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Bounded rationality and social interaction in negotiating a climate agreement

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Abstract An agreement on climate change mitigation hinges on large-scale international cooperation. Rational agents are supposed to consider the cost and benefits of cooperation, which then determine their negotiation positions. Behavioral economics provides experimental evidence that decision-making in negotiation-like situations is influenced by systematic cognitive biases and social interaction. In this paper, we examine the impact of bounded rationality and social preferences on bargaining in international climate negotiations and illustrate how particular deviations from full rationality affect the incentives to cooperate. Of special interest are fairness preferences for burden-sharing rules and behavioral responses to different framings of climate change and policy, as well as implications of these for communication about climate change. The analysis will further address different levels of representation, including individual citizens, politicians, experts, and (professional) negotiators. The consequences of the most prominent nonstandard preferences and biases for negotiating a climate treaty are assessed, and specific strategies to foster cooperation are suggested.

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1 Introduction

Climate change can be regarded as a large-scale social dilemma, because it involves a global public good, namely the atmosphere. An effective climate policy aimed at reducing greenhouse gas emissions requires a collective effort by the most important emitters of greenhouse gases. This is difficult to achieve because cooperators—countries reducing emissions—pay the cost of mitigation, while any benefits are shared between cooperators and free-riders alike. A basic problem here is that cooperation is needed among a very large group of unrelated individuals, in effect the entire human population. The issue is further complicated by the multilevel nature of institutions: voters and politicians at national level and national representatives (negotiators) at an international level.

Two related prominent features of an international climate agreement are temporal and spatial asymmetries of, and uncertainty about, the benefits and costs of mitigation, even under full cooperation (Barrett 2001, 2007). Cooperation means certain costs now but uncertain future benefits, accruing partly to later generations (temporal asymmetry). Moreover, the prospects of benefitting from a stable climate vary widely from country to country (spatial asymmetry). For example, developing countries will generally benefit to a greater extent than developed countries due to the fact that the damage curve is steeper for such countries. As opposed, developed countries carry a main, historical responsibility for the climate problem but are likely to suffer less from it in the future. Associated with this, the costs of an agreement will mainly fall onto a subset of negotiating countries (major emitters) and are more certain than any long-term benefits.

Most economic analyses apply standard game theory to international climate negotiations in order to study the participation decision of negotiators when bargaining over emission reductions.[1] This theory is based on the core assumptions of rational agents driven by net benefit maximization, stable preferences and perfect information (see, for example, Carraro and Siniscalco 1993; Barrett 1994; Finus 2001; Heitzig et al. 2011). This leads to the prediction of free-riding as the dominant strategy. An incomplete agreement or unilateral action is then the second-best outcome. Yet, in both these cases, capital flight of dirty industries and thus carbon leakage are likely, with the consequence that emissions reduction will be limited (Babiker 2001; Paltsev 2001; Kuik and Gerlagh 2003).

The assumption of rational agents and self-regard in current analyses of climate agreements is not in line with reality as this approach neglects many important aspects of human behavior. In this respect, much can be learned from behavioral economics, which has identified the factors that influence cooperation and generally economic decision-making (Simon 1955; Kahneman and Tversky 1974, 1979; Ostrom 1990; Boyd and Richerson 1992; Fischbacher et al. 2001; Fehr and Gächter 2002; Nowak and Sigmund 2005). Recently, some studies have examined the importance of alternative models of individual behavior for environmental issues (Shogren and Taylor 2008; Gsottbauer and van den Bergh 2010). The context of climate negotiations has, so far, hardly been examined. Exceptions are Lange (2006), Gowdy (2008), and Brekke and Johansson-Stenman (2008), who all focus on fairness and discounting.

[1] For an overview of theories of multilateral environmental agreements, including behavioral approaches, see van den Bergh and Castells (2004).

This paper will take a broader view and suggest that, in trying to understand negotiations for an international climate agreement, one needs to take into account a range of aspects of bounded rationality and other-regarding preferences. Our aim is to show how insights will alter, or which new questions will appear, if rationality and isolated individuals are replaced by bounded rationality and other-regarding preferences. This can be seen to provide for a microfoundation of certain political and institutional group processes underlying negotiations. In general, one may expect that with bounded rationality and social preferences, the net benefit of cooperation is perceived as lower or higher than with perfect rationality and self-interest. This in turn will affect the willingness to cooperate. Of course, with this approach, we do not claim to capture the complete set of factors and constraints determining the outcome of climate negotiations. But we are able to offers some new insights as well as suggestions for making negotiations more successful.

The remainder of this paper is structured as follows. Section 2 highlights the relevance of bounded rationality and limited self-interest for climate negotiations, distinguishing between behaviors of citizens, civil servants, politicians, negotiators, and experts, both at individual and at collective levels. Section 3 provides a basis for later sections by briefly reviewing the role of communication, punishment, and reward in negotiations for an international agreement, as assessed with theoretical and experimental studies. Section 4 examines the impact of particular social preferences, including fairness, altruism, spite, and parochialism, on striking a climate agreement. Section 5 identifies several decision biases, namely loss aversion, framing, risk perception, myopia, cognitive dissonance, and overconfidence, and discusses their implications for climate negotiations. Finally, Sect. 6 draws conclusions and suggests possible strategies to foster cooperation in negotiations for a climate agreement.

2 Rationality and negotiations: from voter to negotiator

Negotiations about global public goods involve many actors at different levels, namely citizens and politicians at a national level and negotiators (politicians or professional negotiators) at an international level. The latter implement certain negotiation strategies, which are guided by national politicians, who in turn need support from voters. In addition, interest groups are influential in political decision-making, as acknowledged in public choice theory (Buchanan 1984; Mueller 1989). Each of these actors show bounded rationality and other-regarding behavior, though possibly not to the same extent. For example, many political decisions in the areas of economics and environment show considerable myopia.

At each level of climate negotiations and preparation, information is filtered and decisions are taken by individuals (be it civil servants, politicians, advisors, lobbyists, etc.), which means that the outcomes of negotiations are directly connected to their behavioral features and preferences. Indeed, the latter are crucial for understanding both individual and group processes underlying climate negotiations, where groups may range from teams through regions to countries. Country behavior, for example, may look a bit like the sum (although not exactly, given majority rules in a democracy) of individual decisions, but this does not mean that individual behavioral characteristics are completely lost at "higher" or "representative levels." Understanding the role of nonstandard preferences as one determinant of global climate policy can provide insights about strategies to get out of the current impasse in climate negotiations.

Herbert Simon already argued that politicians are boundedly rational. In particular, when decisions are more complex, political choices generally deviate from perfect rationality. For example, politicians operate under stress and time constraints causing selective attention and oftentimes make decisions based on imperfect information. These limitations lead them to make mistakes so that their choices are better described by "satisficing," that is, making a choice that is "good enough" rather than maximizing some social welfare function (Simon 1985). In line with this, limits on human rationality have been identified as playing a key role in political decision-making, such as political failures in cooperation giving rise to wars and overconfidence contributing to the profoundness of the current economic crisis (van Evera 1999; Johnson 2004; Shefrin 2010). This research suggests that behavior by politicians, negotiators, and experts involves many deviations from rationality and selfishness.

Politicians often make use of decision heuristics (Miller 2009), suffer from unrealistic forecasts based on optimistic judgment (Kahneman and Lovallo 1993), and tend to be myopic as they are driven by electoral cycles and short-term economic interests (Congleton 1992). Myopia is a phenomenon which is often discussed with respect to political decision-making. It means that temporal incentives or preferences of politicians—mainly driven by considerations of reelection—do not match societal interests or the social discount rate. The latter implies taking seriously into account outcomes far in the future. This affects political decision-making about climate policy as this involves near-term costs and long-run benefits. Myopia in effect means neglecting the long-term costs of climate change, even though these are the reason to worry about it in the first place.

Not only individuals but also groups and large organizations, such as national governments, are involved in climate negotiations. Many economists (e.g., Williamson 1981; Colinsk 1996; McFadden 1999) agree that bounded rationality is important in understanding decision processes in all kinds of organizations. Jones (1999) observes that in complex environments, neither individuals nor groups respond perfectly. Nelson and Winter (1982) introduced the famous concept of routines that determine the practices and processes of many organizations, both in business and in political contexts. Moreover, Prospect theory has been applied to the study of international relations to explain that decision-making biases and heuristics can favor international conflicts rather than cooperation (Johnson and Tierney 2003; Kahneman and Renshon 2006).

Are agents at certain levels more rational than at others? For example, are negotiators or politicians more rational than individual citizens? Assuming that politicians and their representatives in negotiations base their decisions on a wide range of expert opinions, political decisions might be believed to be of a higher quality, better informed, and hence more rational than non-political decisions. According to Tetlock (2005), however, professionals are prone to the same biases as non-professionals. He provides empirical evidence asserting disappointing accuracy and forecasting skills of many policy experts. Similarly, Fischhoff et al. (1982) explain that even if experts are knowledgeable, this does not guarantee they can avoid mistakes in intuitive judgments. The misinterpretation of risks is a prime example of a commonly made mistake. As many individual decision biases undermine the objectivity of decision-making, Fahr and Irlenbusch (2008) suggest groups of experts or committees as better decision-makers. In fact, their experimental results show that groups behave more rationally than individuals. This has important implications for the design of decision-making processes in negotiations or organizations, such as the IPCC. Here, a negotiation committee might be more successful in avoiding common decision mistakes than a single decision leader.

Table 1 Actors directly or indirectly connected to climate negotiations

Actors	Associated groups and organizations
Citizens	Business managers, employees, consumers
Politicians	Political parties, ministries, parliament, government
Civil servants	Negotiators, climate officials, policy makers
Experts/scientists	Advisory councils (IPCC, UNFCC), energy councils, environmental councils, economic councils, external consultants
Stakeholders/interest groups	Employer organizations (emitters), trade unions, environmental NGOs, consumer organizations

Table 1 lists the various mentioned actors and their collective decision-making counterparts. Voter and political interests are connected, as elections lead politicians to compete for votes and consider interests and desires of potential voters. Politicians are also influenced by lobbyists and interest groups. Negotiators and "climate officials" (a term often used in the media to denote civil servants involved in negotiations) possess the characteristics of civil servants which strongly represent national interests. A public choice perspective is that civil servants want to protect their own interests, in particular securing their employment. Climate and economic experts evaluate the status of climate change and its economic impacts under different policy scenarios, which serve as the basis for climate negotiations. Interest groups provide information to policy processes, such as emitters giving detailed advice about available abatement technologies and their costs. Nevertheless, they may seek to influence policy outcomes in their own favor.

In summary, the application of behavioral economics to the analysis of climate negotiations captures certain essential aspects of the real world. As we will see later, this approach allows an explicit treatment of issues such as fairness and framing, which play a very strong role in ongoing negotiations. One may argue that not every step in the negotiation process can be explained by a single behavioral model. For example, Underdal (1998) presents various frameworks (one being the rational actor model) to account for the variance observed in cooperation in, and compliance with, environmental agreements. In addition, some strategic games may explain certain choices. On the other hand, it is likely that long-run negotiation solutions bear a relation to bounded rationality and social preferences, simply because perfect rationality, irrationality, and individual isolation are exceptional or not tolerated in the negotiation process.

3 Communication and incentives to induce global cooperation

This section will draw attention to the importance of communication and incentives in climate negotiations. It aims to provide a set of insights from studies that have theoretically and experimentally examined the effectiveness of various types of incentives and information provision in realizing a climate treaty. We will here not yet be explicitly dealing with bounded rationality and other-regarding preferences. However, as we will see in later sections, communication, punishment, and reward will affect negotiations differently when bounded rationality and social interaction play a role. So, this section can be seen to provide a basis for analyses in later sections.

The reduction in carbon emissions and the mitigation of climate change can be considered a global public goods game. Milinski et al. (2008) presented the first experimental study on the emergence of cooperation in a climate change game. Groups of six students were equipped with a starting capital of €40. Players could contribute to a climate account (i.e., the public good) in order to reach climate protection. Instead of dividing the climate account among the six group members, as in standard public goods games, it was used to encourage people to reduce their carbon emissions. In particular, the collected money was suggested to sponsor newspaper advertisements on climate change action. Contributions by players can thus be classified as purely altruistic acts, since they solely benefit others (future generations or the environment) at a cost to oneself.

In order to make his public goods game resemble more closely the dilemma caused by climate change, Milinski and his team also introduced uncertainty about the provision of the public good. If the students of one group failed to establish sufficient cooperation over the course of several rounds, they faced the risk of losing not only money invested in the public good, but also their personal income. This can be interpreted as an extreme climate disaster. If all players together invested at least €12 per round, this prevented dangerous climate change. Milinski shows that many groups failed to establish cooperation and missed out on the benefits of a stable climate, reflected by individual, personal gains.

This experiment suggests that successful international cooperation on the reduction of greenhouse gas (GHG) emissions will not emerge in the absence of adequate incentives for cooperation. Barrett and Stavins (2003) note that the current Kyoto Protocol indeed provides very poor incentives for participation and should therefore be restructured in order to overcome the free-riding problem. That is, a treaty must offer clear net benefits to all participating countries. Moreover, such benefits and associated strategies need to be communicated very well.

3.1 Communication

Experimental studies of common-pool resources[2] and public goods document that communication, that is, the ability of players to discuss strategies in advance or during the game, increases cooperation (see, for example, Ostrom et al. 1992). The reason is that communication reduces uncertainty about others' strategies and thus about the net benefit of cooperation. Public information about other players' behavior can further trigger conformist tendencies, that is, cause individuals to cooperate when others cooperate. Such behavior can be described as conditional cooperation (Fischbacher et al. 2001). Of course, the tendency to copy the most frequent behavior in the population does not always maximize social welfare. The most extreme example is that individuals may start to free-ride when interacting with other free-riders, with the likely effect that cooperation breaks down (Carpenter 2004).

The aforementioned climate game of Milinski has been adjusted by Tavoni et al. (2011) to allow for communication in the form of announcing intended contributions by players. This improved cooperation. It indicates that transparency with respect to countries' abatement strategies, such as commitments to emission reductions, can be useful in order to reach successful outcomes. One such mechanism was implemented during the climate talks in Copenhagen: Countries were able to make voluntary pledges on minimum carbon reductions which were then publicized. But merely cooperative countries participated in this.

[2] In contrast to public goods games where subjects contribute money or effort, in common-pool resource dilemmas players exploit a resource. In game-theoretic terms, both games represent a social dilemma.

3.2 Punishment and reward

Several laboratory and field studies have emphasized the widespread willingness to punish non-cooperative group members (free-riders). Monetary punishment like a fine reduces payoffs to free-riders, but also represents a cost to the participant imposing the sanction. This in turn can lead to high contributions to public goods where players may contribute up to 90 % of their starting capital (Fehr and Gächter 2002). An effective monetary punishment to enforce climate agreements could be severe trade restrictions imposed on non-complying countries (Barrett and McIlveen 2009).

Besides punishment, positive incentives like a monetary reward can be effective in fostering and maintaining cooperation. The reason is that rewards increase the net benefit of cooperation by a fixed amount in the form of a monetary reward, subsidy or bonus (Falkinger et al. 2000). Rewards may be based on revenues from a global carbon tax or involve compensation payments by countries that gain most from a climate treaty to countries losing out on it. Concerning the latter, transfers from developed to developing countries might induce participation of the latter (Barrett and Stavins 2003).

Punishment and reward may also be non-monetary. For example, punishment can take the form of social disapproval, ostracism, or even gossip (Rege and Telle 2004; Maier-Rigaud et al. 2010; Sommerfeld et al. 2007). Such non-pecuniary punishment encourages cooperation by activating reputational concerns, which reduces the benefits of free-riding (Rockenbach and Milinski 2006; Hilbe and Sigmund 2010). Experimental research further shows that potential utility from positive social reputation, a non-monetary reward, resembles a type of "currency" increasing the benefits of cooperation (Milinski et al. 2002). Milinski et al. (2006) demonstrated that players' investment in climate protection increases substantially if players can make their investment public, thus gaining social reputation which functions as a reward.

In actual climate negotiations, non-monetary punishment in the form of disclosing a country's inaction may affect its reputation and possibly bring negotiations forward.[3] However, the fact that the US did not want to ratify Kyoto is public information as climate negotiations and action on climate change are topics widely covered and discussed by the media. So far, public condemnation of the US by many NGOs, media, and even other countries (which ratified Kyoto) has not stimulated them to change their bargaining attitudes. This may in fact be seen as a kind of a puzzle, which we will address in the decision bias "cognitive dissonance" in Sect. 5. Possibly, reputational incentives may play a more important role in contract compliance, that is, once countries are committed to an agreement. For example, in the Kyoto protocol, non-compliance damages a negotiating party's reputation and may negatively affect its options to benefit from other, future international treaties, such as on foreign direct investment or technology transfers (Nentjes and Klaassen 2004).

Research on which one of the two (monetary) incentives is more effective is inconclusive. As opposed to punishment, rewards lead to increased contributions and payoffs only under repeated interactions (Rand et al. 2009). Sefton et al. (2007) contrast reward and punishment in a public goods experiment and find punishment to be a more effective mechanism for sustaining contributions than reward. Hilbe and Sigmund (2010) show that if reward and punishment incentives are available, cooperators more quickly dominate the population. The latter is consistent with evidence on successful international environmental

[3] Reputation systems in general are used to facilitate interaction of negotiating parties, such as buyers and sellers in e-commerce, such as on e-bay.

Table 2 Mechanisms to stimulate participation in a climate agreement and their impact on perceived net benefits (monetary and non-monetary) of cooperation in an international climate agreement

Mechanisms	Description	Net benefit of cooperation
Communication	Decreases uncertainty about benefit	+
Punishment	Decreases benefit from free-riding	+
Reward	Increase benefit from cooperation	+
Punishment and reward	Increase benefit from cooperation	++

Note "+" Increases net benefit; "++" increases net benefit very much

agreements. Barrett and Toman (2010) argue that the success of the Montreal Protocol[4] (in terms of cost and environmental effectiveness) is based on the fact that it provided a combination of monetary reward and punishment opportunities. As a reward, it offered side payments to compensate developing countries for the additional cost of phasing out ozone-depleting substances. It further included trade restrictions (punishment) directed at non-participating countries.[5]

Table 2 summarizes our findings on the different types of mechanisms to stimulate participation in a climate agreement and their impact on the net benefits of international cooperation to reduce global warming. All of the incentives have a positive impact on the net benefit and subsequently on the likelihood of cooperation. In particular, the combination of punishment and reward is very effective.

4 Social preferences and climate change negotiations

Here, we focus on how other-regarding preferences and heterogeneity of actors and interests can influence the negotiation process. For example, negotiations are often characterized by reaching mutual benefits among participating parties. Such a preference for fair outcomes may be, in part, explained by actors holding social preferences. This means participating parties not only are motivated by their self-interest, but also care about the benefits of others. This is consistent with evidence from many economic experiments which shows that social preferences are important in bargaining situations (Charness and Dufwenberg 2006).

Besides fairness, other social preferences that play a role in decision-making are altruism, spite or envy, and parochialism (Fehr and Fischbacher 2002). In game-theoretic terms, these signify that players can value the payoff of others either positively or negatively. In short, altruistic agents value others' payoffs positively, while spiteful agents put a negative value on others' payoffs. Parochialism or in-group bias means that agents value solely the payoffs of group members positively (in-group favoritism), while valuing those of outsiders negatively (out-group hostility). As we will see, the presence of some social preferences may move negotiations forward, while that of others may limit cooperation among countries.

[4] The Montreal Protocol is an international environmental agreement on the protection of the ozone layer through the phasing-out of ozone-damaging gases.

[5] There are a number of other reasons why the Montreal Protocol was successfully negotiated fairly quickly: a strong connection between ozone depletion and health, notably the risk of cancer; readily available substitutes for damaging gases; and a relatively small sector of the economy which facilitated a transition. Therefore, a comparison between the Montreal and Kyoto Protocols cannot offer strong conclusions about the effectiveness of incentives to participate.

4.1 Fairness

A preference for fairness is also known as inequity aversion (Fehr and Schmidt 1999). Heterogeneity with respect to wealth or endowment in public goods games indicates that fairness matters more in asymmetric situations, such as negotiations between unequal partners. Experimental research generally finds a negative effect of wealth inequality in public goods games, where fairness concerns and inequity aversion can explain low levels of cooperation in unequal situations (Baland and Platteau 1999; Cardenas et al. 2002).

In the context of climate change, countries differ in many respects, such as wealth, size, economic development, vulnerability, historical responsibility, and projected emissions. This is reflected in an unequal distribution of cost and benefits, which affects climate negotiations. For example, Reuben and Riedl (2009) show that players with different benefits from a public good will contribute perfectly proportionally to the ratio of their marginal benefit, which indicates that players are highly motivated by a fair contribution norm. Translating this to climate negotiations means that countries with a low net benefit, like large emitters (high cost, low long-term benefit), may contribute less than others if fairness concerns matter.

What are the likely consequences of fairness perceptions among negotiating countries? Negotiations are dominated by multiple types of fairness. Particular aspects of negotiations such as the distribution of benefits and costs—outcome fairness—and negotiation procedures and context—process or procedural fairness—are two of them (Albin 1993). How to distribute mitigation costs among the participating countries, that is, a burden-sharing system, is one of the key issues in current negotiations. Perceptions of fair burden-sharing may differ across countries. Table 3 offers a summary of the most prominent proposals for burden-sharing rules in climate negotiations and corresponding equity principles.[6]

To guide negotiations, it is important to think about a fair negotiation process and implications for voting procedures, participation in committees, and access to information. Cooperative outcomes may be less likely under certain procedural rules that affect fairness. An example is that only some countries participate in early negotiation behind closed doors, as happened in the post-Kyoto negotiations. Most of the climate negotiations take

Table 3 Burden-sharing rules and different equity principles

Burden-sharing rule	Description	Equity principle
Polluter Pays	Abatement in proportion to (historical or current) emissions level	Countries with high emissions reduce more than countries with low emissions
Ability to Pay	Abatement in proportion to GDP	Countries with high GDP reduce more than countries with low GDP
Population size	Abatement in proportion to population	Countries with large populations reduce more than countries with small populations
Land area	Abatement in proportion to land area	Countries with large territories reduce more than countries with small territories

[6] Rose and Kverndokk (1999) provide an overview of equity criteria to evaluate the distributional consequences of climate policy.

place behind closed doors and oftentimes only involve a handful of countries. In past climate talks, such negotiations have led to much dissatisfaction among other nations that were excluded from parts of the negotiation process.

The few experimental studies examining fairness of climate negotiations underpin the importance of fairness principles for successful negotiation outcomes. An experiment by Tavoni et al. (2011) shows that an unequal distribution of endowments of participants in a climate game negatively affects cooperation levels. They designed their experiment in a way that the wealth inequality is correlated with countries' historical responsibilities, that is, their cumulative carbon emissions. They suggest that communication can improve acceptance of such responsibilities and reduce the negative effect of inequality, which makes cooperation more likely. Dannenberg et al. (2010) study equity preferences of climate negotiators and find that they dislike unequal negotiation outcomes. Another finding is that negotiators from different countries do not differ with respect to their degree of inequity aversion. As different fairness principles imply particular burden-sharing rules, first trying to agreeing on fundamental fairness principles may increase the likelihood of arriving at an agreement on burden-sharing rules. Possibly, pre-negotiating on a common fairness principle may contribute to stronger reputation and shame effects.

4.2 Altruism

Decision-makers are altruistic if they act to benefit others at a cost to themselves. Experimental research reveals that altruism favors cooperative behavior and the provision of public goods. Altruistic behavior is motivated by a variety of motives. For example, Andreoni (1990) suggests the existence of both pure and impure forms of altruism. The latter denotes the behavior of individuals that contribute to public goods because they derive utility from the act of giving, also referred to as "a warm glow." Moreover, altruism is facilitated by social interaction. Rege and Telle (2004) show that if one's behavior in a public goods experiment is publicized, altruistic contributions increase. This is also referred to as a type of reputational altruism. Other reasons for altruistic actions are kinship, that is, family relations (Hamilton 1964), and reciprocity (Trivers 1971). Another finding is that altruism decreases if it becomes too costly (Fehr and Fischbacher 2003).

With respect to climate negotiations, the question arises whether politicians are likely to exhibit altruism. Against the common assumption in public choice theory that decisions by stakeholders in a political context (voters, civil servants, politicians, interest groups) are based on self-interest, altruism in political judgment is common. Fowler (2006) shows that high levels of voter participation in elections can be explained by voters being sufficiently altruistic. Other empirical studies present a more pessimistic view of altruism in political contexts. Younas (2008) shows motivations for giving development aid are dominated by economic considerations. Donor countries seem to be very much motivated by trade benefits and thus self-interest.

Can altruism explain cooperation in an international climate agreement? Milinski's (2002, 2006, and 2008) experimental research shows that altruism motivates investment in the climate account. Players in his game behave altruistically when they observe that all players contribute. However, altruism is limited and groups generally fail to reach the contribution target necessary to avoid a climate disaster. Milinski also shows that altruistic contributions can be increased if made public. This can be explained by the presence of reputational altruism, a type of impure altruism. Another motivation for contributions may be reciprocal altruism, a strategy based on repeated interaction. This suggests that reciprocity among countries may be important for large-scale cooperation. Such reciprocity

may be fostered by linking climate agreements to trade and technology (R&D) agreements (Folmer et al. 1993).

There may be little willingness to cooperate among negotiating parties because of limited solidarity across generations, despite connections between parents, children, and grandchildren in overlapping generations (Howarth and Norgaard 1993). Moreover, any investment in emissions reduction will mainly benefit future generation in developing countries, while the cost of cooperation is mainly for developed countries. The question is what type of institutions can promote the extension of the relevant reference group to other countries and future generations? One possible approach would be the inclusion of different age groups, including very young people, in climate negotiations, so as to represent the different generations associated with climate change and policy.

4.3 Envy

Envy or spite is a type of negative social preference where individuals desire to decrease others' welfare. Elster (2007) acknowledges the phenomenon of envy in economic and political decision-making, which is relevant to consumption, working environment, and cooperation in negotiations. He asserts that envy is provoked in others by unequal allocation of enviable goods. He refers to Veblen's concept of conspicuous consumption, which is a type of consumption intended to provoke envy through the display of costly goods.

Findings from experiments show that spiteful individuals are willing to give up benefits from cooperation to reduce the benefits of, or increase the cost to, the bargaining partner with the ultimate goal to improve their own payoff (Saijo and Nakamura 1995; Fehr et al. 2008). Their net (non-monetary) payoff will increase then. However, this also lowers the net benefit from cooperation. Experimental research has further found that spitefulness can lead to punishment not only of free-riders, but also of cooperative group members. Such punishment is solely motivated by concerns for relative positions or status, that is, the punisher makes herself relatively better off rather than improving social welfare (Falk et al. 2005).

To what kind of actions may envy give rise in climate negotiations? The first critical aspect is the asymmetry between notably developing and developed countries in terms of historical responsibilities (cumulative emissions), income level, wealth, etc. Since envy is triggered by comparison and unequal allocations and payoffs, negotiations between developed and developing countries can be expected to be influenced by feelings of envy. In this respect, envy and equity are intertwined concepts. Already Varian (1974) described a fair division as equitable and "envy-free." For the context of climate change, this can be seen as relevant to the case of developing countries. For example, current proposals on burden-sharing are seen as unfair and inequitable by these countries, but these perceptions may at the same time be influenced by envy of those that are better off. This means that the evaluation of the burden-sharing is based on relative rather than absolute economic outcomes (Roberts and Parks 2007). In line with this is the claim of developing nations that the rich countries have to abate more (also proportionally) because they have more ability to pay. However, although in practice it is difficult to tell fairness and envy concerns apart, the existence of both suggests that the many inequalities and asymmetries among the negotiating countries may be an impediment to reaching an agreement.

4.4 Parochialism

Parochialism describes individual and group behavior employing individual categorizations and distinctions, such as similarity, common fate, or physical proximity and its likely

consequences. Parochialism means in-group bias, behavior that favors one's own group, restrict benefits to its members, and foster loyalty to the group (Tajfel and Turner 1979). Parochialism also includes hostile behavior, such as strong punishment toward outsiders or out-group members (Bowles and Choi 2003; Choi and Bowles 2007). This behavioral pattern manifests itself in political parties, interest groups like trade unions, religious and ethnic groups, football matches, and even in interactions between citizens of different nations (Brewer 1999; Bowles and Gintis 2004).

Evidence from public goods experiments shows that people behave more cooperatively toward their in-group than toward their out-group (Koopmans and Rebers 2009). Cooperation is stimulated by the fact that members similar to oneself benefit from it. In line with this, countries sharing similar characteristics may adopt similar negotiation positions. For climate negotiations such in-group favoritism or solidarity might explain why some negotiating parties are only in favor of certain emission allocations (burden-sharing rules) that benefit not only themselves but also their in-group members or countries that are considered as being culturally proximate. Parochialism might also contribute to inaction or protective strategies when countries that have to reduce emissions a lot feel that the benefits go mostly to nations that do not belong to their in-group, that is, that are culturally distant. In particular, parochialism may lead to smaller coalitions, like a coalition of large emitters (notably developed countries) instead of a coalition including all countries.

Table 4 summarizes the role of social preferences in climate negotiation processes and their impact on the perceived net benefit of cooperation. A negotiator motivated by altruism is generally more cooperative. Fairness or inequity aversion offers some explanation as to why countries still have not agreed on emission reduction commitments. So far, equity concerns and envy due to unequal allocations may have discouraged cooperation. Parochialism neither has made large-scale cooperation easier.

5 Uncertainty, decision biases, and climate negotiations

Decisions relevant to climate change negotiations are surrounded by uncertainty. For example, there are scientific uncertainties about how GHG concentrations will precisely affect future global temperatures, sea level, ecosystems, and the economy. The IPCC even classifies uncertainty (from virtually certain with >99 % probability to exceptionally unlikely with <1 % probability) in order to establish a consistent and transparent terminology of the likelihood of future outcomes. Experimental evidence documents that

Table 4 Impact of social preferences on perceived net benefits of cooperation in an international climate agreement

Social preference	Description	Perceived net benefit of cooperation
Altruism	Preference to increase the payoff of others	++
Fairness	Preference for equitable payoffs	+
Spite/envy	Preference to decrease the payoff of others	−−
Parochialism	Preference to increase the payoff of similar nations (in-group bias) and to decrease the payoff of outsiders	−

Note Signs denote changes relative to a situation with rational, self-regarding agents

"+" Increases net benefit; "++" increases net benefit very much; "−" decreases net benefit; "−−" decreases net benefit very much

decision-making under uncertainty often violates full rationality assumptions, referred to as cognitive or decision biases. The IPCC (2001) acknowledges the existence of such biases in decision-making, noting that experts may show myopia or overconfidence when making judgments about the likelihood of climatic events. Therefore, the analysis presented in the IPCC assessment reports gives more weight to methods less prone to subjective judgments by experts.

Many decision biases have been documented (Kahneman and Tversky 1979; Suedfeld and Tetlock 1991; McFadden 1999). Below, we discuss what we regard as the most relevant ones for the case of climate negotiations. The following are additional ones that may receive attention in future research (as space is too limited here): anchoring (a decision relying heavily on one feature or piece of information); primacy effect (tendency to give more weight to more recent events); projection bias (prediction of future events resembles current situation); and biases related to reference points, such as status-quo bias (a tendency to place a higher value on the current state) and the endowment effect (a tendency to place a higher value on something we own). In the following, we focus on a selection of decision anomalies that may be important to climate negotiations.

5.1 Prospect theory and framing

An important theory to explain people's judgment and decisions under conditions of uncertainty is Prospect theory. It accounts for many inconsistencies and decision biases that may limit cooperation. Examples are loss aversion and framing (Kahneman and Tversky 1979). As opposed to expected utility theory based on rational assumptions which only considers absolute wealth when it comes to the evaluation of uncertain outcomes, Prospect theory models individual attitudes to risk with a value function. It allows for different weights on gains and losses where the function is concave for gains and convex for losses, and steeper for losses than for gains. This means that the disutility associated with a loss is larger than the utility associated with an equivalent gain. As a consequence, people are risk-seeking for losses and show risk-aversive preferences for gains. This is also referred to as loss aversion. Moreover, loss aversion combined with another behavioral tendency, the certainty effect, that is, certain outcomes being overweighed relative to uncertain ones, leads to the following predictions: individuals prefer a deterministic gain over a probable one (risk aversion) and a higher probable loss over a certain one (risk-seeking).

This previous insights hold only if probabilities are high. In a later contribution, Tversky and Kahneman (1992) find if probabilities are low (10 % or smaller) individuals are risk-averse for losses and risk-seeking for gains. This additional insight of Prospect theory is based on the probability weighting function. Botzen and van den Bergh (2009) note that probability weighting is especially important for climate change because most of the large climate risks are expected to have low probabilities. Further, the interaction between probability weighting and valuing monetary outcomes has non-trivial consequences for insurance demand. Table 5 summarizes the insights from probability weighting for climate change framing.

Table 5 Framing and probability weighting

Framing about climate change	Probability	
	HIGH	LOW
GAIN	Risk-averse	Risk-seeking
LOSS	Risk-seeking	Risk-averse

Describing a problem as a gain or a loss elicits different risk attitudes. Negative frames, interpreted as losses, lead to riskier choices, while positive frames generally stimulate risk aversion. Table 6 summarizes the various insights from Prospect and Advanced Prospect theory for climate change framing. Such reversal of preferences between negative and positive frames is also referred to as the reflection effect. Frames are important, if not crucial, for the success of negotiations as framing may influence risk perceptions and preferences for climate policy. For example, research on the communication of climate risks confirms that positive frames produce stronger behavioral intentions to act on climate change than negative, loss frames (Spence and Pidgeon 2010; Morton et al. 2011). On the other hand, negative events, information, and experiences generally can count on more attention than positive ones, from both media and the public. For example, bad news and negative information (e.g., high unemployment and inflation rates, natural disasters, traffic accidents) receives more attention in the media than good news, which is referred to as bad news bias (Baumeister et al. 2001; Soroka 2006). This asymmetry is also reflected in macroeconomic dynamics where consumption tends to drop relatively more in the case of an economic downturn than in times of economic prosperity (Bowman et al. 1999). For climate change, the relatively large attention effect of negative information is illustrated by the success of Al Gore's documentary "An Inconvenient Truth." The attention effect for different climate frames is shown in the bottom row of Table 5. The frame bias and bad news bias taken together defy a definite conclusion about which frame is more effective in fostering a climate agreement.

It is not immediately clear what are the basic negative and positive frames in the context of climate agreement and policy. After deliberation, we came up with five frames linked to well-known advocates of (no) climate policy, involving politicians and scientists.[7] With regard to the negative frame, one can use as an orientation either climate change or climate policy, leading to opposite views, as expressed clearly by Al Gore and the Bush administration, respectively. With regard to the positive frame climate policy has been the focus, as reflected—in different ways—in the well-known economic studies by Nordhaus and Stern (Nordhaus 1992, 2008; Stern 2007).[8] In order to include a positive frame with "no climate policy" (or climate change), we reframe the original Bush position. As a result, one then arrives at five frames in total, as shown in Table 6. Note that although we could also reframe the other positions, this would not increase diversity of outcomes in the positive and negative (row "choice outcome"). The Stern Review stressed the negative impact of climate change on GDP, suggesting that under an extreme scenario damage costs might reach up to a 20 % loss of GDP. This explains why Stern, like Gore, attracted much attention (see the bottom row of the table).

It is relevant to understand the dominant climate frames and how the discourse on these can influence the likelihood of a climate change agreement. The original Bush position stresses the high and certain cost of stringent climate policy, and uncertainty about climate change (a "gamble") translating into equally uncertain economic, health, and welfare losses. Risk-seeking behavior with regard to the uncertain loss then supports the choice of no climate policy and no climate agreement. Gore's famous documentary "An

[7] A reviewer suggested that "symbolic politics" is somewhat related (Sears 2001). It stresses the influence of political symbols on political decisions. Examples are political language, the opposition between right and left wing, religious connotations, and family values. Such symbols often elicit emotional rather than rational responses, which in fact gives support to our focus on bounded rationality here.

[8] One might also mention here Cline (2007) who can be seen as close to Stern, both in approach and in conclusions.

Table 6 Prospect theory applied to frames of climate change and policy

	Negative frame		Positive frame		
	Bush original	Gore	Nordhaus	Stern	Bush reframed
Deterministic	High short-term cost of *climate agreement* dominant	Moderate economic costs of *climate agreement*	Net benefits (=avoided cost) of *climate agreement*	High net benefits of *climate agreement*	High net benefits (income minus climate damages) of *no climate agreement*
Gamble[a]	Almost certainly there is no climate change and thus damage costs are highly improbable (*no climate agreement*)	Highly probable damage cost of climate change, serious risk of extreme events (*if no climate agreement*)	Unlikely net benefits in terms of(welfare minus climate damages (*if no climate agreement*)	Extremely uncertain net benefits of climate change, very risky strategy (*if no climate agreement*)	Uncertain net benefits of *climate agreement* because climate change uncertain
Risk attitude	Risk-seeking, which leads to a decision in favor of the gamble	Risk aversion, which leads to a decision in favor of the deterministic alternative	Risk aversion, which leads to a decision in favor of the deterministic alternative	Risk aversion, which leads to a decision in favor of the deterministic alternative	Risk aversion, which leads to a decision in favor of the deterministic alternative
Choice outcome	No climate agreement	Climate agreement (stringent regulation)	Climate agreement (stringent regulation)	Climate agreement (stringent regulation)	No climate agreement
Attention effect	Large	Large	Medium to large	Large	Not relevant

[a] The table mostly corresponds to the typical pattern of Prospect Theory for sufficiently high probabilities for losses or gains, which implies risk-seeking for losses and risk aversion for gains. In the Gore frame, however, the response pattern reverses because of very small probabilities (extreme events): Here, risk-averse behavior for losses with low probabilities is the result

Inconvenient Truth" stresses the high costs and damages of inaction (no climate agreement), whereas it regards the cost—in terms of GDP—of an agreement uncertain but moderate. Here, risk-seeking for the loss prospect implies support for a climate agreement. A positive frame derives from Nordhaus (e.g., 1992, 2008) who highlights the certain net benefits (or costs) of an agreement in terms of reduced GDP growth and compares these with uncertain but moderate losses or even net benefits in case of no agreement, that is, economic growth minus damage costs. This results in risk aversion and a decision in favor of a climate agreement. Another frame relates to Stern (2007) and suggests that the damage costs of climate change outweigh the cost of safe climate policy. In this case, the certain net benefits are much larger than the cost of an agreement. Stern's risky prospect highlights very uncertain net benefits under no agreement. Risk aversion in this case leads to a decision in favor of a climate agreement. A third frame results from reframing the original Bush position. This highlights the high net benefits, that is, economic growth minus climate

damages, in the case of no agreement. The risky strategy is described by uncertain net benefits in case of an agreement due to the very unlikely impacts of climate change. Risk aversion for this positive prospect then leads to no agreement. The above analysis suggests that a simple reframing of climate change into a positive prospect may not be sufficient to reach an agreement.

Climate change frames can serve to inform voters. But they can also be strategically used by negotiators to influence risk perceptions and bargaining outcomes in their interests. Through strategic framing, it is possible for politicians or policy makers to select aspects of climate risks that will magnify or diminish the perceived risk by people (whatever stakeholder). Nevertheless, little is known on such strategic framing and its effectiveness.

5.2 Risk perception biases

An important difficulty in decision-making is correct risk assessment of climate and environmental risks. A bias in risk perception, that is, a discrepancy between an individual's perceived probability and the actual risk, may affect risk estimates and in turn the attitudes toward climate change policies and a climate agreement. Bounded rationality is an important determinant of individual risk perception in the context of climate change risks (see Botzen et al. (2010) assessing climate change flood risk perceptions).

Examples of systematic biases on the perception of risk are the overestimation of low probabilities and underestimation of large risks as well as substantial differences in risk estimates if information is available or not. This means the accessibility of the problem and information about it matters, which is known as the availability heuristic (Viscusi 1989; Viscusi and Zeckhauser 2006). Another mental shortcut for probability judgment is the affect heuristic, that is, (positive and negative) feelings about (climate) hazards. In line with this, the affective-laden representation of risk through images and media reports can influence risk perception and policy preferences (Slovic et al. 2002). For example, Leiserowitz (2006) finds that negative effect is a stronger predictor of climate change risk perception than traditional socioeconomic variables.

Other cognitive biases that particularly influence individual decisions to take precautionary and adaptive measures to mitigate their risk against climate hazards such as flood or droughts are omission bias for negative events, that is, a tendency that favors inaction, and optimism bias, that is, individuals ignoring negative events (Grothmann and Patt 2005; Patt and Schröter 2008). This reflects that individuals tend to underestimate their personal risk of negative impacts (such as from climate change) and think they are less likely to be affected than other people. As a consequence, their perceived risk is much lower than the actual risk, and so they are less willing to engage in risk-reducing behavior.

What are the consequences of incorrect public risk perceptions about climate change for an international climate agreement? It is likely that biased perceptions of the likelihood of climate change and its impacts will affect one's willingness to support climate policy and participate in an international climate agreement. In this sense, Leiserowitz (2005) states that distorted risk perception constrains political action due to missing public support for a climate treaty, regulations or taxes. The fact that many Americans only see a moderate risk associated with climate change is likely to contribute to the US not ratifying the Kyoto Protocol.

5.3 Myopia

Myopia refers to an individual's tendency to prefer immediate benefits and to delay costs. This means, myopic decision-makers have high discount rates which can lead them to the

postponement of important investments in the presence (Loewenstein and Prelec 1992; O'Donoghue and Rabin 1999; Frederick et al. 2002). Myopia is equally relevant to intertemporal choice problems like investment in climate change mitigation. Since the cost of mitigation is immediate and benefits come later in time, myopia results in little climate protection generally. For example, Hausman (1979) demonstrates households could realize future energy savings through the purchase of more energy-efficient products, but refrain from doing as future benefits are extremely discounted and thus undervalued relative to immediate costs. In order to overcome such intertemporal failures, Metcalf (1994) suggest energy policy taking the form of a subsidy on the initial investment, which counteracts the effect of high discount rates.

Political decisions may be particularly prone to myopia due to the short time horizons of politicians, reinforced by four-year election cycles. Congleton (1992) calls this political myopia, which he argues can lead to environmental degradation as many politicians refuse to act on long-term issues such as climate change. This exemplifies the intergenerational trade-off politicians are faced with when making decisions that will likely affect future generations. Discount rates applied to political problems such as climate change may thus be inappropriately high. Experimental research shows that if this trade-off is amplified by uncertainty about the benefit to a future generation, this leads to more self-interested behavior rather than intergenerational altruism (Wade-Benzoni et al. 2008). The question is how to ameliorate myopia and align the discount rates of politicians with the socially optimal discount rate. The literature on behavioral economics suggests setting deadlines and peer commitment through public announcement of specific goals (e.g., Ashraf et al. 2006; Bryan et al. 2010). For the context of climate change, commitment devices can take the form of public announcement of emissions reduction.

What are the likely consequences of myopic decision-making for climate negotiations? In this respect, Bosetti et al. (2009) assess the role of immediate versus delayed (myopic) participation of developing countries in an international climate agreement. Their analysis shows that the global economic costs of a delayed participation of large emitters (e.g., India and Brasil) are substantial. In particular, they find that the policy costs double in the case of delayed participation compared with a case of full and immediate participation of all countries.

5.4 Cognitive dissonance

Cognitive dissonance denotes a mental conflict in which people are biased to think of their choices as correct, and incur disutility if they encounter any inconsistency with their beliefs. This leads also to a tendency to search for information that confirms ones expectation and disregard dissonant information (Festinger 1957). The selective use of information that confirms one's belief and expectations (confirmation bias) is related to a moderate risk perception of climate change. For example, some individuals tend to ignore new information on climatic patterns and tend to trust in their initial beliefs (Patt and Schröter 2008). This means people skeptical about climate change will seek information confirming their initial belief, rather than including new, particularly contradicting evidence that may alter their belief.

In order to overcome cognitive dissonance about climate change, these people tend to deny or ignore the facts about climate change and its impacts or claim that climate change is caused by non-anthropogenic factors (Stoll-Kleemann et al. 2001). In the US, climate change action is highly controversial and has provoked climate change denial, endorsed by (certain) scientists, industrial leaders, and conservative politicians. In this context, Dunlap

and McCright (2011, p. 144) refer to a "US climate change denial machine." Their observations suggest that particular conservative politicians, mostly white men, dominate among those who deny human-induced climate change (McCright and Dunlap 2011). This is consistent with the findings that conservatives accept higher technological risks and threats, such as those related to nuclear energy and weapons, than others (Kahan et al. 2007). The authors explain this denial by arguing that conservatives are strongly inclined to justify the current social and economic system and therefore dislike any opinions that seek to undermine it, even more so if they involve potential economic losses to their current state.

5.5 Overconfidence

Evidence generated by economists and psychologist indicates that overconfidence leads individuals to overestimate their own capability, performance and skills, and control over events as well as to misjudge how they perform in comparison with others (better than average effect). The overconfidence bias affects investors who are likely to trade more than rational ones, managers deciding about risky acquisitions, politicians approving prestigious public projects, and negotiators unwilling to make concession (Bazerman and Neale 1992; Doukas and Petmezas 2007; Glaser and Weber 2007; Kahneman and Renshon 2006). Overconfidence has been argued to have played an important role in international crises with overconfident politicians, such as wars, as well as in the current financial crisis with overconfident investment bankers (Johnson 2004; Shefrin 2010).

With respect to climate negotiations, overconfidence may also pertain to the estimated capacity of humans and their economy to accept climate damages or to adapt to climate change. In order to counteract the source of overconfidence, Kahneman and Lovallo (1993) suggest that the introduction of more objective forecasting, and the consideration of views and feedbacks from outside advisers can help to arrive at a more accurate view on future outcomes. For climate negotiations, better considerations of the insights generated by the IPCC and climate and economic experts may improve decision-making.

Table 7 illustrates the influence of all mentioned biases on the perceived net benefit of cooperation. Overall, decision biases in judgments under conditions of uncertainty have a negative impact on an international climate agreement.

Table 7 Impact of decision biases on perceived net benefits of cooperation in an international climate agreement

Decision bias	Description	Perceived net benefit of cooperation
Loss aversion	Preference for avoiding losses leads to risk-seeking behavior	−−
Framing	Negative and positive casting of a problem leads to risk-seeking and risk aversion	−/+
Risk perception	Inconsistency between perceived probability and actual risk	−
Myopia	Preference for immediate rewards and delayed costs	− −
Cognitive dissonance	Discrepancy between current belief and new information	−
Overconfidence	Overestimation of own capabilities	−

Note Signs denote changes relative to a situation with rational, self-regarding agents

"−" Decrease net benefit; "− −" decrease net benefit very much

6 Conclusions

This paper has examined the impact of bounded rationality and social preferences on the perceived benefits of cooperation in climate negotiations. So far, most research on international negotiations has assumed rational actors rather than actors exhibiting some form of bounded rationality and other-regarding behavior. In this paper, we have highlighted the case of decision-makers systematically deviating from rational choices in the context of climate negotiations. Some particular strategies may limit cooperation, while others may increase the likelihood of an agreement.

There is no doubt that countries will need to participate in a climate agreement in order to reduce global GHG emissions effectively. So far, countries have little incentive to do so (Barrett 2005). Findings from laboratory experiments support the positive impact of incentives like communication, punishment, and reward. These mechanisms are successful in inducing countries to join a climate coalition as they increase the (perceived) net benefits of cooperation, which have to be sufficiently high to induce large-scale cooperation. This paper has emphasized that a treaty must offer clear net benefits even when participants are characterized by bounded rationality and other-regarding preferences. However, the latter means that benefits will be differently perceived than under perfect rationality and self-regarding behavior.

We argued that social preferences can affect climate negotiations. Empirical and experimental research shows that consideration of payoffs for other countries influences climate negotiators in their evaluation of burden-sharing rules. Relevant social preferences are altruism, fairness, envy, and parochialism. Altruism leads to the prediction that individuals and groups refrain from free-riding and instead cooperate for the common good. The multiple asymmetries between countries suggest that fairness (or inequity aversion) and envy, which oftentimes are difficult to tell apart, are likely to play a role in negotiations. This means that unequal allocations of emission reductions may destroy cooperation. Parochialism, a preference for cooperation with similar countries, may exert a negative effect on climate negotiations, leading to treaties that are limited to a subset of similar countries. This can be used constructively in the sense of forming a starting point for a more ambitious agreement extended with other countries. Another suggestion is to include different generations in the climate negotiation process so as to stimulate expressions of altruism from current to future generations.

Decision biases matter as well for negotiating a climate agreement. Behavioral economics has identified various anomalies that lead to making decision errors, as compared with rational choice. Prospect theory influences decision processes in climate negotiations through the differential evaluation of gains and losses and risk-seeking behavior for losses. Moreover, it is likely that an agreement will be influenced by myopic behavior by politicians, leading to little attention for problems with a long-term horizon, such as climate change. All decision biases that were indentified here have a potentially negative influence on cooperation and should, if possible, be ameliorated.

Reframing of climate change and policy needs more attention. Two effects are important here, namely attracting attention, which is characterized by negative news bias, and asymmetric risk attitudes to gains and losses (that is, the reflection effect in Prospect theory). With regard to the latter, the framing can focus on climate change impacts or on climate policy impacts. We find that for one negative frame (Gore) and two positive frames (Nordhaus and Stern), the choice outcome according to Prospect theory is a climate agreement. For one negative (Bush) and one positive (Bush hypothetical), no support for a climate agreement is obtained. The two effects taken together suggest that the best frame to

adopt is Gore. Another strategy is to use both positive and negative frames simultaneously (as is the reality), although this may create confusion among voters and politicians, unless they are perceived as complementary, that is, in terms of problem identification and solutions. An argument for positively framing information is that people believe that there is a solution to the climate problem and are thus more willing to act. But first they need to be convinced that there is a problem to be solved, for which the negative frame may be needed. This points at complementarity. Therefore, if one really intends to do everything to make an international climate agreement likely, then perfecting frames and more generally communication strategies seems worthwhile.

Given all these behavioral effects, an obvious question is whether we need the help of psychologists to guide negotiations for an effective international climate agreement? More fundamentally, do we need to accept bounded rationality and social preferences, or should we try to change them and make people more rational? Is this a realistic goal? Psychologists can perhaps answer what is possible and impossible in this sense. We suggest that incentives for cooperation need to be restructured to fit the various alternative models of human behavior discussed here. For example, even if financial incentives exist, they might not be sufficient to induce large-scale cooperation. A future climate treaty may include the possibility of status or reputational benefits of cooperation. This assumes that the relative rather than absolute benefits of emissions reduction will influence participation by countries. Reputational concerns may gain importance through increased transparency created by the media and internet (e.g., through disclosure portals), which can increase the long-run cost (including reputation effect) of a country not ratifying a climate treaty.

This paper has provided a starting point for identifying the impact of bounded rationality and social preferences on the outcomes of climate negotiation processes. Future research could try to identify the preferences of current negotiators and assess the empirical magnitude of the various types of bounded rationality and social interaction. To achieve this, research is needed to characterize utility functions of important stakeholders in negotiations and the role of climate variables in these. The outcome of such research might serve as an input to experiments that test particular behavioral features, like Prospect theory or inequality aversion, in combination with alternative framings of climate change. In addition, connecting our approach to relevant variables from political science approaches to studying negotiations, such as ideology, power, and discourse, may be worthwhile. This all can hopefully contribute to a better insight about effective incentives and strategies to accomplish a global climate treaty.

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