Who do you Trust? Inefficiency Incentives in Climate Change Mitigation

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Abstract

Climate change is an extremely polarized issue in the United States, with leaders across the political spectrum sending very different messages about whether and how we should implement mitigation policies. Do citizens have the tools necessary to distinguish between helpful and unhelpful information about mitigation policies? Leaders have different incentives which constrain their support for or opposition to mitigation spending. Here we test whether citizens are sensitive to different institutions which may give leaders an incentive to misrepresent the cost of providing public goods like mitigation or disaster prevention. We use an incentivized experiment to do so, specifically using a modified collective risk social dilemma. In this public goods game, players must contribute enough money to prepare for an ongoing disaster. Leaders know the exact cost of damage prevention, and send signals to the other players about the cost. We show that people are sensitive to institutional differences: when leaders have a stake in inefficiency, citizens trust the leader less and contribute less to the public good. In the midst of bleak research on mitigation policy support, we provide optimistic evidence of people's ability to differentiate between helpful and unhelpful information about mitigation policies.

1. Introduction

Climate change is largely a political problem. A variety of solutions to curb climate change have been developed over the past few decades such that technology exists today which could drastically slow global mean temperature rise (IPCC 2014a). The biggest barriers to successful mitigation are no longer technical problems, but political ones. How do we mobilize support for climate change mitigation policies, and how do we then govern the implementation of these new policies? Experts and global leaders share information to help determine and coordinate on the best strategy to cut emissions. However, these political elite offer a variety of policy proposals, and coordinating on the most effective strategy poses a major political problem. Some, like the Intergovernmental Panel on Climate Change, emphasize we must cut emissions now to keep global mean temperature from rising over 2ºC (IPCC 2014b, 2018). Others, like the current President of the United States, do not believe in climate change at all, as illustrated by his tweet "Brutal and Extended Cold Blast could shatter ALL RECORDS – Whatever happened to Global Warming?" (Trump 2018).

Our primary question is whether or not citizens can successfully differentiate between correct and incorrect advice about mitigation policies. If citizens are uninformed (Delli Carpini and Keeter 1993) and process information in a way biased by their partisanship (Jerit and Barabas 2015), then in the current environment where climate change opinions are highly polarized there is little hope for successfully passing mitigation policies (Egan and Mullin 2017). Furthermore, voters favor short term economic gains over long term risk prevention, rewarding disaster relief spending but punishing spending on prevention (Gasper and Reeves 2011; Healy and Malhotra 2009). This irrational approach to spending hinders support for mitigation. In their recent work, Gailmard and Patty (2018) use a formal model to show that opposition to disaster prevention may in fact be rational. They assume that incumbents differ on whether they are corrupt or honest, and if the electorate cannot distinguish between these types then it is in their rational self-interest to oppose mitigation and adaptation spending. Whether voters are uninformed and myopic, or voting in their own rational self-interest, the recent literature does not paint an optimistic picture of our ability to overcome the political problem of climate change.

In the midst of this bleak research on mitigation policy support, we provide optimistic evidence of people's ability to differentiate between helpful and unhelpful information about mitigation policies. In the tradition of public choice, we argue that whether a leader is corrupt, or their type, is not an inherent personal quality of leaders (or at least not only) but is at least partially the product of institutions constraining the leader. We show that citizens generally trust signals from more informed individuals about how to best prevent oncoming disasters, but this trust is conditional on the institutions constraining the informant. People are sensitive to differences in leaders' institutional incentives and therefore may be able to better navigate the complex information environment surrounding climate change mitigation than previously thought.

We specifically test the effects of revenue generating institutions, or institutions which generate a surplus that can be captured by the leader. Because under such conditions the leader has a stake in inefficiency, citizens should be opposed to these revenue generating policies even when the generated revenue is redirected to other mitigation programs. Work in mechanism design has used both equilibrium analysis and behavioral experiments to understand the consequences of variations in cap and trade institutions (eg. Franciosi et al. 1993; Goeree et al. 2010). This work has assumed there will exist opposition to such revenue generating programs, but has yet to test whether or not this opposition exists (Ledyard and Szakaly-Moore 1994). Our goal here is not to identify the best institutions for successful mitigation programs, but instead to identify whether or not citizens are sensitive to such institutions.

While leadership and communication are broad topics even under the umbrella of public choice and climate change, this research project aims to answer a specific set of questions. When people respond to a leader's signal, how does this change depending on whether leaders can capture excess revenue generated by the institution? We answer this question using both a formal model of a signaling game under uncertainty and with an incentivized experiment using a modified collective risk social dilemma (Milinski et al. 2008). While including leaders and any form of communication in experiments with uncertainty tends to lead to more cooperation and success (Chaudhuri 2011; Ledyard 1995), these benefits should be diminished when the leader has an incentive to generate a surplus for themselves. We find that regardless of the institution type, people do follow signals sent by leaders. Furthermore, we find that even when they have an incentive to generate a surplus, not all leaders are corrupt. However, people are sensitive to the institutional incentives that leaders face. When the leader has a stake in inefficiency, participants trust them less and rationally reduce their contributions to the proposed mitigation strategy. People can differentiate between the institutional incentives leaders face, which optimistically suggests that, under the correct circumstances, people may support effective climate change mitigation.

2. Institutions and Electoral Accountability

The key question in this paper is whether or not citizens are sensitive to differences in institutional arrangements that give leaders an incentive to misrepresent information about climate change. If not, then there is little reason to believe that people will support mitigation policies (Gailmard and Patty 2018). Below we discuss the literature on electoral accountability – specifically whether voters have the knowledge and ability to incorporate factual information into their calculus of voting. Furthermore, we discuss the literature on mechanism design and cap and trade policies which has largely ignored research on political knowledge and sophistication. Bringing these two literatures together reveals the importance of testing whether citizens are actually sensitive to institutional arrangements which affect the information environment. While formal modeling reveals the circumstances under which citizens should change their behavior, experimentation reveals whether citizens are actually sensitive to these institutional arrangements.

2.1 Informed Enough?

Whether or not people have the cognitive tools necessary to successfully navigate the complex political environment is one of the longest running debates in political science. The Michigan Model suggests that people do not, that partisanship forms a perceptual screen through which we view new information (Campbell et al. 1980). It argues that citizens are uninformed, and lack coherent political attitudes (Converse 1964). Research on political knowledge supports this claim, finding that the public lacks factual knowledge about policies (Delli Carpini and Keeter 1993), heuristics do not overcome this lack of knowledge (Kuklinski and Quirk 2000), and partisanship biases information processing (Jerit and Barabas 2015). A competing model optimistically argues that partisanship is the result of a rational running tally. Under this model, citizens constantly monitor the political environment and update their view on political parties accordingly (Bullock 2015; Fiorina 1981).

Evidence from voting on disaster prevention and relief spending supports for the former argument. Citizens reward politicians for relief spending (Gasper and Reeves 2011; Healy and

Malhotra 2009), but not for disaster prevention (Healy and Malhotra 2009). This suggests a lack of knowledge because spending on disaster prevention is more efficient and effective than disaster relief spending. Healy and Malhotra argue this shortcoming in accountability is the product of voters voting myopically – they prioritize short term economic savings over long term economic success.

Other models dispute the mechanism through which voters oppose prevention spending and reward relief spending (Gailmard and Patty 2018). Rational actors voting in line with their long term economic interests may still oppose prevention spending. The key assumption in this model is that incumbents differ on their type, whether they are honest public good providers or corrupt revenue generators, and that citizens cannot distinguish between these types. Therefore, voters are always better off opposing prevention spending. However, this assumption is at odds with research on designing effective cap and trade policies, which instead assumes that citizens are sensitive to institutional arrangements which dictate a leaders' ability to be corrupt.

2.2 Mechanism Design and a Stake in Inefficiency

Mechanism design is rooted in the search for incentive compatible mechanisms, or institutions which efficiently provide public goods by eliciting truthful signals from citizens about their valuations of public goods. However, incentive compatible mechanisms are not budget balancing. The central planner extracting messages from citizens has an incentive to generate a surplus, or inefficiency, and a rational citizen should recognize this incentive and refuse to participate in systems claiming to be incentive compatible (Miller and Hammond 1994). This assumption, that individuals are wary of any such revenue generating systems, is largely implicit in the study of designing institutions to stop climate change.

For example, there is expansive behavioral economic research attempting to determine the most efficient and welfare enhancing rules for emission permit trading systems. Drawing inspiration from mechanism design, these systems leverage the power of the free market to stop climate change by distributing emissions permits to industries that pollute, and then allowing those industries to trade and sell their permits to meet their emissions needs (Muller and Mestelman 1998). Research on these permit systems have explored how different initial distributions of permits (Goeree et al. 2010; Murphy and Stranlund 2006; Wråke et al. 2010) and permit trading rules (Franciosi et al. 1993; Ledyard and Szakaly-Moore 1994; Murphy and Stranlund 2006) lead to the most efficient and effective reductions in emissions.

These studies either ignore the government's stake in these institutions or assume citizens are opposed to the government generating revenue from these systems. When comparing a system of free grandfathering or selling permits to industry members based on an initial auction, studies do not discuss who keeps the auction money and how that changes the government's incentive to prefer the auction (eg. Franciosi et al. 1993; Muller and Mestelman 1998). Others assert that emission permit systems that generate revenue for the government are less politically tenable. They imply but do not test that citizens recognize these policies generate a stake in inefficiency that reduce their overall welfare (eg. Ledyard and Szakaly-Moore 1994; Noll 1982).

Here we are not attempting to design new, more effective mechanisms, but instead test the assumption inherent in these designs that citizens respond to institutional differences that create a stake in inefficiency. The lack of support for disaster prevention can be interpreted as evidence that citizens do not – that they simply vote myopically for their short term self-interest (Healy and Malhotra 2009). However this support could also be a rational response to uncertainty in the motives of leaders pioneering disaster prevention policies (Gailmard and Patty 2018). To successfully pass climate change mitigation policies, we must first understand the root of opposition to such policies.

3. Uncertainty and Leadership in Overcoming Social Dilemmas

Climate change is a global social dilemma, and we must avoid global mean temperature rise above 2ºC to prevent catastrophic climate change related damages (IPCC 2014a). There is uncertainty in exactly how much we must reduce carbon emissions to avoid this threshold (Kriegler et al. 2009), and this uncertainty reduces cooperation and success (Barrett and Dannenberg 2012). To study the mechanisms that promote or hinder cooperation in social dilemmas under uncertainty like climate change, previous research has relied heavily on economic games. Specifically, they have used the collective risk social dilemma, a modified public goods game where players have to contribute enough to meet a threshold in order to avoid losing their remaining funds (Milinski et al. 2008).

Introducing communication or a leader, conceptualized as someone who makes the first public contribution towards public goods, serve as important coordination points. These coordination points increase cooperation and success (Chaudhuri 2011). Experiments thus far have not combined communication and informed leadership. They leave open the question of how players respond to signals from well informed leaders when facing uncertainty in public goods games under different institutional arrangements.

3.1 Uncertainty and Cooperation in Public Goods Games

In simple public goods games, each player starts with a private good which they can choose to keep or invest in a public good (Camerer 2011; Ledyard 1995). Investments in the public good are then multiplied by some factor and redistributed to each player, regardless of whether or not they contributed initially to the good. Though a rationally self-interested player in equilibrium should contribute nothing to the public good, most studies find that players contribute 40-65% of their endowment to the public good (Chaudhuri 2011; Ledyard 1995). These games successfully capture the collective nature of climate change mitigation, as the costs and benefits each player receives are contingent on the behavior of those in their group. It also captures the free rider incentives inherent in mitigation where countries are best off emitting like usual and benefiting from the emissions reductions of others (IPCC 2014b). The benefits of emissions reduction are generalized to the entire planet, while the costs are borne by those who reduce their emissions.

While previous public goods games capture something interesting about the strategic nature of cooperating under social uncertainty, they assume a continuous relationship between the amount of emissions and the damages inflicted on the players. The relationship between emissions and catastrophic climate change related damage is better represented with a stepwise function. There exists a threshold of global mean temperature which, if surpassed, will lead to irreparable damage (Barnosky et al. 2012). While there are continuous marginal effects associated with increased pollution, what is more important is the difference between the small effects of emissions below this threshold and the catastrophic increase in damages associated with crossing this threshold. The collective risk social dilemma captures this phenomenon. Players in the game each have an endowment which they can contribute toward a threshold. If the sum of these contributions is large enough to meet the threshold, all players keep their remaining endowments. If the group does not successfully meet the threshold, they lose their remaining funds with some probability (Andrews, Delton, and Kline 2018; Milinski et al. 2008; Milinski, Röhl, and Marotzke 2011; Del Ponte et al. 2017; Tavoni et al. 2011).

The collective risk social dilemma has also been used to understand the consequences of uncertainty in the location of the threshold beyond which climate change related damage is certain (Barrett and Dannenberg 2012; Dannenberg et al. 2015). This uncertainty reflects the difficulty in determining the exact amount of emissions reduction necessary to keep the earth's global mean temperature below 2ºC (Kriegler et al. 2009). Unfortunately, threshold uncertainty consistently leads to a breakdown in cooperation and failure of groups to meet the threshold, though some studies have found that communication between subjects helps facilitate cooperation even under uncertainty (Tavoni et al. 2011). In the following experiment and model, we hope to explore a narrower form of communication and understand the conditions under which an informed leader can improve cooperation.

3.2 Leadership and Communication

Most experimental studies have conceptualized leaders as a point of coordination. In these studies, one player is selected to make their contribution decision first. Then, their decision is broadcast to the remaining players who then make their contribution decisions simultaneously. Though having a first mover should not change the game theoretic prediction that all players defect and keep their private endowments, increased leader contributions lead to increased follower contributions (Gächter and Renner 2003; Sturm and Weimann 2006). Including a leader further increases cooperation if the leader has the additional power to exclude non-cooperative players in future rounds of repeated games (Güth et al. 2007). Leaders have also been conceptualized as a single player who makes decisions for other members of the group (Milinski et al. 2016). Unfortunately, people tend to choose leaders who contribute less to the public good.

While the above definitions of leadership are informative, they do not capture the full importance of leaders when attempting to address climate change. Leaders, such as politicians and journalists, have access to resources beyond those of the average citizen. The information they share has important behavioral impacts. For example, sharing messages about the dire consequences associated with failing to mitigate climate change increases concern about climate change (O'Connor, Bord, and Fisher 1999), but can decrease people's willingness to spend resources on climate change mitigation (Levine and Kline 2017). Understanding when leaders will send messages with truthful information, and how the receivers of that information will respond under different circumstances, is crucial in designing institutions that promote cooperation.

Returning to economic experiments, studies have also explored communication between players with equal information as a coordinating mechanism. Overall, communication between subjects increases cooperation and decreases negative externalities in public bad games (Barrett and Dannenberg 2012; Sturm and Weimann 2006). In the collective risk social dilemma with unknown thresholds, players use communication to coordinate on a single threshold (Tavoni et al. 2011). However, the incentives to free ride in these experiments also lead to an incentive to strategically promise less than their fair share to push others to carry the burden of meeting the threshold (Barrett 2012).

We extend this literature and test the assumption inherent in political economic studies of climate change negotiation: leader incentives matter. Uncertainty reduces cooperation, and certain types of communication and leadership increase cooperation under uncertainty. In previous studies, the conceptualization of leadership as a first mover turns leaders into a coordination point to help the rest of the group converge on a single threshold to try to meet. In our study, we will expand this conceptualization, making the leader both a first mover and better-informed player. Furthermore, we want to explore the institutional arrangements that promote trust and cooperation with informed leaders. As described in Miller and Hammond, leaders and those contributing to stop climate change often face contradictory motives such that leaders benefit from inefficiency (1994).

Though we introduce an incentive for leaders lie for their own benefit in one condition of our experiment, we do not expect all leaders to fully capitalize on this opportunity. People have social preferences – they are willing to pay a cost to benefit others (Charness and Rabin 2002; Fehr and Fischbacher 2002). In the following model, we show how different incentives should change the signals sent by rationally self-interested leaders, and how followers should respond to those messages. Then, we provide experimental evidence showing that incentives do matter. Leaders who benefit from exaggerating the cost of mitigation lie, though not to the extent predicted by the formal model. These incentives change the behavior of followers as well, undermining the successful provision of the public good.

4. The Model

In this modified collective risk social dilemma there are *n* followers who each have an endowment, D_i. There is also one leader, *l*, who has an endowment of *E.* At the start of the game, a threshold is randomly drawn from five possible values ranging from T_1 to T_5. The leader knows the exact value of the threshold, and then can send a signal, *s*, to all of the followers. The signal is selected by the leader and can equal any value ranging from T_1 to T_5. The followers then simultaneously choose a value to contribute, c_i, out of their endowments such that $c_i < D_i$. If the sum of contributions meets or exceeds the threshold, leaders keep their endowments and followers keep their endowments minus their contributions. If the group fails to meet the threshold, each player gets nothing. We can represent the payoffs to the leader as a function of the sum of the contributions of the followers, conditional on the signal sent by the leader such that:

$$U_l\left(\sum_{i\to n} c \mid s_l\right) = \begin{cases} E \ if \sum_{i\to n} c \ \geq T \\ 0 \ if \sum_{i\to n} c < T \end{cases}$$

We can similarly represent the payoffs for the followers as:

$$U_i\left(\sum_{i\to n} c|s_l\right) = \begin{cases} D - c_i \ if \sum_{i\to n} c \geq T \\ 0 \ if \sum_{i\to n} c < T \end{cases}$$

The nature of the collective risk social dilemma is such that any situation in which the sum of the contributions exactly meet the threshold is a Nash equilibria (see Barrett and Dannenberg 2012). Therefore, instead of exploring the full range of possible equilibria, here we focus on the obvious focal point of symmetric equilibria where each player contributes one fourth of the expected threshold (Schelling 1980). To solve the game, we assume that the thresholds are equidistant from one another, and the distance between each threshold is equal to the size of the smallest threshold, T_1. The amount each of the followers must give to meet the smallest threshold is *k*, which is equal to T_1/n. The amount they must each individually contribute to exactly meet T_m is therefore *mk*. We have parameterized the game such that if players ignore the signal sent by the leader, they will maximize their utility by exactly meeting the middle threshold, *T3.* This is the case as long as $D > 5k$ and $D < 7k$ (See Appendix A).

So, for example, if each follower contributes k and the threshold is T_1, the payoff for each follower is $D - k$ and the payoff for the leader is E. Table 1 shows the payoff for the leader and the followers at each possible set of symmetric contributions at each threshold. The final column displays the expected utility of each symmetric equilibria. So, while each follower maximizes their payoff by exactly meeting the lowest threshold, this payoff is discounted by the low probability that Nature draws the low threshold. In this game players maximize their utility by contributing to meet T_3 if they ignore the leaders' message.

	T_1	T_2	T_3	T_4	T_5	$U_i(\sum_{i\to n} c \mid s_l)$
c_1	*E*, *D-1k*	0,0	0,0	0,0	0,0	$\frac{1}{5}(D - 1k)$
c_2	*E*, *D-2k*	*E*, *D-2k*	0,0	0,0	0,0	$\frac{2}{5}(D - 2k)$
c_3	*E*, *D-3k*	*E*, *D-3k*	*E*, *D-3k*	0,0	0,0	$\frac{3}{5}(D - 3k)$
c_4	*E*, *D-4k*	*E*, *D-4k*	*E*, *D-4k*	*E*, *D-4k*	0,0	$\frac{4}{5}(D - 4k)$
c_5	*E*, *D-5k*	*E*, *D-5k*	*E*, *D-5k*	*E*, *D-5k*	*E*, *D-5k*	$D - 5k$

Table 1: The utility of the leaders and contributors playing each equilibrium strategy at each threshold are displayed (leader payoff, follower payoff). The final column shows the expected utility for the contributors playing each symmetric equilibrium.

4.1 Leader Signals

What happens when we allow the leader to send a signal, s, to the followers? When the leader's fate is tied to the followers, such that the leader does not benefit from deception and only from the followers successfully meeting the threshold, then there exists a separating equilibrium where the leader sends a signal such that $s = T$ and the followers contribute their fair share such that $c = s/n$. In this case, the leader acts as a coordination point so that in the absence of communication the followers can still contribute their fair share to T. This is possible because the leader is indifferent between the contributors meeting any threshold including T or greater. So, when the leader does not have a stake in inefficiency, they should send truthful signals and the followers should follow these signals.

This coordinating equilibrium no longer exists when the leader has an incentive for inefficiency. In this condition, we change l's utility function as follows:

$$U_l\left(\sum_{i\to n} c|s_l\right) = \begin{cases} E + \frac{1}{4}(\sum_{i\to n} c) - T \ if \ \sum_{i\to n} c \geq T \\ 0 \ if \ \sum_{i\to n} c < T \end{cases}$$

Rather than simply keeping their endowment if the contributors meet or exceed the threshold, the leader keeps ¼ of what is contributed above the cost of the threshold. Table 2 displays the modified payoffs for the leaders and followers at each symmetric strategy at each threshold. Because we assume that the followers play a symmetric strategy and $mk = T_m/n$, then the leader will get their endowment plus k times the threshold minus the equilibrium strategy. The final column displays the leaders' payoff at each symmetric equilibrium. This table illustrates that the leader always does better if the followers contribute to T_5, and the leader is best off when the followers meet T_5 but the true threshold is T_1.

	T_1	T_2	T_3	T_4	T_5	$U_l(\sum_{i\to n} c\|s_l)$
c_1	$E, D-1k$	0,0	0,0	0,0	0,0	$\frac{1}{5}E$
c_2	$E+k, D-2k$	$E, D-2k$	0,0	0,0	0,0	$\frac{2}{5}E+\frac{1}{5}k$
c_3	$E+2k, D-3k$	$E+k, D-3k$	$E, D-3k$	0,0	0,0	$\frac{3}{5}(E+k)$
c_4	$E+3k, D-4k$	$E+2k, D-4k$	$E+k, D-4k$	$E, D-4k$	0,0	$\frac{4}{5}E+\frac{4}{5}k$
c_5	$E+4k, D-5k$	$E+3k, D-5k$	$E+2k, D-5k$	$E+k, D-5k$	$E, D-5k$	$E-2k$

Table 2: The utility of the leaders and contributors playing each equilibrium strategy at each threshold are displayed (leader payoff, follower payoff). The final column shows the expected utility for the leader when the contributors play each symmetric equilibrium.

The followers' preferences haven't changed, such that in the absence of a leader signal the contributors should prefer c_3 as long as $D > 5k$ and $D < 7k$. However, the above table illustrates that the leader maximizes their payoff when the contributors play c_5, regardless of the true threshold. Therefore, regardless of the true T, the leader will always send a signal such that $s=T_5$. There is no separating equilibrium where the leader tells the truth and the contributors use that as a coordinating signal. Instead, the leader in equilibrium will send signal $s = T_5$ and the contributors will contribute T_3/n.

5. An Incentivized Experiment

5.1 Experimental Procedures

Participants were recruited from the online convenience sample Amazon's Mechanical Turk (Mturk) and given 50¢ for their participation in our study. Behavior on MTurk is consistent with behavior in the lab for many incentivized experiment (Amir, Rand, and Gal 2012; Buhrmester, Kwang, and Gosling 2011). Furthermore, previous work has shown consistent behavior in the lab and on MTurk specifically using games modeling cooperation and environmental disaster (Andrews, Delton, and Kline 2018; Del Ponte et al. 2017).

After reading a consent form, subjects were randomly assigned to a condition, read the experimental instructions and then answered a series of comprehension questions. They then made their incentivized decisions, and could win up to $1.35 in bonuses depending on their decisions and their condition assignment. After completing the primary experiment, participants completed a non-incentivized risk elicitation task (Eckel and Grossman 2002), and answered a series of demographic questions.

5.2 Experimental Methods

To test how leader signals and participant behavior changes when leaders have a stake in inefficiency, we used a modified collective risk social dilemma. Because we are interested in general underlying behavioral responses to different institutional arrangements and because partisan identifications moderate responses to questions about climate change (Leiserowitz et al. 2015), we framed our game in a way that was policy neutral. Participants were recruited on Amazon's Mechanical Turk and played in groups of five. At the start of the game, the players were asked to imagine they were living in a town with a flood coming. They had to cooperate and contribute enough money to build a levee to stop the flood, or they would lose all of their remaining funds. The cost of the levee was randomly drawn from 80¢, 160¢, 240¢, 320¢, and 400¢, representing each of the five possible values of T_m

Four players were followers, in the instructions they were referred to as "townspeople". Each follower has 135¢ which they stood to lose if they did not successfully build the levee. These thresholds and endowments were chosen to satisfy the conditions under which, in the absence of a leader signal, the followers should prefer to contribute toward the middle threshold of 240¢. The followers simultaneously decided how much from this endowment to contribute to building the levee, up to 100¢ in increments of 20¢. They did not get back any money they contributed to the levee no matter what else happened in the experiment. If they contributed enough to build the levee, the followers each kept their remaining funds. If they did not successfully build the levee, they lost all of their remaining funds. The additional fifth player was the leader, in the instructions referred to as the "mayor". The leader knew the exact cost of the levee, and must send a signal to the rest of the group that the levee cost either 80¢, 160¢, 240¢, 320¢, and 400¢. The leader was free to send any signal regardless of the actual cost of the levee, so they could lie. The leader could not contribute toward the cost of the levee, but they had a 75¢ endowment which they would lose if the rest of the group did not contribute enough to build the levee.

In this experiment, we manipulated the incentives of the leader. In the control condition, if the followers contributed more collectively than the cost to build the levee, the excess contributions simply disappeared. Here, the leader's earnings are tied directly to those of the followers, where as long as the followers contribute enough to build the levee each player is better off. In this condition, leaders should send truthful signals and followers should contribute to the threshold that equals the signal sent by the leader.

In the inefficiency incentive condition, if the followers contributed more than the cost of the levee, the leader kept one fourth of the excess contributions. So, if the levee costs 80¢ but the followers collectively contributed 160¢, the followers will kept their remaining personal accounts. Furthermore, the leader kept their personal account as well as an additional 20¢ (i.e., one fourth of the 80¢ contributed above the actual price of the levee). (See Appendix B for full instructions). In this condition, leaders should always signal that the threshold costs ¢400. Followers should ignore this signal, and contribute to the middle 240¢ threshold.

Our primary dependent variable is the contribution of the followers. However, we are also interested in whether or not followers' trust in the leader changes as a function of the institutional incentives and/or message sent by the leader. We therefore asked followers to guess how much they think the actual value of the threshold is after they received a message from the leader. We used the distance between the followers' guess and the leader's signal to gauge trust in the leader.

In order to maximize the amount of information from each participant, we employed the strategy method, i.e. each participant responded to all possible states of the world that they could face. So, each follower responded to each *possible* message the leader could send. So, each follower was asked how much they would contribute if the leader said the threshold cost either

80¢, 160¢, 240¢, 320¢, or 400¢. Similarly, the leaders were asked which signal they would send to the followers at each *possible* threshold. Then, groups were matched and payoffs are calculated for one randomly selected true threshold. We manipulate whether participants were leaders or followers and whether they were in the control or inefficiency incentive condition. Within subjects, we manipulate the size of the threshold (for players in the leader role) or message sent by the leader (for players in the follower role). Using the strategy method in this way is typical for incentivized experiments (eg. Fischbacher, Gächter, and Fehr 2001).

Drawing both from the game theoretic equilibria and the existing assumptions in the literature on revenue generation and mechanism design, we propose the following hypotheses for follower behavior:

> H1: Followers will be less likely to believe the leader in the inefficiency condition than in the control condition.
>
> H2: Followers will contribute less to the threshold in the inefficiency condition than in the control condition.
>
> H3: Fewer groups will successfully meet the threshold in the inefficiency condition than in the control condition.

These hypotheses are at odds with work on voter sophistication, as well as with recent evidence on citizen's ability to successfully reward politicians for disaster prevention spending. This literature suggests that participants will not be sensitive to institutional differences.

Using the strategy method gives us more leverage to study follower behavior at each possible message. Though leaders should never send a signal less than 400¢ in the inefficiency condition, using the strategy method we can determine how followers would react if the leader did send such a message. In the inefficiency condition, followers should ignore the signal sent by the leader and contribute to the expectation of the threshold, or to the 240¢ threshold. So, if the leader sends a message that the threshold is *less* than 240¢, the followers may take such a message into account. We therefor hypothesize an interaction between the condition and the message sent by the leader. We predict that:

> H4: The inefficiency condition should reduce trust in the leader most at the highest messages. As the signal sent by the leader increases, followers should be less likely to believe the threshold is equal to the signal.
>
> H5: Followers in the inefficiency condition should contribute less to the threshold compared to those in the control condition when the message sent by the leader exceeds 240¢.

6. Results

Our data provides clear evidence that inefficiency undermines group success. Table 3 shows the results of logit models predicting whether or not the followers and leaders were in groups which successfully met their threshold. Even controlling for the actual size of the threshold and the message sent by the leader, and consistent with Hypothesis 3, the inefficiency condition reduces the probability that groups successfully meet the threshold and provide the public good by 6%. To understand the mechanism behind group failure in the inefficiency incentive condition, below we look more closely at the effects of the condition on beliefs about the leader and contribution behavior.

	(1) Follower Success	(2) Leader Success
Inefficiency Condition	-0.346^{***}	-0.461^{*}
	(-3.47)	(-2.28)
Threshold	-0.0248^{***}	-0.0235^{***}
	(-19.79)	(-9.58)
Message	1.530^{***}	1.395^{***}
	(15.73)	(7.24)
Constant	1.874^{***}	2.002^{***}
	(11.81)	(6.22)
Observations	2440	590

Table 3: The results of logistic regressions predicting the success of each group in meeting their threshold. T statistics in parentheses, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.00$.

6.1 Follower Beliefs

To see how the experimental manipulation affects trust in the leader, we subtract the follower's guess of the size of the threshold from the leader's message. If this number is negative, then the followers believe the actual threshold is larger than the leader says, and if the number is positive it means followers believe the leader is exaggerating. The larger the positive number, the more the followers think the leader is exaggerating. A simple t-test shows that while followers tend to believe the leader is exaggerating to some degree, they believe the leader is exaggerating almost twice as much in the inefficiency condition (mean = 30.74) than in the control condition (mean = 17.03), t(2438) = 3.566, p<0.001, two-tailed. This supports Hypothesis 1, that the inefficiency condition undermines trust in the leader.

To test Hypothesis 4, that this trust should be conditional on the size of the message and decrease in the inefficiency condition as the threshold increases, we construct a binary variable of belief which is equal to 1 if the followers' guess of the size of the threshold is equal to the message sent by the leader, and 0 otherwise. We then run a logistic regression using the condition, message, and interaction between the two to predict whether followers believe the leader. The results are in Table 4. The significant negative interaction provides support for Hypothesis 4. We display the interaction in Figure 1, which plots the relationship between the message sent by the leader and proportion of respondents who believe the leader in each condition. The figure illustrates that across the board participants are less trusting of higher messages, but the effect is much stronger for those in the inefficiency condition.

	(1) Believe Message	(2) Follow Message	(3) Under-Contribute
Inefficiency Condition	0.423*	0.611**	-0.0361
	(2.15)	(3.20)	(-0.12)
Message	-0.211***	0.127**	0.595***
	(-5.13)	(3.14)	(10.44)
Condition X Message	-0.260***	-0.225***	0.112
	(-4.24)	(-3.91)	(1.40)
Constant	0.514***	-0.288*	-3.240***
	(3.80)	(-2.15)	(-14.83)
Observations	2440	2440	2440

Table 4: Logistic regression results predicting whether or not participants believe messages sent by the leader, contribute in a manner consistent with the message sent by the leader, and under-contribute to the message sent by the leader. *T* statistics in parentheses, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

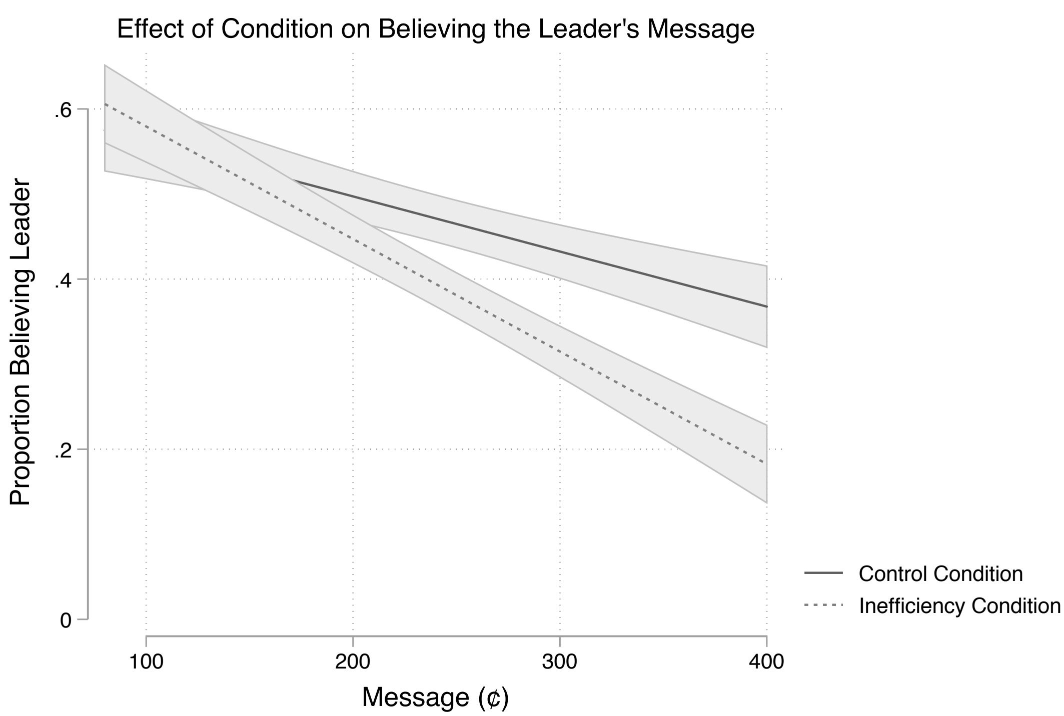

Figure 1: Plotting the probability the followers believe the message sent by the leader in each condition at each threshold.

Whose trust is most affected by the institutions? The least knowledgeable should be least able to distinguish between leaders who have an incentive to misrepresent the cost of providing the public good. To measure knowledge, we ask participants a series of comprehension questions which test their knowledge on the key aspects of the game (See Appendix B for all questions).

To test for individual differences in trust, we run a logistic regression, regressing belief on the condition, message, number of correct comprehension question answers, and the interaction between the condition and comprehension scores. The results are in Table 5. Unsurprisingly, we find that those who correctly answer all comprehension questions are the most sensitive to the manipulation, and are the least trusting of the leader in the inefficiency condition even when controlling for the message. Those who do poorly on the comprehension questions believe the threshold is equal to the message sent by the leader, even when the leader has an incentive to lie.

	(1) Believe Leader	(2) Under-Contribute
Inefficiency Condition	0.0926	-0.123
	(0.57)	(-0.71)
Message	-0.336***	0.694***
	(-10.99)	(16.65)
Correct Comprehension Answers	0.724***	-1.586***
	(5.45)	(-10.05)
Condition X Correct Answers	-0.595**	0.832***
	(-3.13)	(3.83)
Constant	0.368**	-2.580***
	(2.60)	(-14.30)
Observations	2440	2440

Table 5: The results of logistic regressions predicting whether followers believe the leader by guessing the threshold is equal to the message sent by the leader, and whether followers contribute less than their fair share of the message sent by the leader. T statistics in parentheses, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

6.2 Follower Behavior

Does mistrust of leaders in the inefficiency condition translate into reduced contributions to the public good? A t-test shows that follower contributions are lower in the inefficiency condition (mean = 55.72) than in the control condition (mean = 58.48), providing initial support for Hypothesis 3, $t(2438) = 2.39$, $p = 0.017$, two-tailed.

Though there are key differences in follower behavior across conditions, it is important to note that most participants do contribute their fair share to the message sent by the leader. To illustrate this point, we construct a variable for whether each follower made a fair symmetric, less than fair, or more than fair contribution based on the message sent by the leader. A contribution is fair symmetric if it is equal to the message sent by the leader divided by the number of followers (i.e., by four). It reflects followers contributing their fair share as though the actual threshold is equal to the message sent by the leader. A contribution is less than fair if it is less than the message sent by the leader divided by four, and more than fair if it is more than the message sent by the leader divided by four. Figure 2 shows the proportion of followers contributing a fair symmetric, less than fair symmetric, or more than fair symmetric at each threshold in each condition.

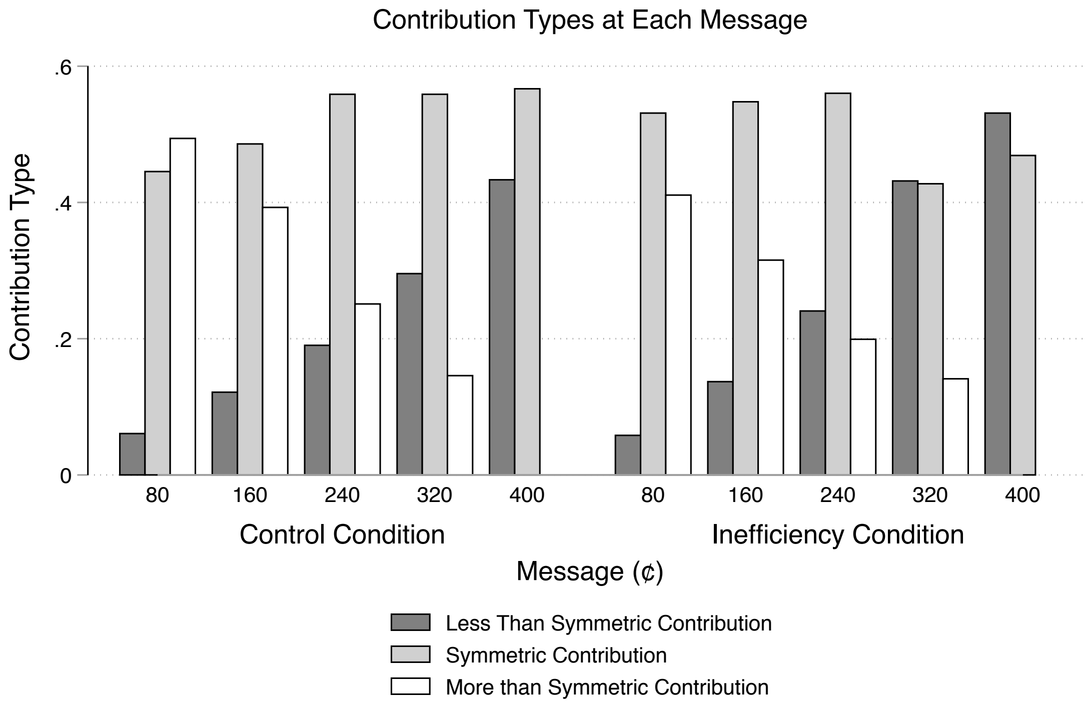

Figure 2: The proportion of followers making a fair symmetric, less than fair, or more than fair contribution to the message sent by the leader in each condition.

Figure 2 reveals two key pieces of information. First, for most thresholds in each condition the followers tend to follow the message sent by the leader. Second, as the threshold increases participants are more likely to under-contribute and less likely to over-contribute. While this pattern is consistent across both the control and inefficiency condition, Hypothesis 5 suggests there will be subtle differences in behavior, especially at the highest thresholds where those in the inefficiency condition are less likely to believe the leader.

To test Hypothesis 5, we first run a logistic regression, regressing whether participants make a fair symmetric contribution (given the leader's message) on the condition, message, and interaction between the two. The results are in Table 4. We plot the marginal effect of the inefficiency condition at each threshold from this model in Figure 3, along with the proportion of followers making a symmetric contribution at each message in each condition. The results show that, consistent with Hypothesis 5, it is only when the threshold exceeds the midpoint of 240¢ that followers become less likely to follow the signal sent by the leader if the leader has a stake in inefficiency. Participants are no less likely to follow the suggestion made by the leader at the low thresholds.

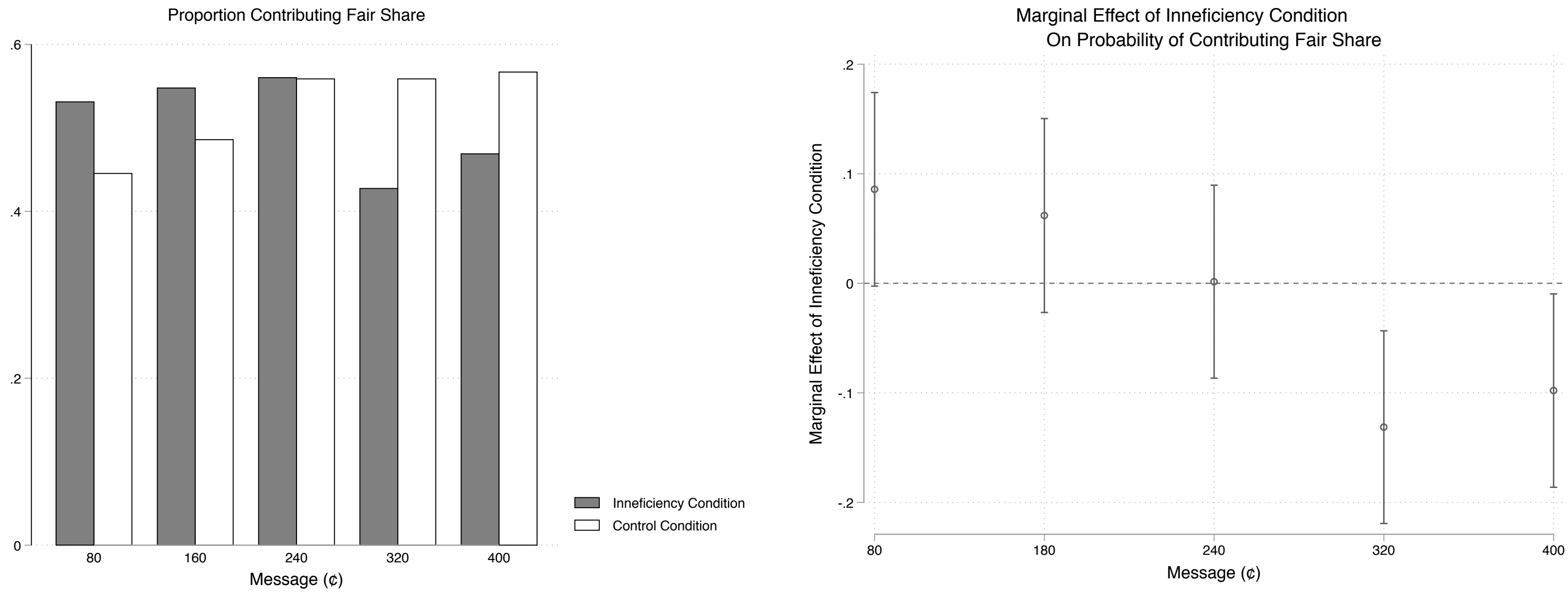

Figure 3: The first panel shows the proportion of followers contributing their fair share to the message sent by the leader in each condition. The second panel shows the marginal effect of moving between conditions on the probability a follower contributes their fair share to the message sent by the leader. Error bars are 95% confidence intervals using OLS standard errors. The condition only has a significant effect on contributions when the message exceeds the 240¢ midpoint.

In the inefficiency condition, followers are not only less likely to follow the message sent by the leader at high thresholds, but they are more likely to under-contribute. The third column of Table 4 shows the results of a logistic regression, regressing whether or not participants contributed less than their fair share to the message sent by the leader on the condition, message, and interaction between the two. Figure 4 plots the marginal effect of the condition on under-contributions at each threshold, along with the proportion of participants under-contributing at each threshold in each condition. These results again support Hypothesis 5, showing participant mistrust in the leader translates into lower contributions to the public good at thresholds above the midpoint of 240¢. Table 5 shows this effect is strongest again for those who fully understand the game. There is a significant negative interaction between the condition and number of correct comprehension questions on the probability that participants under-contribute to the public good. Those who are the least informed are more likely to trust the leader and contribute to the threshold accordingly.

In sum, though follower behavior does reveal a general tendency to respond to the message sent by the leader, we find support for Hypotheses 1-5. Groups are less successful in the inefficiency condition, even controlling for the message sent by the leader and the actual size of the threshold. This failure is due to followers not trusting leaders, and therefore under-contributing to the public good. This trust is rationally conditional on the message sent by the leader, where skepticism is localized only to the highest thresholds. Overall, these results provide optimistic evidence that people are able to evaluate the institutions which incentivize leaders to send honest or corrupt signals, and that they respond rationally to these signals.

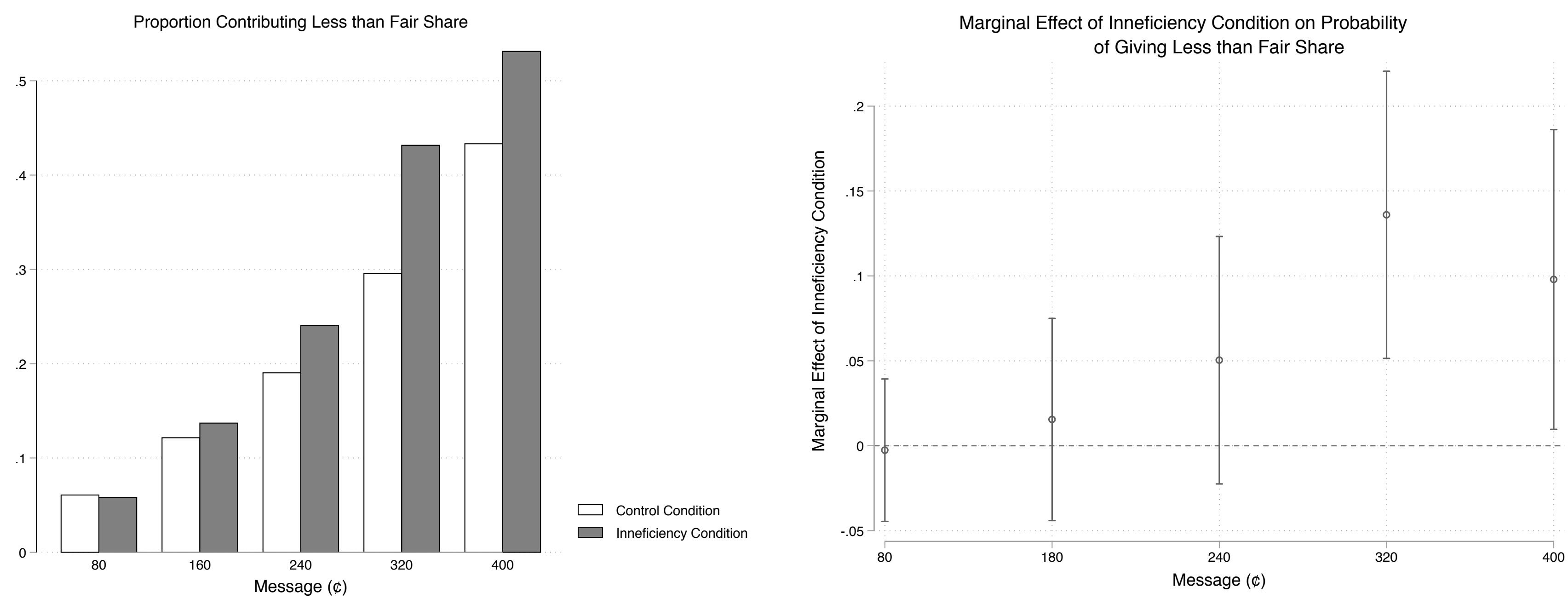

Figure 4: The first panel shows the proportion of followers who contribute less than their fair share to the message sent by the leader. The second panel shows the marginal effect of the inefficiency condition on the probability a follower contributes less than their fair share. Error bars are 95% confidence intervals using OLS standard errors. The condition only has a significant effect when messages exceed the midpoint of 240¢.

6.4 Leader Behavior

Is the followers' response to the different experimental conditions justified? Though our research is primarily focused on understanding how citizens navigate different signals from leaders, our experimental design also lets us explore how the leaders themselves might respond to different institutional constraints and incentives. It is important to note our participants were recruited from an online convenience sample, and therefore do not have the same experience or expertise as actual political elites. We therefore expect smaller responses to institutional changes than we might if we were able to study actual representatives, making this a conservative test of elite responses to institutional changes. Furthermore, leaders likely have social preferences, such that even when they can benefit from deception they may still be willing to pay a cost to help the followers.

To see if leaders are more likely to exaggerate the size of the threshold in the inefficiency incentive condition, we generate a variable that is the message sent by the leader minus the true threshold. If this number is positive, then the leader is exaggerating the size of the threshold. We find leaders do exaggerate the size of the threshold more in the inefficiency condition than in the control condition, $t(470) = -1.851$, $p = 0.032$, one-tailed.

The biggest difference in lying should, however, be at the lowest thresholds. Leaders in the control condition have no incentive to generate a surplus, so they should not exaggerate the size of the threshold at its lowest values. Those in the inefficiency condition, however, should be sending signals that the threshold is costly even when the threshold is at its low values. Figure 5 shows the average distance between the message and threshold at each actual threshold in each condition. It is important to note that at the highest threshold, leaders cannot exaggerate the size of the threshold. Therefore, any deviation from the actual threshold will produce a negative value. The figure confirms that at the lowest thresholds, leaders in the inefficiency condition exaggerate more than leaders in the control condition.

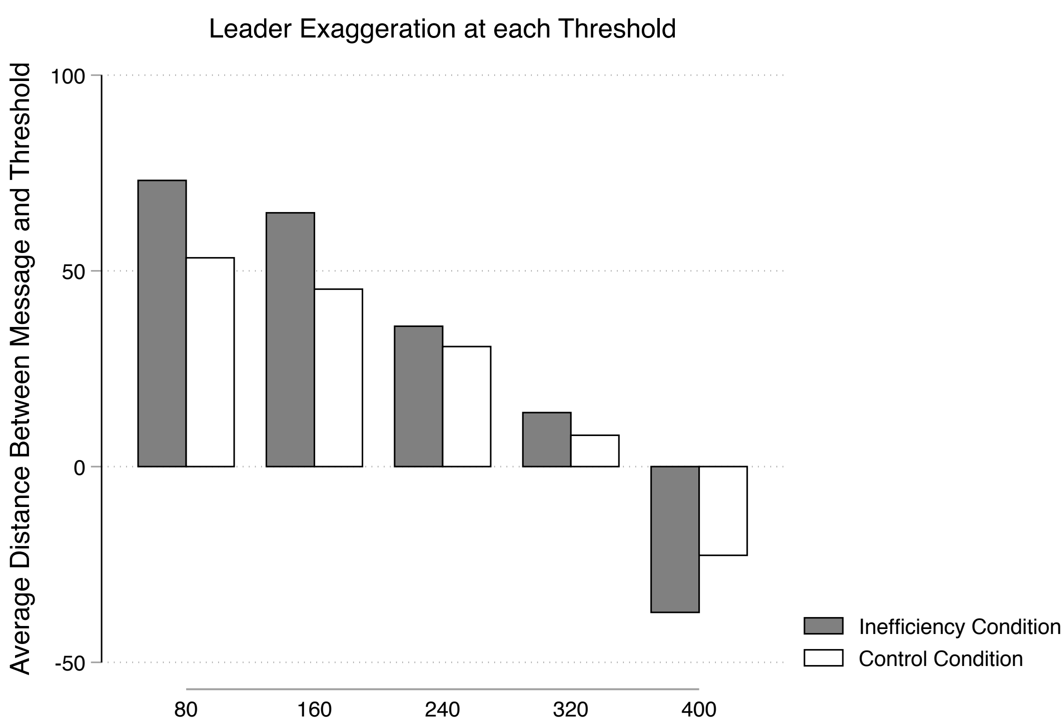

Figure 5: The average distance between the real threshold and the messages sent by the leaders in each condition.

We first test the significance of this interaction by running a separate t-test for exaggeration at the thresholds below the midpoint, and those at or above the midpoint of possible thresholds. We find leaders are more likely to say the threshold is larger than it really is in the inefficiency condition compared to the control when the actual threshold is below the midpoint, $t(234) = -2.113$, $p = 0.018$, one-tailed. This difference disappears when the threshold is at or above the midpoint of possible thresholds, $t(234) = -0.59$, $p = 0.28$, one-tailed. As a more conservative test, we regress the distance between the message and threshold on the condition, threshold, and interaction between the two. The results are presented in Table 6. There is a significant interaction between the condition and threshold, $p = 0.048$. Ultimately, leaders are somewhat sensitive to the incentive structure of the different conditions of the experiment. Even if they can be, however, leaders are not all corrupt and largely send signals close to the true values of the threshold (See Appendix C). Using laypeople as subjects is likely a conservative test of responses of leaders to institutions, and the results indicate followers are behaving rationally when they are ware of signals sent by leaders in the inefficiency condition.

	(1) Leader Exaggeration
Inefficiency Condition	0.398^{*}
	(2.31)
Threshold	-0.00296^{***}
	(-6.49)
Condition X Threshold	-0.00129^{*}
	(-1.98)
Constant	0.997^{***}
	(8.25)
Observations	590

Table 6: The results of a logistic regression predicting the message sent by the leader minus the actual threshold, indicating the extent to which those in the inefficiency condition exaggerate the size of the threshold. *T statistic in parenthesis,* * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

7. Discussion

In this study, we combine insights from literature on political behavior, political sophistication and public choice, and apply it to one of the most pressing political issues of our time: climate change mitigation and disaster prevention. Specifically, we test an implicit assumption in the literature on climate change mitigation—that citizens mistrust revenue generating mechanisms that ostensibly are meant to fund disaster prevention. To do so, we conduct an incentivized experiment based on a game-theoretic signaling model. Our key manipulation is whether the leaders in the game—who have private information about the true cost of disaster prevention—can personally profit from misrepresenting their private information. Our results show that citizens are more distrustful of leaders when their incentives are not aligned, and that this differential distrust is even greater for more knowledgeable citizens. Moreover, we find that this distrust is justified—leaders are indeed more likely to misrepresent their private information when they can benefit from doing so. Our results provide evidence that citizens are able to successfully navigate complex informational environments, and rationally respond to institutional structures that provide incentives for corruption on the part of leaders.

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