj et al. 2016, Jiang et al. 2019, UNEP 2019) showing that the intended nationally determined pledged CO₂ emission 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 nonbinding agreement, such as the Paris Agreement, as compared to a binding agreement, such as on a uniform global carbon price. However, a uniform carbon price limits free-riding because fossil fuel producers can leverage their participation for keeping the carbon price low.

Our final Result 4 shows that in 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 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 lend some support for the proposal to focus international climate negotiations on a uniform carbon price. However, additional research is required to test the validity of this proposal. Furthermore, it is important 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. These problems have been left aside in our study. Finally, it would be very interesting to study the dynamic features of different negotiation designs: Is it more difficult to achieve an upward spiral over time of individual commitments or of a uniform common commitment?

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