

Cooperation in the Climate Commons

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Introduction

Many situations in everyday life involve social dilemmas, the solutions to which require cooperation. Most of these situations involve the provision of local public goods or the management of common-pool resources. Sustaining cooperation in these settings represents one of the major achievements of our society, since cooperating on social dilemmas requires overcoming the temptation to free ride. From a narrow economic perspective, cooperation represents an anomaly that contradicts the ideal of rationality (Dawes and Thaler 1988). Nevertheless, cooperation is often observed in the real world, suggesting that individuals may be more sophisticated than predicted by theory (Sen 1977). Although for the sake of model parsimony it may be tempting to assume that societies can dispense with morality and civic spirit (Hirschman 1984), understanding cooperation is a crucial challenge for economists and policymakers. Thus a growing literature on cooperative behavior has emerged in recent decades that concerns a range of economic interactions and different social environments (see Fehr and Fischbacher 2003).

Natural resource management inevitably involves overcoming local dilemmas. From a standard economic perspective, any situations involving the use of open-access common-pool resources are viewed as susceptible to free riding, inevitably leading to overexploitation. While overexploitation has been shown to be an issue in certain situations—for instance, in competitive environments characterized by open access—other contexts have been found to be

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more conducive to cooperation. As [Ostrom \(1990\)](#) famously demonstrated, cooperative outcomes can be sustained if stakeholders trust each other and trust is maintained through monitoring and the sanctioning of norm violators. In fact, after surveying much evidence from the field, [Poteete, Janssen, and Ostrom \(2010\)](#) concluded that commons need not turn into tragedies. However, this body of work focuses on local commons, where successful management tends to occur in situations where the actors know and can observe one another. What about the global commons? Can we identify patterns of cooperation that scale up to the global level?

In this article we consider measures aimed at promoting “climate cooperation,” as revealed by contributions to the global public good of climate change mitigation. Due to its global public good nature, climate change mitigation presents the toughest conditions for the emergence and stability of international cooperation; that is, its benefits are enjoyed worldwide, regardless of who bears its burden. Adding to this challenge, mitigation is also plagued by temporal externalities, with mitigation today mostly benefiting future generations. Although the potential for sustained cooperation among small groups in the local commons is now widely recognized, free riding is still viewed as the norm in the climate commons. Decades of largely unsuccessful climate negotiations would appear to support this view ([Barrett 1994](#)). On the other hand, there has thus far been virtually no comprehensive account of the evidence regarding the extent of cooperative achievements in the climate commons (beyond what self-interested actors would unilaterally do). We aim to fill this gap by reviewing the recent literature on the economics of environmental cooperation.

A preliminary question is why we should observe cooperation when facing a global dilemma. According to [Ostrom \(2010\)](#), subjects may still be willing to cooperate even in a global setting if they expect others to cooperate as well. Ostrom presents evidence concerning a number of local communities and subnational entities that successfully organized and collectively engaged to mitigate climate change. Recent developments in climate change negotiations—for example, the ambitious deal struck at the December 2015 Conference of the Parties (COP) in Paris—have also triggered renewed interest in cooperation from the bottom up. In fact, this agreement was built on several years of grassroots efforts and unilateral initiatives, including the broadening use of carbon pricing, which can be seen as costly signals of countries’ willingness to cooperate. However, only time will reveal how effective the treaty will be in fostering sufficient emission abatement to meet its target of limiting global warming to below 2°C, and specifically whether its parties will deliver on their pledges and ratchet up ambition over time.

Because countries’ mitigation pledges, such as the nationally determined contributions in the Paris Agreement, must be turned into policies, an additional layer of cooperation is necessary at the domestic level. In order to leverage individuals’ willingness to cooperate, policymakers need to understand when and why cooperation in the climate commons works. Thus we examine both the theory and empirical evidence concerning many public good situations that have implications for climate mitigation. We also review microeconomic evidence from empirical studies of the adoption of green technologies, laboratory and field experiments that leverage social comparison effects to spur environmentally friendly behavior, studies of the demand for carbon offsets, and microeconomic and macroeconomic analyses of the relationship between trust and environmental outcomes.

By looking at the deep roots of cooperation, we try to identify its drivers in the global commons. Our review of the literature strives to be extensive, but it is not exhaustive due to

the large body of cross-disciplinary research that feeds into the topic of climate cooperation.¹ By collecting an important set of recent evidence on cooperation in the climate commons, this review contributes to reconciling different literatures and provides a critical overview of the potential for scaling up localized cooperation efforts. A number of questions remain unanswered, highlighting the gaps in the current state of knowledge and avenues for future research. The remainder of the article is organized as follows. The next section examines the theoretical underpinnings of cooperation, beginning with local action, targeted first at local dilemmas and then at global dilemmas, and finally scaling up to international cooperation for addressing global dilemmas. Then we present empirical evidence on the role of local social norms in driving behavior and discuss its implications for climate mitigation. The final section summarizes the main findings and discusses avenues for future research.

Economic Theory and Cooperation Across Scales

Economics has traditionally been concerned with rational selfishness, under the premise that the representative *Homo economicus* pursues their objectives based on narrow self-interest. This logic underlies the narrowly selfish maximization of utility by consumers and profits by firms. However, this narrow approach ignores external effects such as environmental degradation, implying that public goods will be underprovided and the commons will be overexploited in the absence of private markets or regulation (Olson 1965; Hardin 1968). This view was well captured by John Stuart Mill (1836), who suggests “an arbitrary definition of man, as a being who inevitably does that by which he may obtain the greatest amount of necessaries, conveniences, and luxuries, with the smallest quantity of labour and physical self-denial with which they can be obtained.”

Social scientists have long questioned the realism of the assumption of selfish rationality as a pervasive driver of human behavior. The criticisms generally focus on either logical, empirical, or behavioral/psychological grounds. Amartya Sen is an eminent economist who challenged the logic underpinning selfish rationality. In the 1970s, he criticized the narrowness of the economic man portrayed by the then-dominant rational choice theory; he famously exposed the illogical extremes to which self-interested rational “fools” would go in the following passage, which concerns an encounter between two strangers (Sen 1977, p. 332):

“Where is the railway station?” he asks me. “There,” I say, pointing at the post office, “and would you please post this letter for me on the way?” “Yes,” he says, determined to open the envelope and check whether it contains something valuable.

¹Other studies that survey aspects related to climate cooperation include Kraft-Todd et al. (2015), which reviews field experiments promoting cooperation and examines the importance of the visibility of prosocial behavior; Nyborg et al. (2016), which extends the discussion of the importance of social norms to several social dilemmas; Farrow, Grolleau, and Ibanez (2017), which reviews economics and social psychology studies that manipulate social norms; Tavoni and Levin (2014), which provides a multidisciplinary investigation of the complexity of managing the climate commons; Drews and van den Bergh (2016), who review the sociopsychological factors underlying the (un)popularity of carbon taxes; and Carattini, Carvalho, and Fankhauser (2018), which analyzes the role of information asymmetries and provides a set of stylized facts suggesting that people tend to overestimate (underestimate) the drawbacks (benefits) of carbon taxes.

Such a paradoxical situation is indicative of the gap between reality and how neoclassical economics portrays it by assuming “standard” preferences. In another famous quote, [Laffont \(1975, p. 431\)](#) illustrates the paradoxical implications of assuming rational self-interest as the sole guiding principle of human behavior. In introducing Kantian economics, he asked:

Why is it, then, that (at least in some countries) people do not leave their beer cans on beaches?

[Buchanan \(1967, p. 113\)](#) argued that people behave in a reciprocal way in the provision of public goods as follows: “By increasing rather than by decreasing his own contribution, Tizio may hope that Caio will, over a series of learning and response periods, follow suit and cooperate in response.” However, it was not until [Dawes and Thaler \(1988\)](#) that the concept of cooperation entered (with some force) the mainstream economic arena. In their seminal paper, they labeled cooperation as one of the anomalies that could not be explained by standard economic theory. While they also presented abundant anecdotal evidence of cooperative behavior beyond what rationality predicts, their strongest arguments were based on the emergent experimental literature, which had already provided robust evidence of behaviors that could not be explained by standard economic theory. [Dawes and Thaler \(1988\)](#) summarized a number of regularities from public good games, showing an important role for altruism and “reciprocal altruism.” In light of the (then) new experimental evidence, the theory needed to be updated.

In the remainder of this section we review recent work that updates the theory by relaxing some of the common assumptions in the standard economic model and discuss the implications of this work for the prospects of achieving cooperation in the climate commons. We start from the premise that focusing on rational decision making based on pure self-interest and neglecting contextual drivers of behavior may undermine the goal of achieving behavioral change in a cost-effective way. Scholars in psychology, economics, and philosophy have long recognized that prosocial preferences and public interventions could interact in a detrimental way, potentially leading to motivational crowding out ([Deci and Ryan 1985](#); [Frey 1997](#); [Bénabou and Tirole 2006](#)). However, one aspect of human behavior that is underappreciated is the fact that social and policy interventions can also lead to crowding in ([Ostrom 2010](#)). Given that individuals do not respond to monetary rewards, punishments, and other incentives in the simple-minded self-interested way that *Homo economicus* would, the policy challenge becomes finding effective ways to encourage cooperation while accounting for motives and ethical considerations. To this end, incentives need to be carefully designed in order to avoid the pitfall of crowding out good behavior, and instead leveraging (crowding in) prosocial inclinations.

Challenging the Tragedy of the Local Commons

In her influential book, [Ostrom \(1990\)](#) studied the issue of cooperation in local environmental commons. More specifically, she provided evidence that Hardin’s prediction of the commons ending in tragic overexploitation in the absence of markets (privatization) or coercion (government intervention) need not materialize, and indeed is only likely to occur in the presence of additional circumstances, such as open access to the resource as well as

when there is a lack of norms, informal institutions, and communication opportunities. While these conditions are likely to be met in large and competitive environments such as global financial markets, [Ostrom \(1990\)](#) shows that this is hardly the case in many local commons and formalizes the mechanisms that lead to cooperative outcomes in the management of common-pool resources.

Ostrom's stylized facts about cooperation

[Ostrom \(2000\)](#) provides further evidence challenging the standard economic theory of collective action and, more specifically, the prediction that individuals will not contribute any positive amounts to the public good (which Ostrom refers to as the “zero-contribution” prediction arising from individually rational, but collectively inefficient, free riding). Following the example of [Dawes and Thaler \(1988\)](#), [Ostrom \(2000\)](#) synthesized the emerging literature in experimental economics, presenting seven stylized facts concerning cooperation in local settings. We summarize them here because they apply to cooperation more broadly.

First, subjects contribute about 40–60 percent of their endowment to the public good in the first round of play in repeated (linear) public goods games. Second, even if contributions decrease in later rounds, on average they do not converge to zero. Third, the belief that others will contribute increases one's own contribution to the public good. Fourth, learning helps: experienced subjects tend to contribute more (over consecutive sessions in which subjects returned to the lab to play a similar game on a different occasion). Fifth, communication, even if it does not entail a credible commitment (i.e., it amounts to “cheap talk”) facilitates cooperation: subjects appear to use it to decrease defection rather than to fool others into shouldering more of the burden. Sixth, people may be willing to forgo part of their endowment to engage in costly punishment towards noncooperative players. Seventh, contextual factors, such as the framing of the situation or the use of sanctioning mechanisms, tend to affect the outcome of the game.

An updated theory of collective action

In an effort to rationalize these stylized facts, [Ostrom \(2000\)](#) sought to develop an updated theory of collective action. Her call for a new theory is based on the recognition that society includes a significant fraction of conditional cooperators, whose behavior (unlike that of “rational egoists”) is compatible with the experimental evidence. The key ingredient of her theory is trust. That is, conditional cooperators are likely to cooperate so long as they believe that the other players are trustworthy reciprocators. The presence of conditional cooperators in society is consistent with insights from evolutionary theories, which suggest that human beings are inclined to learn social norms, and that with sufficient information on others' behavior, trustworthy individuals may fare well and spread in societies ([Barkow, Cosmides, and Tooby 1995](#); [Cummins 1996](#))—to the point that, depending on how precise the signal is, rational egoists may not survive in an evolutionary process (cf. [Axelrod 1986](#)).

Related theories of human behavior that support the idea of cooperation at multiple scales have developed over the years (see, e.g., [Fehr and Schmidt 1999](#); [Brekke, Kverndokk, and Nyborg 2003](#); [Nyborg, Howarth, and Brekke 2006](#); [Roemer 2015](#)). [Tabellini \(2008\)](#) and [Dixit and Levin \(2017\)](#), among others, attempt to explain why prosocial behavior may emerge and persist in societies. In the seminal model of [Tabellini \(2008\)](#), parents rationally decide

whether to invest effort in educating their children in a prosocial way and transmitting prosocial values to them, depending on the social environment and the strength of sanctioning of noncompliance. In [Dixit and Levin \(2017\)](#), the instilling of prosocial preferences is the result of a collective action effort. Thus this model captures the efforts undertaken by societies—i.e., not only families—to socialize young individuals in a prosocial fashion (see [Bisin and Verdier \[2000, 2001\]](#) for other theoretical perspectives). Furthermore, a large body of knowledge has developed that provides further evidence of cooperative behavior in local settings ([Fehr and Gächter 2000](#); [Fischbacher, Gächter, and Fehr 2001](#); [Ostrom and Ahn 2003](#); [Kocher et al. 2008](#); [Poteete, Janssen, and Ostrom 2010](#); [Dixit, Levin, and Rubenstein 2013](#)). However, it was only after Elinor Ostrom was awarded the Sveriges Riksbank Prize in Economic Sciences in Memory of Alfred Nobel in 2009 that the updated theory of collective action received general recognition in mainstream economics.

Scaling Up Cooperation

Although Ostrom's updated theory of collective action provides useful lessons for governing local commons, it does not, at first glance, appear to offer insights for managing global dilemmas. Can this literature help to identify an escape route from the tragedy of the climate commons?

A partial answer to this question comes from the influential discussion in [Ostrom \(2010\)](#). First, Ostrom reviews a long list of local, regional, and national efforts aimed at curbing greenhouse gas (GHG) emissions. Then, based on this evidence, she challenges the prediction of zero contribution in the climate commons, arguing that the standard theory of collective action may not be well suited to understanding and addressing climate change mitigation. That is, the limits shown by the standard theory in explaining behavior at the local level may also have implications for understanding the global commons.

While the empirical part of our review will focus mainly on individual behavior, there are numerous examples of unilateral political action undertaken in the climate commons by nonstate actors. The [United Nations Environment Programme \(2015\)](#) considers about 200 nonstate climate initiatives involving more than 20,000 actors, including local governments, the private sector, and nongovernmental organizations, and finds that these initiatives are associated with emissions reductions in the range of 2.5–3.3 gigatons of carbon dioxide (CO₂)-equivalent.

[Ostrom \(2010\)](#) further argues that norms tend to guide the choice of the appropriate actions that should be taken in a given context, and individuals may find it important to gain a reputation for being trustworthy by adhering to such norms. Over time, reputation may be internalized so that one's own self-image is sufficient to evoke behavior that is compatible with the norm. This suggests that one may be willing to contribute to a global public good, for instance, by voluntarily reducing GHG emissions, provided that there is agreement on the socially desirable behavior, and that this behavior is at least partly visible (more on this below). Accordingly, societies in which moderately high levels of cooperation can be sustained (i.e., with a significant fraction of trustworthy reciprocators) may be particularly apt and prone to address issues such as climate change. As a result, the key mechanism that leads local commons to be successfully managed may also explain (unilateral) efforts toward climate change mitigation.

Global Agreements Revisited

International environmental agreements have long been modeled in game theory through coalition-formation games (Hoel 1992; Carraro and Siniscalco 1993; Barrett 1994). The underlying principle is that the equilibrium number of signatories to a self-enforcing international agreement follows from the conditions of internal and external stability, whereby no signatory is better off leaving the coalition and there is no incentive for a nonsignatory to join the coalition. Such conditions are necessary because treaties such as the Kyoto Protocol (and to an even greater extent the Paris Agreement) cannot be enforced by external institutions, due to national sovereignty, and must therefore rely on incentives to ensure compliance.

Strategic complementarity and strategic substitutability

The established insight from the theory of international environmental agreements is that self-enforcing treaties are unlikely to result in substantial mitigation efforts, especially when cooperation is most needed (i.e., when the potential gains from cooperation are large due to high mitigation costs and high mitigation benefits). A more optimistic account is found in Heal and Kunreuther (2012), who instead investigate the implications of the existence of a tipping point in the adoption of climate policies by the international community. The authors provide descriptive evidence on the role of early adopters in triggering a global shift away from the use of damaging pollutants, such as the unilateral U.S. adoption of unleaded gasoline to replace leaded gasoline. This unilateral decision meant that the subsequent adoption costs for other countries were limited to modifying refinery capacity, since industries exporting to the U.S. were forced to transition to lead-free fuel immediately after the move by the early adopter. Strategic complementarity meant that, due to the lower costs for the followers, the new technology spread quickly worldwide.

Unfortunately, while under certain circumstances some countries (or blocs of countries) may enjoy strategic complementarities in GHG emission choices, for instance, because they trade goods with each other (Copeland and Taylor 2003; Eichner and Pethig 2014), GHG emissions are generally considered to be strategic substitutes. That is, when the marginal damages from global emissions are increasing, a unilateral reduction in emissions by one country will be matched by an increase in emissions by the remaining countries (everything else being equal). This implies that in the absence of a treaty guaranteeing the coordination of mitigation effort, governments will be reluctant to lead, due to a loss of competitiveness for the domestic industry relative to the laggards.

This type of situation, which stems from the global public good nature of GHG emission reductions and the lack of credible supranational authority for enforcing commitments, is predicted to be less prone to defection when a tipping point is clearly identified—that is, a level of GHG emissions that is compatible with keeping the global temperature increase below a universally agreed target, such as 2°C. Such a threshold for dangerous climate change transforms the social dilemma inherent in gradual climate change (where free riding on the effort of others is the dominant strategy) to the relatively simple problem of equilibrium selection (in this case, coordinating collective action on the agreed goal of limiting GHG emissions by symmetrically sharing the burden). The fact that the cost of deviating from such a plan is very high, because of the threat of catastrophe, virtually ensures compliance.

Unfortunately, coordination can be undermined by asymmetries in wealth (and past emissions) among countries (Tavoni et al. 2011; Gosnell and Tavoni 2017) and by two forms of uncertainty that plague climate change negotiations: strategic uncertainty and scientific uncertainty (Barrett and Dannenberg 2012; Dannenberg et al. 2015). When enough of either (asymmetry or uncertainty) is present, the “climate negotiation game” reverts to a prisoner’s dilemma, whereby countries would be better off cutting emissions, but delay action indefinitely in the pursuit of their self-interest. The theory underlying this finding is intuitive: a sufficiently high degree of asymmetry or uncertainty (about the other actors or about the location of the threshold) effectively removes the coordination mechanism and brings us back to the unhelpful world of strategic substitutes.

Design features for deeper cooperation

In light of the previous discussion, scholars sought to identify design features that may be conducive to effective international environmental agreements. More specifically, the game-theoretic literature on international environmental agreements has identified mechanisms that have the potential to increase mitigation efforts.² These mechanisms range from expanding the strategy space via side payments and issue linkage (Barrett 2005), to introducing minimum participation rules and open membership (Weikard, Wangler, and Freytag 2015), to imposing trade restrictions on nonparticipants (Nordhaus 2015). European politicians appear to believe that issue linkage may be helpful. For example, in a 2018 address to the French parliament, Jean-Baptiste Lemoine, the French Foreign Affairs Secretary of State, reiterated that France will insist that the stalled Transatlantic Trade and Investment Partnership between the European Union (EU) and the United States never be revived if President Donald Trump carries through on his promise to leave the Paris Agreement: “No Paris Agreement, no trade agreement. The US knows what to expect.”³ Similar rhetoric concerning new trade deals can be heard from the EU, where Cecilia Malmstrom, the EU’s trade chief, announced that a binding reference to the Paris Agreement would be required in all EU trade agreements, such as the upcoming ones with the South American trade bloc Mercosur. The current provisions, however, may create an incentive for countries to remain in the agreement, but do little to ensure compliance with voluntary national pledges.

Another strand of the literature on international environmental agreements examines the dynamics of climate agreements of variable length. Harstad (2016) finds that the combined problem of too much pollution and too little investment in green technologies is mitigated when strong property rights can be enforced. In a similar setting, Battaglini and Harstad (2015) find that when investments in green technologies are noncontractible, wide participation in environmental agreements and little free riding can be rationalized by countries’ desire to avoid the holdup problem associated with renegotiating short-term agreements. This occurs because only large coalitions commit to long-term treaties.

²The standard models predict either the formation of a large stable coalition that does little abatement (large but shallow) or a small stable coalition undertaking greater mitigation efforts by few signatories (small but deep), both of which translate into unambitious treaties achieving modest targets. See de Zeeuw (2015) for a recent review.

³<https://www.euractiv.com/section/climate-environment/opinion/trade-and-climate-how-the-eu-can-protect-the-paris-agreement/>.

An updated theory of international environmental agreements

The literature has traditionally modeled governments (and the negotiators acting on their behalf) as rational agents with standard preferences, representing citizens with the same preferences. That is, decision making is viewed as being the result of the aggregation of preferences from the *Homo economicus* described above. A recent strand of literature has explored the implications of relaxing these assumptions. Examples include introducing equity preferences (Lange and Vogt 2003; Lange 2006), reference dependence (İriş and Tavoni 2016), and policymakers' appetite for campaign contributions (Habla and Winkler 2013; Marchiori, Dietz, and Tavoni 2017). These departures from the standard assumptions, while modifying different aspects of the game (either the preferences or the assumption that governments negotiate as unitary agents, absent lobbying), can rationalize larger coalitions of contributors, and larger investments to climate change mitigation.

Of particular relevance to the study of climate cooperation, recent contributions to the international environmental agreements literature introduce reciprocity in their framework. For example, Hovi, Ward, and Grundig (2015) assume that some countries or blocs (such as the EU) may be willing to send a costly signal (e.g., by engaging in relatively ambitious mitigation) in order to credibly reveal their "type" to other conditional cooperators in the group. When modeled in this way, climate change mitigation follows a stepwise path, with each step providing a signal to the other players, such that they gradually learn the other countries' "types" and may in turn reciprocate with small but increasing mitigation commitments. These steps may take the form of a tax on domestic emitters, which may be easily ramped up if others follow suit. The cascading process envisioned by Hovi, Ward, and Grundig (2015) is reminiscent of the signaling in local dilemmas (discussed earlier), and is aimed at building trust incrementally. In the Hovi, Ward, and Grundig (2015) model, countries that are embedded in dense networks, such as important nodes in trade networks, may have further opportunities to signal their trustworthiness to others, as well as more to lose in reputational terms when behaving uncooperatively. Buchholz and Sandler (2017) also observe that during the lead-up to the 2015 COP in Paris, signaling one's conditional commitment might have provided a "motivational push" for governments to reciprocate others' efforts. Interestingly, actors such as the EU made their mitigation pledges first, perhaps leveraging the bottom-up approach to start the process of reciprocation.

There is, of course, a complementary strategic response that pulls governments in the opposite direction—toward inaction. That is, a country may be concerned about the consequences of undertaking a leadership role in climate mitigation, because of the risk that stringent targets may negatively affect the competitiveness of its industry relative to countries with unambitious policies. In fact, the threat of such free riding by laggard states has the potential to induce a vicious cycle of countries decreasing their ambition, which is reinforced by the same preference for reciprocity that underlies the Paris Agreement's increases in ambition over time. This potential destructive impact of reciprocity has long been recognized in behavioral economics, beginning with Rabin (1993), who pointed out the transformative role of reciprocity: if two players have sufficiently strong reciprocal preferences, they will perceive a prisoner's dilemma game as a coordination game, where both coordination and defection are equilibria. The first studies to investigate the transformative role of reciprocity are Hadjiyiannis et al. (2012) and Nyborg (2018). Hadjiyiannis et al. (2012) find that the effect

of reciprocity in a two-country pollution abatement game depends on what the countries view as fair abatement: if both players have modest expectations about the other's abatement, more cooperation can emerge than when there is no reciprocity. High expectations, however, destabilize environmental cooperation. Nyborg (2018) casts the problem in the setting of participation in a coalition formation game among countries acting according to reciprocal preferences. She finds that reciprocity induces less abatement than standard preferences when few other countries abate. Conversely, if enough players have sufficiently strong reciprocal preferences, either the grand coalition or a majority coalition are stable outcomes. Hence both studies confirm that reciprocity can either help or hinder mitigation efforts.

Buchholz and Sandler (2017) examine how the constructiveness of reciprocity can be leveraged by introducing reciprocal preferences in a two-player game with a leader and a follower. People in the follower country may enjoy some "warm-glow"-like benefit (conditional on others' contributions) by supporting the common goal of mitigating climate change. This assumption results in strategic complementarity between each country's contributions. That is, higher contributions from the leader no longer lead to lower contributions from the follower; rather, they lead to higher (reciprocal) contributions. Moreover, the follower country may also influence the leader country through its own contributions. More specifically, the leader's effort acts as a signal of goodwill, thus having a "trust-building" effect on the follower country. The larger the leader's contributions, the more the follower is likely to believe that the leader will reciprocate the follower's effort. Hence Buchholz and Sandler (2017) conclude that unilateral initiatives would no longer be disadvantageous, suggesting that leveraging reciprocal preferences may be an effective mechanism for addressing climate change.

Taking stock

To summarize, the modifications to the standard model that we have discussed here may, to some extent, ease the collective action problem, casting a more favorable light on the prospects of addressing it, compared to the earlier literature. Thus the models we have reviewed may help to explain the extent of cooperation observed in the real world. While the current level of cooperation is still insufficient, it is not negligible and may reflect the fact that we are undertaking the initial steps in the above-mentioned reciprocal game. However, these updated theories also hinge on important assumptions. The main assumption we have been considering here is the one related to conditional cooperation. Is there any empirical evidence that indicates that such behavior exists in the climate commons? The next section tackles this question.

Empirical Evidence on the Role of Local Social Norms in the Climate Commons

Many of the studies discussed in the previous section assume that at least part of the community is willing to conditionally cooperate. With this in mind, in this section we present empirical evidence of such behavior, which suggests that local social norms influence people's behavior, including when their actions affect the climate commons. We pay special attention

to the visibility (or salience) of social norms and examine social norms in a decreasing order of visibility. We start by analyzing peer effects in the presence of very visible behavioral change, then focus on social interventions that make behaviors observable that would otherwise be invisible, and finally examine the role of beliefs about others' cooperativeness when specific behaviors cannot be observed.

Not all situations that we describe in this section concern pure contributions to climate change mitigation. Some goods also provide private benefits. As theorized in the case of impure public goods (Kotchen 2006), however, their adoption is not uniquely motivated by the private benefits. Overall, the evidence presented here follows a common pattern, suggesting that local social norms are a key driver of behavior for decisions that pertain to the climate commons. Furthermore, we conclude that people appear to be more likely to engage in cooperative behavior if such behavior is observable to others in the local social environment.

Peer Effects

We focus here on two forms of easily observable proenvironmental behaviors: the adoption of photovoltaics and the adoption of hybrid cars. Specifically, we are interested in whether people are more likely to adopt these behaviors if they observe that others in their local environment have already adopted such behaviors.

Adoption of photovoltaic technology

Because of their visibility, rooftop solar photovoltaic (PV) panels convey information about the behavior of others in a given community (i.e., the local social norm). Empirical evidence of peer effects in the adoption of rooftop PV technology adoption has been identified in California (Bollinger and Gillingham 2012), Connecticut (Graziano and Gillingham 2015), Germany (Rode and Weber 2016), and Switzerland (Baranzini, Carattini, and Péclat 2017). In fact, Baranzini, Carattini, and Péclat (2017) show that solar panels that can be installed on facades and steep roofs (building-integrated PV), which means they are more visible, lead to greater adoption by others (more new installations of any type) than the standard building-attached photovoltaics. While the adoption of solar panels may have financial drivers, the literature suggests that both proenvironmental and prosocial motives also play an important role in driving behavior. For example, Islam (2014) shows that emissions abatement is among the factors encouraging higher PV adoption, even when controlling for energy savings. Palm (2018) confirms this finding, especially for early adopters. Kwan (2012) finds that communities in the United States that lean towards the Democratic Party tend to have higher adoption of PVs, even when controlling for economic incentives and electricity cost.

Adoption of hybrid vehicles

Hybrid cars provide further evidence on the role of visibility in determining peer effects in the adoption of green technologies. As shown by Narayanan and Nair (2013), peer effects drive the adoption of hybrid cars in California, but only for the Toyota Prius Hybrid and not, for instance, for the Honda Civic Hybrid. While the Prius exists only in its hybrid form and is thus immediately identified as a green car, the hybrid versions of the Civic look exactly like their nonhybrid versions (Narayanan and Nair 2013). This suggests that “going green” seems to

lead to peer effects only when such behavior is sufficiently visible. Using data on vehicle purchases in the states of Colorado and Washington, [Sexton and Sexton \(2014\)](#) show that in areas with stronger environmental preferences (defined as those in which the share of residents registered as Democrats is high), the market share of Priuses grew faster than the market share of any other hybrid cars. The authors estimate that in states in which the share of Democrat voters is high, and proenvironmental behavior is thus more likely to be socially rewarded, people are willing to pay a premium of up to \$4200 to drive a Prius (and hence signal their “greenness”) rather than another hybrid car with comparable characteristics.

Social Interventions

In many cases the norm is not directly visible but can be made visible through external intervention. An increasing number of studies have focused on information campaigns and social interventions aimed at influencing individuals’ perception of the social norm, especially when the social norm is sufficiently high (i.e., a given behavior is relatively widespread). Although there is extensive literature on the role of information provision in the adoption of proenvironmental behavior (e.g., [Cohen and Viscusi 2012](#)), we focus here on a set of interventions in which information is provided on the behavior of peers with the objective of encouraging the adoption of such behavior.

Descriptive and injunctive norms

Following [Cialdini \(2003\)](#), descriptive norms (about what people do) have been increasingly combined with injunctive norms (about what people should do) in order to redirect citizens’ behavior toward socially preferable alternatives. [Schultz et al. \(2007\)](#) apply this approach to a field experiment on household energy consumption and treat a community in California as follows. A descriptive-norm treatment, providing information on the neighborhood’s average energy consumption as well as on the household’s past consumption, is assigned to all participants, whereas an additional injunctive-norm treatment is assigned only to a randomly selected sample. The injunctive-norm treatment consists of receiving a positively (negatively) valenced emoticon depending on whether the household’s energy consumption was below (above) average. The authors find that the descriptive-norm treatment leads households to converge toward the level of consumption of their neighbors, so that the level of energy consumption of those households that were above the mean prior to the treatment decreases (intended effect), but, at the same time, the level of energy consumption of those that were below the mean prior to the treatment increases (unintended effect). This unintended (“boomerang”) effect suggests that “bad” environmental behavior can be as contagious as “good” environmental behavior (see also [Dur and Vollaard 2015](#)). However, [Schultz et al. \(2007\)](#) also show that this perverse boomerang effect can be addressed by reverting to injunctive norms. More specifically, the combination of descriptive and injunctive norms results in a decrease in the amount of energy consumed by households above the mean, but no significant change in behavior is observed for the households below the mean. Thus, when injunctive norms are added, the convergence that is observed is not toward the descriptive norm, but rather toward the low and desirable level of consumption of below-average households. This suggests that when descriptive norms are used in combination

with injunctive norms, people tend to replicate the behavior of the more cooperative individuals in their local context. Note that the presence of a boomerang effect, with an increase in energy consumption for below-average households, supports the idea that the main driver of behavior is the local social norm, not potential economic savings.

Larger interventions

A similar experiment was conducted on a much larger scale on behalf of several utilities by the company Opower, which provided treated households with home energy reports designed to spur energy conservation. [Allcott and Rogers \(2014\)](#) find that people respond to the comparison of their energy consumption with the energy consumption of their neighbors (and with their own past energy consumption) even after several reports, and that the program continues to be effective in reducing energy consumption even after half a decade and also after being discontinued. Although there was, of course, some backsliding, average treatment effects in the discontinued-treatment group were still on the order of -0.5 kWh/day two years after the program was discontinued. The cost-effectiveness analysis in [Allcott and Rogers \(2014\)](#) confirms just how powerful social norms can be, although the Opower intervention provides (in a unique report) information about neighbors and the households own level of consumption, which does not allow for disentangling the effect of the descriptive norm from information on one's own consumption.

Observability is also the key feature of another behavioral intervention, fostering voluntary participation in “demand response” programs (see [Yoeli et al. 2013](#)). In these programs, a pool of households agrees to have their energy consumption remotely controlled and potentially reduced during demand peaks to prevent blackouts and cost spikes. By sacrificing comfort if their appliances are switched off, each participating household provides a small contribution to the public good. In a large field experiment based on more than 2,000 participants, [Yoeli et al. \(2013\)](#) found that sharing information about who among the neighbors is participating in the program induces much more participation than a monetary reward of \$25, and argue that even a monetary reward of about \$170 may still be less effective than making others' participation observable. Observability is only shown to matter for individuals who believe that voluntary participation in a demand response program is a public good, thus suggesting that an inclination to cooperate (or reciprocate) is a necessary condition for behavioral change. Greater effects are found for people who live in apartment buildings rather than houses; according to [Yoeli et al. \(2013\)](#), this difference is likely due to the many more interactions between neighbors in the former case.

Pure provision of a global public good

Although in the experimental settings of [Schultz et al. \(2007\)](#) and [Allcott and Rogers \(2014\)](#) households could also save money by changing their behavior in the ways encouraged by the experimenters, behavioral interventions have also been found to be effective when the cost of contributing to the public good is clearly positive. For example, [Lindman, Ek, and Söderholm \(2013\)](#) recruit a sample of Swedish students and analyze their willingness to pay for carbon offsets; they find that the students' purchase of carbon offsets is a positive function of the participation figures that the authors provide for the population overall, suggesting that making the local norm visible may also be effective when people are asked to contribute to

a global public good. The numbers given for the overall population (10%, 30%, 50%, and 70%) are, however, false, and include deliberately high figures. Although the use of deception can generally be challenged on several grounds, the findings of [Lindman, Ek, and Söderholm \(2013\)](#) may suggest that cooperation could be spurred by showing large figures, for example, for a subsample of the population that behaves in a particularly climate-friendly way.

Less Visible Social Norms

In most cases, however, it is particularly hard to infer the extent to which others are cooperating. When the level of cooperation of others is uncertain, we can expect people to form beliefs about it and behave accordingly. It is an empirical question whether one's expectation of a high level of cooperation in a given environment leads one to reciprocate. The research we have surveyed thus far suggests that the visibility of the local norm may result in increased provision of climate change mitigation, although with exceptions and mixed evidence (e.g., [Bolsen et al. 2014](#)). The next step consists of assessing whether this relationship also holds when norm visibility is limited, such that individuals must rely on subjective beliefs about others' choices.

Recent evidence suggests that the relationship may hold, to some degree. For example, in a study of Swiss individuals' willingness to pay for climate change mitigation, [Blasch and Farsi \(2012\)](#) find that the private demand for carbon offsets depends positively on "people's expectation about the percentage of Swiss consumers that participates in voluntary carbon offsetting schemes" (p. 20). In a similar setting, [Schwirplies and Ziegler \(2016\)](#) use survey data to examine the willingness to pay for climate change mitigation in Germany and the United States (measured in terms of hypothetical demand for carbon offsets and other environmentally friendly products). The authors consider many variables that determine the stated adoption of carbon offsets and the willingness to pay a premium for green products, including a variable called "expectation of society," which measures people's expectation of the level of cooperation of others. [Schwirplies and Ziegler \(2016\)](#) find that this variable is positively correlated with stated environmental behavior in the U.S. sample, but find no significant effect for the German sample. The positive relationship between the variable "expectation of society" and stated environmental behavior in the United States corroborates the findings of [Blasch and Farsi \(2012\)](#), suggesting that expectations about other people's behavior, at the local level, influence contributions to climate change mitigation.

Trust

The evidence from peer effects, social interventions, and other situations in which local norms are less visible suggests that the local context is an important driver of the adoption of climate-friendly behavior. A natural question is whether these microeconomic relationships between local social norms and proenvironmental behavior translate into broader, measurable relationships between societal cooperativeness and environmental outcomes measured at the subnational or national level. An emerging literature has addressed this question by looking at trust as a measure of a country's culture of cooperation.

Trust has been indicated not only as one of the keys for the successful management of open access resources, but also as an important determinant of prosperity (Fukuyama 1995). The beneficial effect of trust on economic development has also been identified empirically (cf. Algan and Cahuc 2013). Here we extend the analysis to the role of trust in shaping cooperative behavior in the climate commons.

Owen and Videras (2008) investigate the relationship between trust, measured by the widely used World Values Survey, and efforts to pursue the goals of sustainable development by many municipalities in 60 different countries. Using cross-sectional regressions, the authors find a positive correlation between a country's level of trust and its adoption of Agenda 21 programs, an initiative that builds on local sustainable development projects. Based on observations for 29 European countries between 1990 and 2007, Carattini et al. (2015) find a negative correlation between trust and GHG emissions, suggesting that a countries' culture of cooperation matters for their cooperativeness in the climate commons. To further investigate this issue, Carattini and Jo (2018) rely on an identification strategy developed by Algan and Cahuc (2010), who studied the relationship between trust and economic growth, to provide causal evidence on the relationship between trust and CO₂ emissions. They find that the inherited trust of descendants of immigrants to the United States, which serves as a measure of trust in their country of origin, is a significant factor in explaining changes in CO₂ emissions observed between 1950 and 2010 across 26 countries around the world. To confirm that the effect of trust is not confounded by other variables, the authors run a placebo test for the period between 1920 and 1980. Because there was almost no awareness of anthropogenic climate change between 1920 and 1980, and hence no reason for the culture of cooperation to influence emissions, Carattini and Jo (2018) find no effect of trust on GHG emissions during this time period.

Tam and Chan (2018) provide an interesting explanation for the observed relationship between trust and GHG emissions. More specifically, they investigate the gap between environmental concern and (self-reported) proenvironmental behavior and provide correlational evidence that trust plays a moderating role in the relationship between environmental concern and proenvironmental behavior. This finding suggests that the gap between environmental concern and proenvironmental behavior is smaller in countries where trust is high—that is, when people expect others to also translate their concern into action.

The evidence provided by Tam and Chan (2018) is consistent with Alló and Loureiro (2014), who review a large number of empirical studies on the willingness to pay for climate change mitigation and perform a meta-analysis to explain the social and cultural determinants of the cross-country differences that they observe in the sample. They find that countries with a high propensity to conform to social norms are characterized by a high willingness-to-pay for climate change mitigation. Based on data for residential energy consumption in the United Kingdom, Volland (2017) finds a negative correlation between the level of trust stated by respondents and their reported level of energy consumption, with a one-step increase in trust (measured on a 10-point scale) being correlated with a decrease of about 1 percent in energy consumption. These findings further confirm the role of the culture of cooperation in driving behavior in the climate commons.

Summary and Conclusions

Standard economic theory predicts that there should be little cooperation in the climate commons, beyond what can be rationalized on the basis of the expected benefits that can be appropriated from undertaking mitigation effort. We have reviewed recent evidence on the adoption of behaviors with implications for climate change mitigation and conclude that individuals are, to some extent, inclined to behave cooperatively in the face of this global dilemma. That is, when tackling climate change (as in other domains), individuals are more willing to cooperate than standard theory predicts. We have focused on *local* social norms, which allowed us to examine the roots of a wide range of cooperative behaviors observed in the climate commons. The evidence points to a largely untapped potential for leveraging human proclivities for cooperation, which are typically observed in local commons, in order to contribute to the provision of the global public good of climate mitigation.

The main message from the reviewed literature is that local social norms are likely to play a prominent part in triggering individual climate-friendly behavior, because these norms appear to be instrumental in explaining some of the observed cooperative behavior. Thus we conclude that the potential for a virtuous societal change toward environmentally friendly behavior crucially hinges on how visible and widespread such behavior—and hence the norm—is. That is, the more prevalent and the more observable the behavior, the more likely it is to be locally adopted by others. As a result, interventions can play a key role in facilitating behavioral change, for instance, by increasing the visibility of otherwise invisible behaviors such as green energy adoption. Such interventions would not only make the social norm more salient, but also create social rewards for those individuals that engage in cooperative behavior. However, social interventions that rely on descriptive norms may backfire if such behavior is rarely adopted, as is the case with carbon offsets. Given the important ethical and practical drawbacks of deception, strategies need to be developed to kick-start and foster contagion even when the initial adoption level is low. This requires researchers and policy-makers to find creative ways to adapt social interventions to leverage the example of early adopters.

The empirical literature also suggests that in addition to fostering cooperation in local environmental dilemmas and economic growth, trust and the culture of cooperation of a society are beneficial for tackling global dilemmas. The challenge here is finding ways to increase trust. While cultural aspects of a society tend to be rather persistent, economists have suggested using education to spur civic spirit and increase cooperation. However, these are long-term investments, which themselves present a collective action problem. In the short run, interventions aimed at increasing the observability of cooperative behavior may already contribute to build trust among relevant actors.

The empirical evidence we have reviewed and discussed here does not match the standard economic theory, which provides rather negative predictions about our ability to reach an effective agreement to tackle climate change. Although the conventional literature is consistent with the sluggish achievements of decades of negotiations, it is at odds with the recent emergence of bottom-up approaches to cooperation in the climate commons, including subnational initiatives and the new regime agreed to at the Paris COP in 2015. The Paris Agreement's departure from the top-down architecture of its predecessors suggests a need for

further research on international environmental agreements, with a more prominent role for domestic politics, including voters and environmental organizations. In this article we have identified a set of recent studies in the international environmental agreements literature that goes beyond standard assumptions, and which may already provide a better fit to real-world observations. We refer to this literature as an updated theory of international environmental agreements.

While we have yet to see how the voluntary nature of the nationally determined contributions of the Paris Agreement will play out, it is important to note that the U.S. decision to withdraw from the agreement did not lead to a cascade of withdrawals. Instead, some countries appear to be pushing for a club approach (Nordhaus 2015). For example, French President Macron organized a climate summit in December 2017 for “committed cooperators only,” and the EU has suggested tying international trade and climate cooperation together. It remains to be seen whether the initiatives discussed here will induce enough actors to commit to, and actually undertake, substantial mitigation efforts that are sufficient to trigger a large-scale virtuous change.

In the meantime, we encourage policymakers to consider and test the potential of club approaches and schemes that leverage reciprocal preferences at multiple scales. That is, common patterns of behavior need to be identified and, ideally, leveraged to meaningfully contribute to global abatement, well beyond the current levels of cooperation. Fortunately, policymakers and organizations can draw insights from a growing number of domestic interventions. These initiatives, some of which we have discussed here, can be used to leverage people’s prosocial and proenvironmental attitudes to increase contributions to climate change mitigation.

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Abstract

Climate change is a global externality that has proven difficult to address through formal institutions alone due to the public good properties of climate change mitigation and the lack of a supranational institution for enforcing global treaties. Given these circumstances, which are arguably the most challenging for international cooperation, commitment problems and free-riding incentives for countries to delay costly mitigation efforts are major obstacles to effective environmental agreements. Starting from this premise, we examine domestic mitigation efforts, with the goal of assessing the extent to which the willingness of individuals to contribute voluntarily to the public good of climate mitigation could be scaled up to the global level. Although individual environmental actions are clearly insufficient for achieving ambitious global mitigation targets, we argue that they are nevertheless initial and essential steps in the right direction. In fact, individual and community efforts may be particularly important if local interventions encourage shifts in norms and behaviors that favor large-scale transformations. With this in mind, we discuss the importance of the visibility of norms and the role of beliefs when such visibility is lacking and their implications for leveraging cooperative behavior to increase climate mitigation efforts locally and globally. (*JEL*: D70, F59, H23, M30, Q54, Q58)