Essays on Social Dilemmas: Incentives and Institutions

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ABSTRACT

ESSAYS ON SOCIAL DILEMMAS: INCENTIVES AND INSTITUTIONS

By

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The focus of this research is on social dilemmas; instances where individual incentives are not aligned to social welfare maximization. The three chapters of the dissertation examine methods to mitigate three different social dilemmas in environmental economics.

The first chapter uses a laboratory experiment to test the relative efficacies of the probability and severity of sanctions in reducing socially suboptimal extraction from a common property resource. Keeping expected penalties constant, the paper tests whether probability or severity is a more powerful deterrent under four quota regimes governing resource utilization.

The second chapter uses secondary data and quasi-experimental empirical techniques to evaluate the performance of community-based resource management programs in Africa. These programs are intended to dis-incentivize poaching of wild animals by providing individuals a share in the revenues generated by national park services like eco-tourism and trophy hunting.

The third chapter discusses a laboratory experiment conducted in Qatar that aims to understand the effectiveness of priming religious identity and national identity on individuals' pro-social preferences. This experiment is a precursor to large-scale randomized intervention designed to reduce residential electricity use in Qatar.

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ACCEPTANCE

This dissertation was prepared under the direction of the candidate's Dissertation Committee. It has been approved and accepted by all members of that committee, and it has been accepted in partial fulfillment of the requirements for the degree of Doctor of Philosophy in Economics in the Andrew Young School of Policy Studies of Georgia State University.

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DEDICATION

To my grandmother, Sumitra Mookerjee.

May you always tell me to answer exams carefully!

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1 Introduction

A typical social dilemma is a situation where self-interest maximization leads to actions that are detrimental to social welfare (Dawes, 1980). Such situations can arise in a variety of contexts, especially in environmental choices where there are divergences between private and social benefits and costs. This dissertation examines methods to overcome three social dilemmas.

The first chapter formulates a classic social dilemma using a laboratory experiment that models extraction from a common property resource. Self-interest maximizing extraction by an individual creates negative externalities on others. In this context, the experiment tests the relative efficacy of two policy levers, (i) the probability of detection, and (ii) the severity of sanctions, on deterring socially sub-optimal extraction from the resource. There is little evidence on the trade-off between these deterrence parameters in resource extraction contexts. This analysis contributes to filling that gap by exogenously varying the quota regime and deterrence parameters, while keeping expected penalties constant. Controlling for individual risk attitudes, the results show that (i) monitoring and sanctions reduce socially detrimental harvest, (ii) a higher probability of monitoring is approximately twice as effective as an equivalent increase in the severity of sanctions.

Moving from a stylized experiment to a naturally-occurring social dilemma, the second chapter studies benefit-sharing institutions that attempt to mitigate loss of wildlife. Using secondary data and quasi-experimental techniques, the paper identifies the effect of community-based natural resource management (CBNRM) programs on elephant populations in Africa. CBNRM programs aim to dis-incentivize illegal hunting of wild animals by sharing benefits from wildlife services with local communities. Though the number of these programs has grown over time, there is a lack of sound empirical evidence regarding their performance. Results show that while CBNRM programs have had positive long-term impacts, the magnitude of the effect depends significantly on other characteristics such as ethno-linguistic fragmentation and whether a country has been a signatory to the international ban on ivory trade.

The third chapter uses experiments conducted in Qatar to test the effect of priming individuals' religious or national identity on their pro-social preferences. Voluntary contributions to a charity are used as the measure of pro-sociality. This chapter is meant to complement a large field experiment on a major social dilemma in Qatar – reducing emissions from fossil-fuel based energy use. Qatar has one of the highest levels of per-capita energy consumption in the world. Randomized treatment messages designed to increase energy efficiency and promote energy conservation are currently being delivered to cellphones of approximately 5,000 households in Qatar. The treatment messages are informed by priors formed through the analysis of these experiments.

The dissertation concludes with a discussion of the broad implications for research and policymaking aimed at mitigation of social dilemmas, and some avenues for future work.

2 Deterring Extraction from the Commons[1]

2.1 Introduction

Resource management programs use monitoring and sanctioning mechanisms to enforce rules governing harvest from common pool resources. These rules often take the form of allowable quotas on harvest. This paper tests the relative efficacies of two policy levers, namely the probability and severity of sanctions, on deterring socially suboptimal harvest from common pool resources under four alternative quota regimes.

The experiment is designed as an extraction game, where individuals choose how much to harvest from a shared resource while facing known probabilities of detection and severity of penalties, conditional on being detected. Each combination of deterrence parameters is implemented under four alternative quota regimes. In the first regime, the quota is fixed at zero harvest. In the second, sanctions are implemented if an individual harvests more than the exogenous average harvest level in the previous period. In the third regime, a fee-bate mechanism is used that imposes sanctions on individuals who harvest more while rewarding individuals who harvest less than the exogenous quota. The fourth regime endogenizes the quota by implementing sanctions and rewards around the average harvest level in the current period.

Prior work has examined the tradeoffs between the probability of detection and severity of sanctions in strategic choice environments, i.e. where individual actions impose externalities on others. Anderson and Stafford (2003) finds that the severity of sanctions is more effective in reducing free-riding on others' contributions to a public good than an equivalent increase in the probability of detection. Murphy and Stranlund (2007) finds

[1] I would like to express my sincere gratitude to James Cox, Michael Price, Andreas Lange and Spencer Banzhaf for their valuable feedback. The paper has benefited through comments received from Vjollca Sadiraj, Garth Heutel, John Whitehead, John Stranlund, Lata Gangadharan, Daan van Soest, Sarah Jacobson, Nicholas Flores, and Christopher Timmins at various stages of the project. Feedback from participants at the Colorado University Workshop for Environmental and Resource Economics 2018, the Southern Economic Association Annual Meetings in 2018 and 2016, and the FEEM-VIU Summer School on Field Experiments in Environmental Economics 2016 is greatly appreciated. The experiments were funded through the Andrew Young School Dissertation Fellowship.

that the effects of the two parameters are not discernibly different. In individual choice environments, Friesen (2012) finds that increasing the severity of sanctions is more effective in increasing compliance to a regulation than increasing the probability of detection. However, several studies on tax compliance comprehensively reviewed in Alm (2012) find that the probability of detection is a more effective deterrent.

In terms of experiment design, this paper differentiates itself from earlier work by using an extraction game instead of a voluntary contribution game. This is done for a closer approximation of behavior in common property resource utilization. Unlike some earlier work (Anderson and Stafford, 2003, Murphy and Stranlund, 2007), this paper uses a standard risk elicitation task (Eckel and Grossman, 2002) to control for individual risk attitudes. The alternative incentivized quota regimes including the fee-bate mechanism also represent a development on existing literature on sanctions in common pool resources.

In terms of the econometric analysis, this paper contributes to the literature through an explicit examination of heterogeneities in treatment effects on two margins. First, treatment effects are differentiated by type of strategic agent, including free riders, altruists and conditional cooperators. Second, the paper analyzes the effects of sanctions and rewards on both the extensive and the intensive margins, i.e. separately estimating effects on the decision of harvesting any positive amount versus nothing, and the decision of how much to harvest conditional on harvesting a positive amount.

The primary result from the experiments is that an increase in the probability of being monitored is significantly more effective in reducing harvest from the shared resource, compared to an equivalent increase in severity of sanctions. The difference in the effects is weakest when sanctions are imposed around a quota that varies across rounds but is similarly strong in all other quota regimes. A higher harvest quota is associated with a less-than-proportionate increase in harvest levels, showing that people respond as expected to an increase in exogenous quotas. The results hold even after controlling for individual risk aversion and standard demographic characteristics. Conditional on baseline harvest levels, sanctions are found to be most effective on free riders, less effective on conditional cooperators and sometimes even backfire on altruists.

The rest of the chapter is organized as follows. Section 2.2 provides an overview of related studies on sanction mechanisms designed to mitigate social dilemmas. Section 2.3 presents the theoretical model of individual-level harvest decisions. Section 2.4 describes the experiment design, parameterization of treatments, and procedures used. Section 2.5 describes the results including the analysis of treatment effects by type of strategic agent, and heterogeneous effects on the intensive and extensive margins. Section 2.6 concludes with a discussion and implications for environmental policy design.

2.2 Related Literature

This paper builds on earlier work on sanctions in social dilemmas and tests of deterrence in individual decision-making situations. Some of the important papers and findings from these two strands of literature are described below.

2.2.1 Sanctions in Social Dilemmas

Although not directly addressing the relative effects of deterrence parameters, a number of studies using experiments have found that monitoring and sanctions can increase cooperation in social dilemmas. Fehr and Gächter (2000) is one of the first to test the effects of peer-monitoring and sanctioning opportunities on public good provision. They found that individuals depart from Nash equilibrium prediction by incurring costs to punish other players in a voluntary contribution mechanism (VCM) game. Moreover, mechanisms leveraging both fines and rewards have been shown to increase cooperation in public goods games (Falkinger et al., 2000).

In earlier work on common pool resources, Ostrom et al. (1992) found that the threat of sanctions can increase net yields, although communication is found to be more effective as a means of increasing cooperation. Further exploring these findings, Nikiforakis (2008) shows evidence that allowing for a second round of punishment opportunities reduces punishment of free riders in the first round and mitigates the efficiency gains from peer punishment found in earlier work.

Compared to decentralized peer-punishment mechanisms, centralized sanctions can generate welfare gains by crowding out vigilante punishment, and people are willing to pay to hire a delegated police mechanism to enforce sanctions (Andreoni and Gee, 2012). Adding more nuance to choice of sanctioning mechanism in social dilemmas, Zhang et al. (2014) shows that individuals prefer centralized sanctions especially when the second-order punishment opportunities are available. However, high up-front costs of formal sanctioning institutions can dissuade individuals from choosing formal sanctions over informal peer-punishment mechanisms (Kamei et al., 2015, Markussen et al., 2013). Another related body of work tests the effects of deterrence in the context of games where one of a randomly matched pair of players has the opportunity to "steal" money from their matched partner (Harbaugh et al., 2013, Khadjavi et al., 2015, Laske et al., 2018, Schildberg-Hörisch and Strassmair, 2010).

2.2.2 Deterrence in Individual Choice Experiments

The relative effects of deterrence have also been explored in individual choice experiments, i.e. where one's actions do not result in externalities on others. The effects of probability and severity of sanctions are most often looked at in the literature on tax compliance. Alm (2012) carries out an extensive review of theoretical and experimental work on measuring and controlling tax evasion. The review suggests that probability of audits have a greater deterrent effect than fines even when the two are equivalent. Moreover, individuals often overweight low probabilities of audits, suggesting that behavioral factors like probability weighting can play an important role. Some studies find that probability of fines can be a greater deterrent than severity of fines when considering costly compliance to a pre-specified regulation (Friesen, 2012). However, Bruner (2009) finds that risk averse subjects prefer an increase in the probability of a good outcome over an increase in the reward from a lottery, while keeping the expected value constant. Using a laboratory experiment with choices framed as whether to speed on a roadway, DeAngelo and Charness (2012) find that when expected cost of punishment is high, individuals violate the rule less when probability of detection is higher.

The existing literature, therefore, has mixed findings regarding the effectiveness of deterrence in strategic choice environments. This paper builds on that body of work by examining not only the effects of probability and severity of sanctions while controlling for individual risk attitudes, but also the differences between alternative quota regimes and fee-bat mechanisms that have not been studied in the context of resource extraction games. Moreover, it also considers differences in the effects of sanctions and rewards along two dimensions: (i) different strategic types identified in established work on social dilemmas like conditional cooperators, free riders and altruists, and (ii) decisions of an agent on the intensive and extensive margin, i.e. the drivers of decisions regarding whether to harvest any positive amount from the common pool versus deciding how much to harvest conditional on harvesting a positive amount.

2.3 Model

This section describes the theoretical model on which the experiment is based. Each individual has access to a private fund and a common fund. The amount in an individual's private fund accrues only to them, while the amount in the common fund is shared equally by all individuals in the same group. Individuals choose how much to take out from the common fund to put into their individual fund. Individuals face a known probability that their group's decision will be monitored. If the group is monitored an individual can be sanctioned or rewarded based on their harvest level and a quota. In this model, monitoring is costless and enforced by an external agency.

Notation

e is the initial endowment in each individual's private fund. h_{max} is the maximum amount that can be harvested from the common fund. p is the probability of the group's decision being reviewed. α indicates the severity of the penalty to be imposed, conditional on being reviewed. M is the efficiency factor or multiplier, i.e. one unit in the private fund is worth M units in the common fund. N is the number of agents in a group. h_i is the amount agent i harvests, where $h_i \in \{0, 1, 2, \cdots, 10\}$. H_0 is the quota from which sanctions or rewards are calculated.

2.3.1 Payoffs, Fines, Rewards and Quota Regimes

The payoff from the extraction game without sanctions is:

$$\pi_i = e + h_i + \frac{M}{N}\sum_{j=1}^{N}(h_{max} - h_j) \tag{1}$$

where $e + h_i$ represents the value of i's individual fund while $\frac{M}{N}\sum_{j=1}^{N}(h_{max} - h_j)$ represents the value accruing to i from the common fund. As long as $M/N < 1$ in this game, each individual should extract the maximum possible to maximize their own payoff, while the social optimum is to extract nothing.[2]

The fine or reward is based on differences between individual i's harvest and the quota.

$$\begin{aligned} f(h_i) = &\quad h_i - H_0 \text{ if } h_i > H_0 \\ = &\qquad 0 \text{ if } h_i \leq H_0 \end{aligned} \tag{2}$$

In the first quota regime, termed "Fixed Quota Fines Only", $H_0 = 0$. So, if a group

[2] The linear game does not predict social optima in the interior as would be the case with concave earnings/yield functions. However, the effects of deterrence as posed in this paper can be answered with linear games where the social optimum does not change, whereas individually rational strategies align with the social optimum in treatments with sanctions and rewards, based on the risk preferences and the incentives implemented. Further, the linear game maintains a clear prediction in the baseline especially when variable or endogenous quotas are implemented.

is monitored and an individual has taken out anything from the common fund, a fine is imposed. The amount of the fine is the severity factor, α, times the fine function $f(h_i)$. In the second quota regime, termed "Variable Quota Fines Only", H_0 is fixed at the group's average harvest in the previous round.[3] This value is exogenous to current period decisions and is, therefore, treated as a constant.

In the third regime, termed "Variable Quota with Feebate", the quota is still exogenous, say H_0. Individuals who harvest more than the quota are sanctioned while those who harvest less are rewarded. The amount of the fine or reward is still the difference between harvest level and the quota times the severity factor, α.

$$f(h_i) = h_i - H_0 \tag{3}$$

In the fourth regime, termed "Endogenous Quota with Feebate", the quota is the average harvest level among all the members of the group, i.e. $H_0 = \frac{\sum_{j=1}^{N} h_j}{N}$. Individuals who harvest more than the average are fined while those who harvest less are rewarded according to the difference between harvest level and quota times the severity factor, α. This is a stochastic version of the simple mechanism for efficient public good provision developed in Falkinger et al. (2000) but applied to the extraction game.

$$f(h_i) = h_i - \frac{\sum_{j=1}^{N} h_j}{N} \tag{4}$$

The Expected Value to agent i of harvesting h_i from the common fund is:

$$EV_i = p\left[e + h_i + \frac{M}{N}\left\{\sum_{j=1}^{N}(h_{max} - h_j)\right\} - \alpha f(h_i)\right] + (1-p)\left[e + h_i + \frac{M}{N}\left\{\sum_{j=1}^{N}(h_{max} - h_j)\right\}\right] \tag{5}$$

Assuming $\frac{\partial h_j}{\partial h_i} = 0$,

$$\frac{\partial EV_i}{\partial h_i} = 1 - \alpha p - \frac{M}{N} \tag{6}$$

[3] This is reinforced using random rematching as described in Section 2.4.

As shown in Appendix A, if $1 - \alpha p > M/N$, the optimal harvest level is $h_i = h_{max}$ $\forall$ $i \in \{0, 1, \cdots, N\}$.

Extending the model to Expected Utility maximization, risk averse agents (i) optimally harvest 0, as long as $\frac{1-p}{p(N\alpha-1)} \leq \frac{U'(A)}{U'(B)}$,[4] and (ii) react more to changes in severity of sanctions (α) than to equivalent changes in probability of detection (p) as shown in Appendix A.

2.4 Experiment Design

In the experiment, the decision to harvest from the common pool is designed as an extraction game. At the start of each round, subjects are randomly assigned to groups of four members ($N = 4$). A subject starts each round with 10 tokens in their "Individual Fund" and each group starts with 40 tokens in their "Group Fund" which is shared equally among all group members. A subject can choose to harvest any whole number of tokens between 0 and 10 from the Group Fund ($h_{max} = 10$). A token in the Individual Fund is worth 1 Experimental Currency Unit (ECU) to a subject while a token in the shared Group Fund is worth 2 ECU ($MPCR = 0.5$). The dominant strategy in the baseline game is to extract 10 (the maximum possible) tokens from the Group Fund, while the social optimum is to extract nothing. Since the Group Fund is shared equally among group members, extraction by one individual creates a negative externality on others, setting up the social dilemma.[5] Each subject makes extraction decisions over 20 rounds, with random rematching into groups of 4 at the start of each round.[6] In each decision round, subjects simultaneously decide how much to extract from the Group Fund.

[4] A is the income level with sanctions while B is the income level without sanctions.

[5] This design is often used to study extraction from a CPR. It is the mirror image of the voluntary contribution mechanism (VCM) game used to examine private provision of a public good. See Andreoni (1995), Cox et al. (2013), Khadjavi and Lange (2015) for comparisons of behavior in payoff-equivalent extraction and contribution games in the laboratory.

[6] Random rematching is chosen to mitigate reputation formation across rounds, and allow for stronger tests of hypotheses. Using different matching protocols can affect decisions in predictable ways (Botelho et al., 2009).

2.4.1 Monitoring and Sanctions/Rewards

Exogenous monitoring, sanctions and rewards are implemented using a design similar to that followed in tax compliance experiments. In each treatment round, subjects are informed, *ex-ante*, the exact probability of their group's decision being monitored. This probability, p, is varied between 12% and 25%. Each group is randomly assigned number(s), $\mathbf{X} \in \{0, 1, 2, \ldots, 8\}$. For example, if the chance of being monitored in the round is 12%(25%), one(two) of the eight possible numbers are assigned to the group. The experimenter then rolls an eight-sided die. If the die roll matches any of the number(s) assigned to a group, the group members' harvest decisions are "reviewed".[7]

If a group is reviewed, individuals in the group may pay a fine from, or receive a reward into, their private fund based on their harvest decision. The severity of sanctions/rewards, α, is varied between 1 and 2 and is known to the subjects in each round before they make their decision. For example if a group's decision is reviewed and the severity is 1(2), and a subject has harvested 2 tokens, he/she is sanctioned 2(4) experimental currency units (ECU) from his/her Individual Fund.

Four probability-severity ($p \times \alpha$) combinations are used for within-subject comparisons: (i) Baseline without sanctions (0×0), (ii) Low-Probability#High-Severity (0.125×2), (iii) High-Probability#Low-Severity (0.25×1), and (iv) High-Probability#High-Severity (0.25×2). Combinations (ii) and (iii) keep the expected penalty or reward constant, conditional on harvest level. Five rounds of each of the four combinations are implemented, while randomizing the order between rounds, ensuring that differences in harvest levels between them are not due to learning the game over rounds.

[7] This allows for variation in review outcomes across groups within each round while rolling the die once for all subjects in the round.

2.4.2 Quota Regimes

Between-subject comparisons are used to test the effects of four governance regimes which leverage varying social norms regarding harvest from the common property resource. In the first regime, the quota is fixed at the social optimum, i.e. zero harvest. The second regime sanctions individuals who harvest more than their current group's average harvest in the previous round.[8] The third regime implements a fee-bate scheme where individuals who harvest more than their group's average harvest level in the previous period are sanctioned and those who harvest less are rewarded. Finally, the fourth regime implements an endogenous harvest norm by using a fee-bate scheme where individuals who harvest more than their group's current period average are sanctioned while those who harvest less are rewarded. This mechanism is akin to the efficient mechanism for public good contributions proposed and tested in Falkinger et al. (2000).

At the end of each round, subjects receive feedback on whether they were reviewed, the amount of fines/rewards, the amount remaining in their Individual Fund and in the shared Group Fund, and their net individual earnings for the round. Their earnings across 20 rounds are accumulated and converted to U.S. dollars at an exchange rate of 1 ECU = $0.05 to determine their earnings. The experiment design, treatments and sample size considerations are described in Figure 1.

2.4.3 Risk Task

After the extraction game, subjects participate in an individual risk task. The expected earning from the risk task was calibrated to be the same as the expected earning from one round of the extraction game, to maintain comparability of stakes when accounting for the effect of risk attitudes on harvest decisions. Each subject chooses one out of six

[8]Calibrating the quota to the average group level harvest in the previous round, coupled with random rematching of subjects across rounds, makes the harvest quota exogenous to individual decisions in the current period. It mitigates the potential for subjects to attempt to "game the system", i.e. increase the quota in a future period by increasing harvest levels in the current period.

lotteries with equi-probable outcomes. This particular risk task allows for differentiation of subjects by their degree of individual relative risk aversion, and identification of individuals as risk averse, risk neutral or risk seeking.[9] After all subjects have made their choice, the experimenter tosses a coin to determine which of the two equi-probable earnings accrue to the subject for their chosen lottery option.

2.4.4 Experimental Procedure

Experiments are operationalized using z-Tree version 3.6.7 (Fischbacher, 2007). The sessions were conducted in Georgia State University's Experimental Economics Center laboratory over February to June, 2018. A total of 256 subjects participated in 13 experimental sessions.

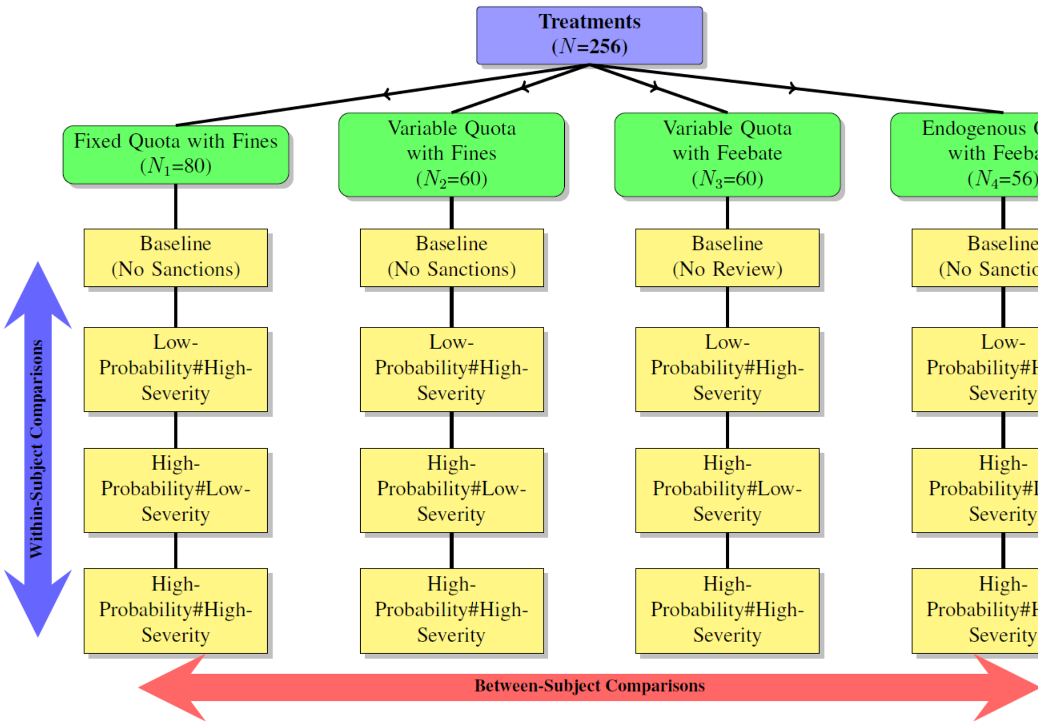
When subjects reached the lab, they read and signed informed consent forms and were randomly assigned to computer terminals indexed by cards drawn from a cup. After all participating subjects were seated, they received printed instructions (included in Appendix A). The experimenter then reviewed the instructions publicly. To better understand the experimental task, subjects were also given an interactive "Earnings Simulator" where they could enter different combinations of their own and others' decisions and see the corresponding earnings in each scenario with and without sanctions. Subjects spent approximately 1.5 minutes on this simulator. Then, paid rounds of the experiment were started. No prior information was provided regarding the total number of rounds or number of rounds in each treatment condition. No communication between subjects was allowed during the experiment. The average earnings was \$23.78 over all rounds of the extraction game, and \$2.09 from the risk task.

After the extraction game and risk task were completed, subjects filled out a debriefing questionnaire, entered their demographic information (summarized in Table 21), and an-

[9]The choices used are adapted from the modified Eckel-Grossman task discussed in Charness et al. (2013).

swered un-incentivized questions regarding their preferences.[10] Subject instructions for all experimental tasks are included in the Appendix A.

Figure 1: Experiment Design

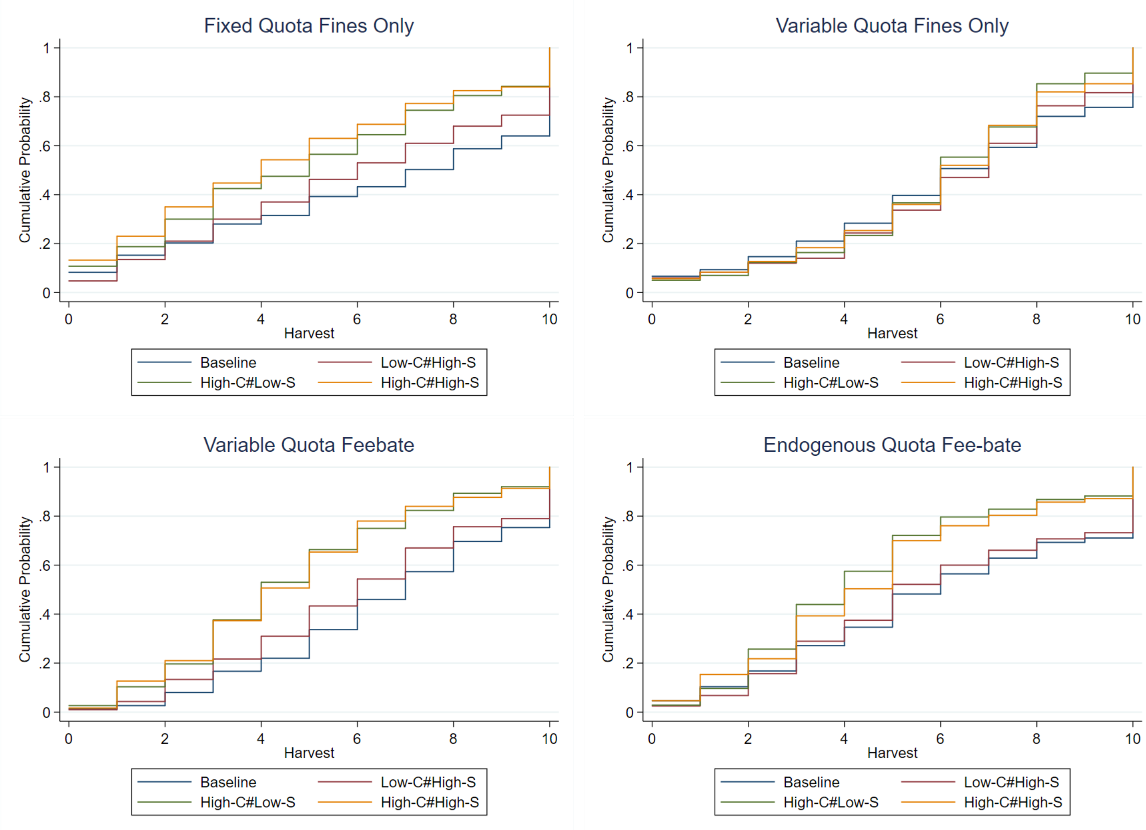


2.5 Results

The cumulative distribution of harvest levels under the deterrence parameter combinations and under the different quota regimes are shown in Figure 2.

[10]The specific questions are adapted from an experimentally validated survey instrument developed in Falk et al. (2016)

Figure 2: Cumulative Distributions of Harvest Levels



The cumulative distribution of harvest confirm that sanctions and rewards are effective in reducing harvest by individuals. Speaking to the primary research question posed in this paper, the figure shows that under High-Probability#Low-Severity (green line), the c.d.f. of harvest first order stochastically dominates the c.d.f under Low-Probability#High-Severity (red line) in the fixed quota regime, the variable quota with fee-bate regime, as well as in the endogenous quota with fee-bate regime. This provides an indication that harvest levels are lower on average when monitoring is more likely but severity of sanctions is lower than in the equivalent condition where monitoring is less likely but severity of sanctions is higher.

2.5.1 Deterrent Effects on Harvest under Alternate Quota Regimes

The effect of deterrence parameters under alternate quota and feebate regimes are first estimated using a random effects GLS model. The results are shown in Table 1. Separate estimations are performed for each of the quota regimes since they are qualitatively different in terms of the incentives involved. The estimation model under each regime is:

$$Y_{ijt} = \alpha + \sum_{k=1}^{3} \beta_k T_{ijt}^k + \gamma X_{ij} + \omega_j + \epsilon_{ijt} \tag{7}$$

where Y_{ijt} is individual i's harvest level in session j in period t, T_{ijt}^k are the treatment variables where $k = 1$ represents Low-P#High-S, $k = 2$ represents High-P#Low-S and $k = 3$ represents High-P#High-S respectively, X_{ij} represent characteristics specific to individual i in session j such as their risk attitude, whether he/she was reviewed in the previous period, amount of fines/rewards in the previous period, their accumulated earnings, the exogenous quota for the round (where applicable), and standard demographic controls including gender, age and race. ω_j are indicators for session j.

Since harvest decisions are experimentally bounded between 0 and 10, two-limit RE Tobit regressions are also estimated.[11] In the two-limit Tobit model, instead of the observed Y_{ijt} in (7), the predicted outcome is an unobserved latent variable, y_{ijt}^*, where

$$\begin{aligned} Y_{ijt} = & \quad 0 \quad \text{if } y_{ijt}^* \leq 0 \\ = & \quad y_{ijt}^* \quad \text{if } y_{ijt}^* > 0 \text{ and } y_{ijt}^* < 10 \\ = & \quad 10 \quad \text{if } y_{ijt}^* \geq 0 \end{aligned} \tag{8}$$

Marginal effects on the observed variable ($E[Y|X]$) are reported in Table 2.

[11]The Tobit model imposes more restrictive assumptions in that the error term should be normally distributed and homoskedastic. A plot of residuals versus fitted values suggests that this assumption may not hold in the data.

Table 1: RE GLS: Effects on Harvest Under Alternate Quota Regimes

	Fixed Quota Fines Only	**Variable Quota Fines Only**	**Variable Quota Feebate**	**Endogenous Quota Feebate**
Average Harvest in Baseline	6.560	6.227	6.673	5.986
Deterrence Factors				
Low-P#High-S (1)	-0.681*	-0.489	-1.008**	-0.877*
	(0.3174)	(0.3105)	(0.3365)	(0.3968)
High-P#Low-S (2)	-1.630***	-0.788**	-1.774***	-1.999***
	(0.2870)	(0.2786)	(0.3630)	(0.4188)
(2) - (1)[a]	-0.949***	-0.298+	-0.766**	-1.122***
	(0.2563)	(0.1601)	(0.2623)	(0.2594)
High-P#High-S	-2.102***	-1.095*	-2.427***	-2.490***
	(0.3485)	(0.4615)	(0.5268)	(0.6216)
Risk Seeking	0.178	0.154	0.253*	0.364*
	(0.1457)	(0.1810)	(0.1007)	(0.1521)
Reviewed_{t-1}	-1.304***	-0.180	0.0784	-0.237
	(0.2494)	(0.1539)	(0.2374)	(0.3053)
Fine_{t-1}	0.162***	0.104+	0.172**	0.0902
	(0.0283)	(0.0631)	(0.0593)	(0.0862)
Reward_{t-1}			-0.0481	-0.0718
			(0.0559)	(0.0931)
Harvest Quota		0.321***	0.429***	
		(0.0556)	(0.0468)	
Period	-0.453*	-0.293	-1.023***	-0.608*
	(0.1903)	(0.2430)	(0.2429)	(0.2650)
Accumulated Earnings_{t-1}	0.0193*	0.0144	0.0447***	0.0280**
	(0.0082)	(0.0102)	(0.0096)	(0.0108)
Gender, Age & Race Controls	Yes	Yes	Yes	Yes
Session IDs	Yes	Yes	Yes	Yes
Observations	1520	1140	1140	1064
Subjects	80	60	60	56

Robust standard errors in parentheses

$^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

a: The differences are estimated using Wald tests of equality of coefficients between Low-P#High-S and High-P#Low-S.

Table 2: RE Tobit: Effects on Harvest Under Alternate Quota Regimes

	Fixed Quota Fines Only	**Variable Quota Fines Only**	**Variable Quota Feebate**	**Endogenous Quota Feebate**
Average Harvest in Baseline	6.560	6.227	6.673	5.986
Deterrence Factors				
Low-P#HighS (1)	-0.800**	-0.570+	-1.289***	-1.044*
	(0.2860)	(0.3002)	(0.3197)	(0.4105)
High-P#Low-S (2)	-2.325***	-1.028***	-2.202***	-2.560***
	(0.2824)	(0.2768)	(0.2962)	(0.3670)
(2) - (1)[a]	-1.525***	-0.458**	-0.913***	-1.516***
	(0.2687)	(0.1905)	(0.2070)	(0.2591)
High-P#High-S	-2.795***	-1.358**	-3.001***	-3.181***
	(0.2993)	(0.4760)	(0.5074)	(0.6447)
Risk Seeking	0.403+	0.223	0.417**	0.518*
	(0.2261)	(0.2566)	(0.1414)	(0.2018)
Reviewed_{t-1}	-1.465***	-0.154	0.131	-0.205
	(0.4203)	(0.2117)	(0.2910)	(0.3541)
Fine_{t-1}	0.180***	0.100	0.151*	0.0592
	(0.0398)	(0.0714)	(0.0717)	(0.0977)
Reward_{t-1}			-0.0315	-0.0885
			(0.0664)	(0.1180)
Harvest Quota		0.372***	0.464***	
		(0.0483)	(0.0460)	
Period	-0.277	0.378	-0.417+	-0.0662
	(0.2255)	(0.2548)	(0.2470)	(0.3162)
$\text{Accumulated Earnings}_{t-1}$	0.0110	-0.0137	0.0204*	0.00675
	(0.0098)	(0.0107)	(0.0101)	(0.0128)
Gender, Age & Race Controls	Yes	Yes	Yes	Yes
Session IDs	Yes	Yes	Yes	Yes
Observations	1520	1140	1140	1064
Subjects	80	60	60	56

Standard errors in parentheses.

$^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

a: The differences are estimated using Wald tests of equality of coefficients between Low-P#High-S and High-P#Low-S.

Wald tests of difference in coefficients on Low-P#High-S and High-P#Low-S indicate that harvest levels are always statistically significantly lower under the latter condition, i.e. when the probability of detection is higher than when the severity of sanctions/rewards is higher. Comparing Tables 1 and 2, and assuming that the Tobit model assumptions hold, the OLS model underestimates the effect of sanctions on harvest decisions. See Table 20 for a comparison of results between all subjects and subjects identified to be risk-averse in the Eckel-Grossman task.

The results confirm that a higher probability of monitoring with less severe fines/rewards (High-P#Low-S) is approximately twice as effective in reducing harvest from the CPR than an equivalently lower probability of monitoring with more severe fines/rewards (Low-P#High-S). High probability and high severity sanctions/rewards perform better than the two equivalent intermediate combinations, showing that both parameters work progressively, as expected.

Result 1: *A higher probability of being monitored is approximately twice as effective as an equivalent increase in the severity of fines and rewards.*

Other results shown in Tables 1 and 2 indicate that lower degrees of individual risk aversion lead to higher harvest levels in all four quota regimes. Being reviewed in the previous period leads to lower harvest in the current period only in the fixed quota with fines regime. In the feebate treatments, the lack of a statistically significant relationship between being reviewed in the previous period and current period harvest is unsurprising since being reviewed does not necessarily lead to a loss of earnings. An increase in exogenous harvest quotas lead to a less than proportional increase in harvest levels.

2.5.2 Elasticity of Harvest

An alternative way to describe the effect of sanctions is to consider the responsiveness of harvest with respect to probability of monitoring and severity of sanctions/rewards, *ceteris paribus*. Estimating elasticities of harvest after regressing harvest levels on the values of probability and severity along with the other controls, Table 3 shows that a 1% increase in probability of monitoring leads to a reduction in harvest between 5.86% (under the variable quota with fines regime) and 19.8% (under the endogenous quota with feebate regime). However, a 1% change in the severity of fines and rewards does not lead to any significant change in harvest decisions.

Table 3: Elasticities of Harvest

	Fixed Quota Fines Only	**Variable Quota Fines Only**	**Variable Quota Feebate**	**Endogenous Quota Feebate**
Probability	-0.184***	-0.0586**	-0.152***	-0.199***
	(0.0271)	(0.0182)	(0.0318)	(0.0349)
Severity	0.001	-0.00578	-0.00166	0.0317
	(0.0316)	(0.0228)	(0.0297)	(0.0328)
Observations	1520	1140	1140	1064
Subjects	80	60	60	56

$^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Note: Elasticities are estimated after RE GLS regressions with specific Probability and Severity values (p and α) as explanatory variables along with all controls used in Table 1.

Result 2: *A 1% increase in the probability of being monitored, ceteris paribus, leads to a reduction in harvest across all quota and feebate regimes. The effect varies between a low of 5.86% in the variable quota with fines regime and a high of 19.9% in the endogenous quota with feebate regime.*

2.5.3 Heterogeneities in Treatment Effects by Agent Type

Starting from Fischbacher et al. (2001) and Falk and Fischbacher (2002), a number of studies have shown that individuals in social dilemmas often follow identifiable patterns of strategic behavior. On the basis of these patterns, individuals can be classified into strategic types depending on their responses to decisions of others.[12]

The method of classification that best suits this experiment is described in Kurzban and Houser (2005) where types are defined *ex-ante* as conditional cooperators, altruists (or unconditional cooperators) and free-riders. Following their methodology, agent types are categorized as follows:

[12]See Chaudhuri (2011) for an extensive review of studies on defining and explaining conditionally cooperative behavior.

- Conditional cooperators are those who harvest more in the Baseline condition when others harvest more. In the fixed quota with fines and the endogenous quota regimes, this implies a positive correlation between an agent's harvest in the current period and the average harvest by others in the previous period. In the variable (but exogenous) quota regimes, this implies a positive correlation between an agent's harvest in the current period and the exogenous harvest quota revealed to the agent in the current period.

- Free riders are those who harvest 50% or more of the maximum possible harvest in all but the first round of the Baseline condition and there exists no positive correlation between harvest in the current period and the previous period's harvest.

- Altruists are those who harvest less than 50% of the maximum possible harvest in all but the first round of the Baseline condition and there exists no positive correlation between harvest in the current period and the previous period's harvest.

Those who do not fall in any of the three above categories are classified as "Uncategorized". Table 4 shows the distribution of agents by type in the sample.

Table 4: Distribution of Agent Types

Agent Type	Free Riders	Altruists	Conditional Cooperators	Uncategorized	Total
Number	71	17	124	44	256
Proportion	27.73%	6.64%	48.44%	17.19%	

To quantify the effect of sanctions on these different types, a difference-in-differences estimation (Equation 9) is used and the coefficients are reported in Table 22. The corresponding marginal effects on different strategic types are shown in Table 5.

$$Y_{ijt} = \alpha + \sum_{k=1}^{3} \beta_{1k} T_{ijt}^{k} + \sum_{s=1}^{3} \beta_{2s} StratType_{ij}^{s} + \sum_{k=1}^{3} \sum_{s=1}^{3} \delta_{ks} T_{ijt}^{k} \# StratType_{ij}^{s} + \gamma X_{ij} + \omega_j + \epsilon_{ijt} \quad (9)$$

where X_{ij} includes all factors specific to individual i in session j mentioned in (7) as well as the average withdrawal by individual i in the baseline. This ensures that the estimation accounts for the different levels of harvest by different strategic types.

Table 5: Marginal Effects by Agent Type

	Fixed Quota Fines Only			**Variable Quota Fines Only**		
	Free Rider	Altruist	Conditional Cooperator	Free Rider	Altruist	Conditional Cooperator
Low-P#High-S	-2.412***	3.865***	-0.268	-1.145**	-0.152	-0.426
	(0.6156)	(1.0452)	(0.3134)	(0.5805)	(0.4829)	(0.3445)
High-P#Low-S	-2.752***	1.350**	-1.303***	-1.817***	0.174	-0.550*
	(0.5164)	(0.5280)	(0.3975)	(0.4851)	(0.4871)	(0.3081)
High-P#High-S	-4.069***	2.614***	-1.636***	-1.987***	0.0266	-1.178**
	(0.6531)	(0.7350)	(0.4048)	(0.6866)	(0.8732)	(0.4628)
	Variable Quota Feebate			**Endogenous Quota Feebate**		
	Free Rider	Altruist	Conditional Cooperator	Free Rider	Altruist	Conditional Cooperator
Low-P#High-S	-1.400***	-0.562	-0.932**	-2.606***	0.224	-0.502
	(0.4371)	(0.3490)	(0.3728)	(0.5424)	(0.5692)	(0.5416)
High-P#Low-S	-3.032***	1.304***	-1.363***	-4.264***	0.000675	-2.050***
	(0.7071)	(0.3441)	(0.3568)	(0.6307)	(0.3943)	(0.4978)
High-P#High-S	-4.087***	0.165	-1.905***	-4.427***	-0.564	-2.258**
	(0.7426)	(0.5974)	(0.5238)	(0.7191)	(0.6362)	(0.9122)

Robust standard errors in parentheses.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Sanctions are most effective in reducing harvest by free riders. They are less effective on conditional cooperators. Under the fixed quota with fines regime, sanctions backfire on altruists, raising the lower than average levels of harvest by this strategic type. This could be due to "crowding out" of their intrinsic motivation to harvest less from the common pool.

Result 3: *Sanctions and rewards are most effective in reducing harvest by free riders. Their effects are lower on conditional cooperators. Altruists sometimes respond to monitoring by increasing their harvest levels.*

2.5.4 Decisions on the Intensive and Extensive Margins

The distribution of harvest levels shows a considerable spike at the maximum possible (Figure 3). Therefore, it is pertinent to conduct separate estimations of the decision of whether to harvest the maximum possible and the decision regarding how much to harvest, given that harvest is less than the maximum possible. The former is estimated using a random effects probit model, while the latter is estimated using a random effects GLS model conditional on harvest level being less than the maximum possible.

Figure 3: Distributions of Harvest Levels

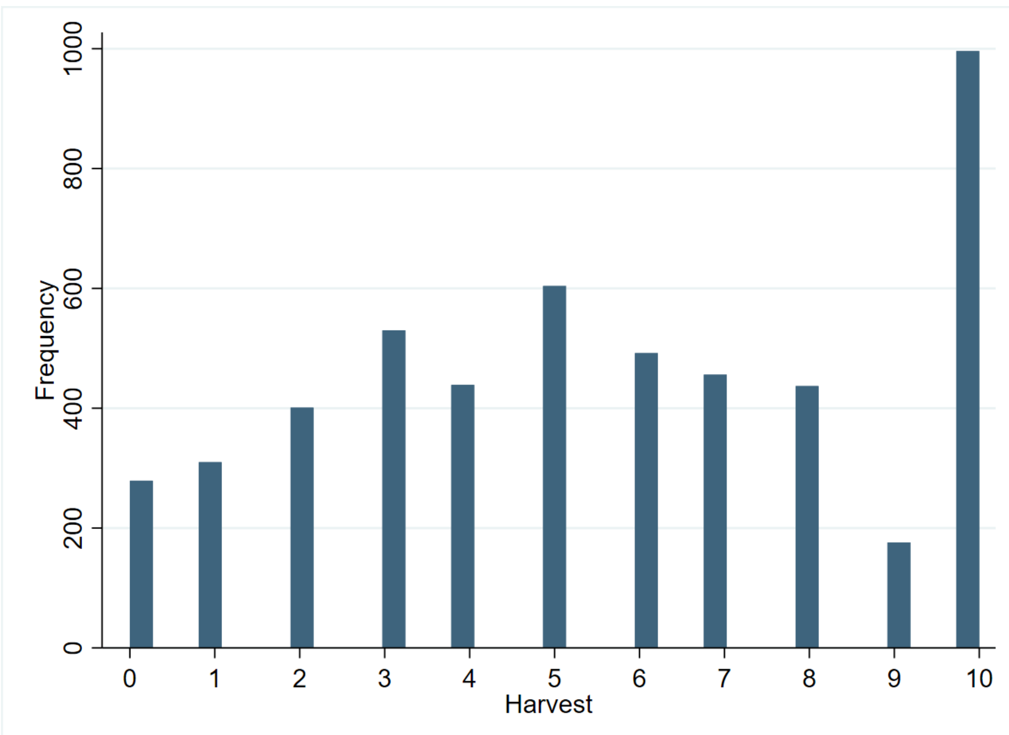


Table 6: Harvest Decisions on the Intensive and Extensive Margins

	Fixed Quota Fines Only		**Variable Quota Fines Only**		**Variable Quota Feebate**		**Endogenous Quota Feebate**	
	Probit	GLS	Probit	GLS	Probit	GLS	Probit	GLS
Low-P#High-S	-0.0888*	-0.233	-0.0505	-0.411+	-0.117*	-0.889**	-0.0997	-0.513
	(0.0429)	(0.2237)	(0.0544)	(0.2282)	(0.0590)	(0.3010)	(0.0643)	(0.3269)
High-P#Low-S	-0.212***	-0.684**	-0.134**	-0.360+	-0.207***	-1.189***	-0.248***	-1.070**
	(0.0368)	(0.2457)	(0.0504)	(0.2187)	(0.0590)	(0.2693)	(0.0642)	(0.3292)
High-P#-High-S	-0.208***	-1.200***	-0.0837	-0.982**	-0.249***	-1.611***	-0.287***	-1.398**
	(0.0420)	(0.2805)	(0.0823)	(0.3323)	(0.0702)	(0.4365)	(0.0747)	(0.4907)
Risk Seeking	0.0492**	-0.268+	0.00791	0.118	0.0304*	0.111	0.0373*	0.232+
	(0.0163)	(0.1596)	(0.0155)	(0.1599)	(0.0147)	(0.0996)	(0.0185)	(0.1196)
Reviewed_{t-1}	-0.0801*	-0.694**	-0.0185	-0.158	0.0200	-0.115	0.0192	-0.210
	(0.0339)	(0.2258)	(0.0343)	(0.1409)	(0.0247)	(0.2131)	(0.0591)	(0.2185)
Fine_{t-1}	0.00984**	0.0924**	0.00907	0.104	0.00911**	0.0583	0.00386	0.000629
	(0.0032)	(0.0286)	(0.0097)	(0.0688)	(0.0033)	(0.0722)	(0.0114)	(0.0489)
Reward_{t-1}					0.000966	-0.0248	-0.0579	-0.0140
					(0.0071)	(0.0403)	(0.0417)	(0.0770)
Male	0.0986	0.765	0.00831	0.552	0.156**	-1.299**	0.0979	-0.645
	(0.0628)	(0.4901)	(0.0502)	(0.6008)	(0.0592)	(0.4447)	(0.0692)	(0.4420)
Exogenous Quota			0.0104	0.347***	0.0130*	0.428***		
			(0.0076)	(0.0631)	(0.0054)	(0.0440)		
Period	-0.00617	-0.330	-0.0281	-0.257	-0.0417	-0.314	-0.0581	0.0305
	(0.0235)	(0.2091)	(0.0355)	(0.2036)	(0.0294)	(0.2177)	(0.0408)	(0.2663)
$\text{Accumulated Earnings}_{t-1}$	0.000163	0.0146	0.00113	0.0136	0.00198+	0.0148+	0.00267	0.000971
	(0.0010)	(0.0089)	(0.0015)	(0.0086)	(0.0012)	(0.0086)	(0.0016)	(0.0110)
Observations	1501	1157	1102	952	1140	968	988	855
Subjects	80		60		60		56	

Robust standard errors in parentheses
$^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Results in Table 6 suggest that the differences in harvest level between Low-P#High-S and High-P#Low-S operate on both the intensive and extensive margins of harvest. The exogenous harvest quota has effects on the intensive margin, showing that a 1 unit increase in the harvest quota leads to between 0.35 to 0.43 unit reduction in harvest, conditional on harvest being less than the maximum possible. Being reviewed in the previous period leads to a 8% reduction in the likelihood that an individual harvests the maximum possible from the CPR. On the intensive margin, being reviewed in the previous period leads to a 0.7 unit reduction in harvest.

Result 4: *Sanctions and rewards are effective on both the intensive and the extensive margin.*

2.6 Conclusions

What are the incentives that affect decisions regarding how much to harvest from common property resources? This paper finds that in the context of exogenous monitoring and sanctioning mechanisms and over relatively small probability and severity values, the probability of being monitored is a more effective deterrent against socially sub-optimal extraction than an equivalent increase in the severity of fines. This result holds across multiple quota and fee-bate regimes that leverage variable norms of CPR utilization. Examining the effects of monitoring and sanctions on different strategic types shows that reduction in harvest are driven by free riders reducing their otherwise high levels of harvest. Altruists, on the other hand, tend to react perversely to externally enforced sanctions, in tune with the idea of "crowding out" of intrinsic motivation.

Looking back at existing work on this issue using experiments, this paper's findings contrast with the broad conclusions in Anderson and Stafford (2003) and Friesen (2012).[13] On the other hand, this paper's results are consonant with a number of studies on tax compliance and traffic violations. As mentioned earlier, Alm (2012) reports a number of studies that find the probability of audits to be a more effective deterrent against under-reporting of income than equivalent increases in severity of fines. A number of studies on driving behavior suggest that even large increases in fixed penalties lead to relatively minor reductions in traffic violations (Elvik, 2016, Moolenaar, 2014). What matters more in terms of reducing such violations is whether the laws are enforced as primary or as secondary offences (Cohen and Einav, 2003), or the effectiveness of information campaigns

[13]Anderson and Stafford's RE Tobit coefficient estimates suggest that contributions to a public good are about a third higher due to a unit increase in severity of sanctions, compared to an equivalent change in probability of sanctions. The authors do not, however, substantiate their results with controls for individual risk attitudes or use Wald tests of differences in coefficients after their regressions. Using individual decisions regarding whether to comply with a costly regulation, Friesen's overall result suggests that severity is a more effective driver of compliance than probability of fines. However, compliance rates are not statistically significantly different over combinations of probability and severity of sanctions similar to those considered in this paper. For instance, the compliance rate under sanctions with probability of 0.1 and severity of 20 is 21%, while that under sanctions with probability of 0.2 and severity of 10 is 19%. The one-sided test for the former being greater than the latter fails to reject the null of equality, with a p-value of 0.43.

about a new traffic safety legislation (Abouk and Adams, 2013).

Some limitations of this study should be mentioned here. Although the risk task used here is relatively easy to understand and provides estimates of individual risk attitudes, it cannot be used to predict probability weights which could be important in the decision making process of individuals. Moreover, the abstract decision context and subject pool, while theoretically sound, do not allow for specific claims regarding how these results might change across decision domains.

A couple of interesting aspects of regulation that have not been addressed in this paper may inform design of future experiments testing relative effects of probability and severity. For instance, the regulator's role can be made more flexible by allowing for re-adjustment of probabilities and severities depending on the outcome of reviews in the current period. Further, a careful categorization of behavioral types can also inform exogenous or even endogenous sorting of different individuals into groups with varying deterrence parameters under the alternative quota regimes considered here.

In summary, this paper finds that a higher probability of monitoring is more effective at deterring harvest from a common pool resource than an equivalent increase in the severity of fines. This result holds across a number of quota and fee-bate regimes that reflect changing norms governing resource utilization. Moreover, sanctions and rewards have heterogeneous effects on different types of strategic agents – reducing the high levels of harvest by free riders while sometimes crowding out the intrinsic motivation of altruists. This suggests that policymakers should stress the probability of detecting violations more than severity of fines. Moreover, norms and strategic behavior in resource extraction should be examined carefully before implementing monitoring and sanctioning regimes.

3 CBNRM and Elephant Populations in Africa[14]

3.1 Introduction

This paper examines whether community-based natural resource management (CBNRM) has had an impact on the population of the biggest terrestrial animals: African elephants. Pioneered by the Communal Areas Management Programme for Indigenous Resources (CAMPFIRE) program in Zimbabwe, CBNRM is an approach that seeks to allow individuals to directly manage and benefit from natural resources. The CBNRM approach, as it relates to wildlife, involves distribution of revenues from wildlife services such as ecotourism or trophy hunting to local people. The perfect community oriented program would involve full assignment of property rights, including rights of extraction and revenue distribution, over wildlife to communities. This would align the incentives for locals to manage their wildlife resources as a common pool instead of an open access resource.

In post-colonial Africa, national governments have historically owned the rights to natural resources in most countries, with the exception of South Africa where there are a sizable share of privately owned game reserves (Child, 2003). Hence, while communities have had to bear the cost of wildlife conservation manifested as human-animal conflicts and displacement, the benefits of conservation – such as tourism revenues – have largely been captured by the national governments.[15] This has driven a wedge between conservation efforts and incentives for local people to engage with such programs. Correcting this misalignment of benefits and costs provides the economic rationale for the shift towards CBNRM programs. In sub-Saharan Africa, CBNRM has evolved as a tool to derive dual benefits of conservation and poverty alleviation by generating a direct revenue stream from wildlife to

[14]I would like to thank Spencer Banzhaf for his comments and suggestions at every stage of this project. I also received valuable feedback from Terry Anderson, Timothy Fitzgerald, Wally Thurman, Daniel Benjamin, Randy Rucker, Dean Lueck, Christopher Timmins, Bart Wilson, and Reed Watson at the Property and Environment Research Center in Bozeman, MT, conference participants at Camp Resources 2017 and the World Congress of Environmental and Resource Economics, 2018.

[15]Crop damage is more likely to occur along the boundaries of protected areas and usually decreases with increasing distance from the boundary. Elephants from the protected area raid crops closest to the boundary because the risk of detection is lowest there (Parker et al., 2007).

the communities living in close contact with them.

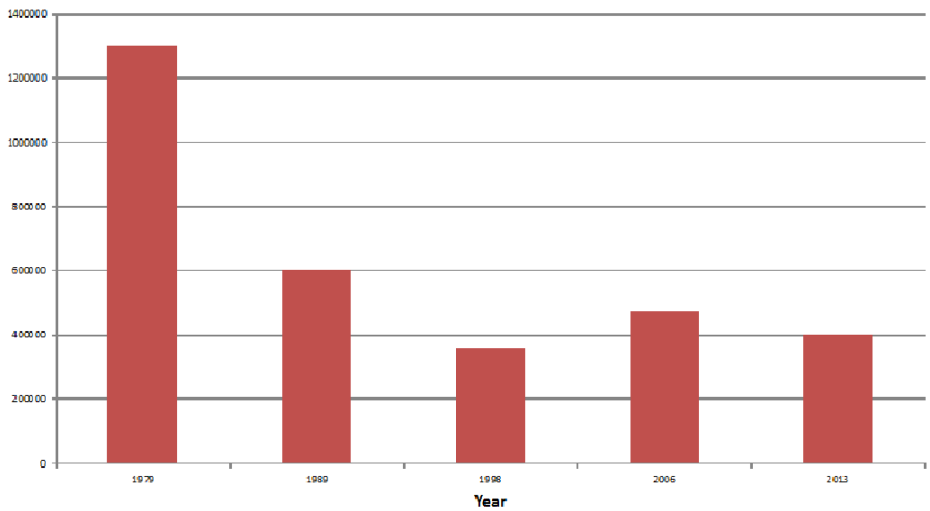
A large number of qualitative articles suggest that the actual experience of CBNRM in Africa has not been very positive. For instance, Turner (2004) points out that unless CBNRM programs are backed by very strong local governance systems, they are not likely to succeed. Oppressive governments and extractive practices have negative effects on CB-NRM programs as well as wildlife resources in a country. This is probably most apparent in Zimbabwe, where the CAMPFIRE initiative has been significantly impeded since the mid-2000s due to worsening governance (Rihoy and Maguranyanga, 2010). Thus, although CBNRM policies might work in theory, their actual effect on wildlife populations is still an open question.

Very few rigorous evaluations of CBNRM programs have been performed, with most analyses restricted to case studies of specific projects. While case studies are useful tools in specific contexts, the external validity of their results is limited by a number of factors that cannot be accounted for without employing a more systematic empirical approach. Given the volume of revenue generated by wildlife services (Di Minin et al., 2016, Lindsey et al., 2007), the outcome on wildlife in general – and elephants in particular – becomes important in order to understand the impact of CBNRM projects. This paper is an empirical evaluation of how community-based programs have affected wild elephant populations in Africa and, further, how this effect is influenced by variation in country-specific characteristics.

3.2 Background

The largest living terrestrial animals, African elephants (*Loxodonta africana*) constitute an important part of the savannah ecosystems of Africa. Over the last three decades, elephant populations have declined dramatically (Figure 4). The species is now classified as "Vulnerable" in IUCN's Red List of Threatened Species – in the same category as polar bears.

Figure 4: African Elephant Population (1979 - 2013)



Sources: Data for 1979 and 1989 from Lemieuex and Clarke (2009); Data for 1998, 2006 and 2013 from African Elephant Database.

International environmental groups, multilateral agencies and national governments have emphasized the need to combat the deterioration in elephant populations. The Convention on International Trade in Endangered Species (CITES) imposed a ban on international ivory trade in 1989.[16] The effectiveness of this ban in improving elephant populations is, however, questionable (Hitch, 2014). In the late 1990s, some countries in southern Africa argued successfully to be allowed to export a pre-specified quota of ivory from their stockpiles.[17]

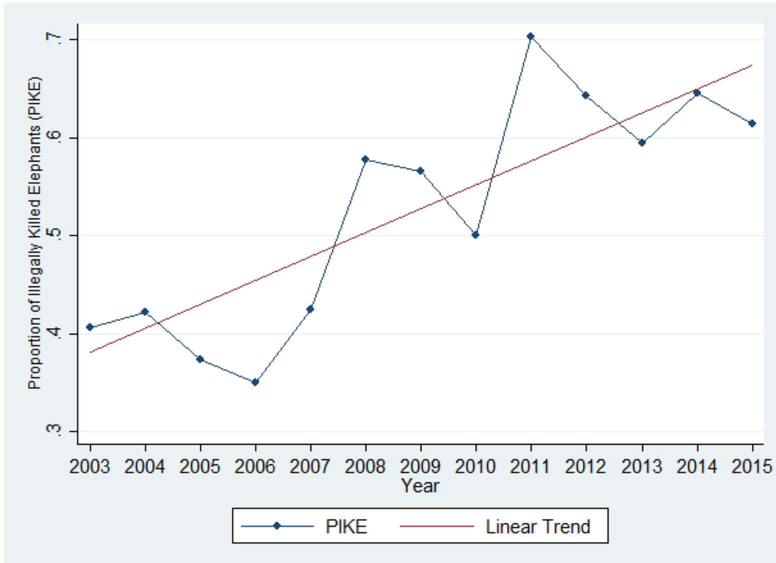
In 2014, an upsurge in illegal poaching of African elephants was recorded, coinciding with increases in illegal ivory seizures and black market ivory prices. Wittemyer et al. (2014) argues that current levels of poaching exceed the intrinsic growth capacity of the species, which they estimate at 4 percent per year. Data on the Proportion of Illegally Killed Elephants (PIKE) collected by IUCN shows that the number of elephants killed

[16]The African elephant was listed in Appendix-I of CITES' endangered species list for all countries in Africa. Appendix-I lists species threatened with extinction. Commercial trade in these specimens is strictly prohibited, while other trade – largely in the form of hunting trophies or for scientific and educational purposes – is tightly controlled (Lemieux and Clarke, 2009).

[17]African elephants were taken from Appendix-I to Appendix-II in Botswana, Namibia and Zimbabwe in 1997, and in South Africa in 2000. Appendix-II lists species not necessarily threatened with extinction, but in which trade must be controlled in order to ensure their survival.

by poachers (as a proportion of the total number of elephant carcasses found) has been increasing over the last decade (Figure 5).

Figure 5: Trend in Proportion of Illegally Killed Elephants (PIKE)



3.2.1 CBNRM

The CBNRM approach to conservation has gained popularity over the last four decades, with more than 50 countries transferring some degree of forest management and decision-making authority to local user groups as of 2002 (Armitage, 2005). In sub-Saharan Africa, modern CBNRM programs were pioneered by the well publicized CAMPFIRE program in Zimbabwe initiated in the 1980s. The motivation behind setting up the program was that "if wildlife provided only public benefits, no matter how many schools and clinics were built this would never achieve conservation" (Child, 2004). Brian Child argues that only if wildlife provides direct, tangible benefits to local communities would they have the incentive to devote resources to conservation.

Multiple reports and case studies on CBNRM projects across the continent suggest that the theoretical ideal of full devolution of property rights over wildlife to communities is seldom actually implemented (Fabricius et al., 2004, Rihoy et al., 2007, Turner, 2004). Instead, CBNRM projects are often a way to institutionalize benefit sharing between the state or regional governments and local people. Thus, instead of all revenues (such as trophy hunting fees, entry fees etc.) being collected by the government, a CBNRM project will typically involve a percentage of the revenue accruing to the communities located in or around the park area. The actual percentage can vary over time and across parks, although at present there is no reliable comprehensive analysis of variation along this dimension.

In terms of project implementation, neighboring communities and settlements meet and choose to appoint members to an administrative body – such as a Community Based Organization (CBO) in Botswana or a Regional District Council (RDC) in Zimbabawe – that acts as the representative of the communities to the government. Formation of these organizations could arguably lower transaction costs of negotiating rights or benefit-sharing with national governments since they are a single body representing a group whose members would otherwise have to negotiate individually with the state.

How well these community organizations actually work depends on institutional factors like governance, rent seeking and differential bargaining power(s) of individuals. The following sections describe three cases of existing CBNRM projects in Zimbabwe, Zambia and Namibia. Although there are other CBNRM projects in sub-Saharan Africa (like those in Tanzania and Botswana) the three projects described here give an overview of how CBNRM strategies are structured and implemented.

3.2.2 The CAMPFIRE Program in Zimbabwe

The CAMPFIRE program in Zimbabwe was developed to manage wildlife and wildlife habitat in communal lands so that people living in these areas could benefit. Before CAMPFIRE, wildlife was exclusively owned by the State, and licences for commercial use were not typically granted. Consequently, individuals and communities, who were largely engaged in agriculture, treated wild animals as pests. CAMPFIRE aimed to align land use with the natural opportunities and constraints of these agriculturally marginal areas. Wildlife use predominated as it produced the most value, principally through safari hunting and ecotourism (Frost and Bond, 2008). The development of CAMPFIRE was influenced by an earlier project called Wildlife Industries for All (WINDFALL), that also involved distributing meat from culled elephants and some revenue from trophy fees to rural communities adjacent to state-managed protected areas, with the aim of encouraging a positive attitude to wildlife. This project was not successful, but provided lessons for the CAMPFIRE paradigm.

Some agreements made under the CAMPFIRE program have included explicit requirements for communities in the concession area not to harass or hunt wildlife, to limit expansion of crops and livestock, to confine human settlement to agreed zones and, in a few cases, to even move away from prime wildlife areas (Frost and Bond, 2008).

The process of allocating hunting concessions and distribution of benefits is recorded through Brian Child's work. First, a list was prepared of animals shot by hunters in each village area and how much the animals were worth. Next, individuals in the community responsible for the hunting area were told how much each member was entitled to. Then, the community collectively discussed how to use the money in terms of setting up public infrastructure or distributing cash to its individual members. At an official ceremony, $60,000 was carried into a public meeting of the whole village and placed in prominent view. Each member came forward and received his or her full share in cash. Then, as they had agreed previously, the members put money into buckets signifying the projects they had chosen and pocketed the remaining cash. Within three years, 73 percent of revenues were reaching the community level (Child and Barnes, 2010). Given its history and scope, CAMPFIRE has long been considered the flagship CBNRM program in Africa.

3.2.3 The ADMADE Program in Zambia

Zambia's hallmark CBNRM program was Administrative Management Design for Game Management Areas (ADMADE). The program began in 1989, but one of the key precursors was the Lupande Development Project that operated from 1984 to 1987 and focused on wildlife management, and especially elephant management.

Sharing of revenue from wildlife hunting with local communities constituted one of the key elements of ADMADE. The experiences gained during ADMADE led to the enactment of the 1998 Zambia Wildlife Act No.12 that makes specific provisions for the participation of local communities in wildlife management through local institutional structures known as Community Resources Boards (CRBs) (Roe et al., 2009). One of the first CBNRM programs was initiated in South Luangwa National Park with benefit sharing starting in 1995.

There is currently an arrangement in place where hunting and eco-tourism revenues are equally shared between Zambia's Wildlife Authority (ZAWA) and local communities. At the Lupande Game Mangement Area (GMA), a consensus was reached to allocate all revenues from Lupande GMA to communities and to allow them to decide for themselves how to use this money - provided they were organised and followed a set of guidelines that ensured transparent, accountable, democratic management at a scale where people could meet face-to-face. This consensus was taken to the project's review and policy meetings in April 1996, where the new approach was formally adopted.

3.2.4 The LIFE Project in Namibia

The Living in a Finite Environment (LIFE) Project has been implemented through a cooperative agreement with the World Wildlife Fund and several local partners. Namibian organizations receive international assistance to work with local communities and support policy and legislative change. A community has to form a legal, registered conservancy in order to get the right to hunt certain species of wildlife for their own use, the right to enter into contracts with the private sector for trophy hunting and photographic tourism activities, and to obtain permits from the government for the sale of live game to ranchers. The community must define its membership, define its borders, have a representative committee, develop an equitable benefit distribution plan, and have a legal constitution. The project partners assist communities in going through these various steps with particular emphasis on ensuring that as many community members as possible are directly involved in the process.

Once conservancies have been established, support is provided for the institutional development of conservancies, including committee administration, financial management, staff management, and accountability and transparency in decision-making. Conservancies also receive considerable capacity building in establishing joint venture partnerships with the private sector for photographic tourism and trophy hunting. The project supports the conservancy in developing its requirements for partners, and then in putting out tenders and negotiating contracts. In 2008, there were 44 registered communal area conservancies in Namibia covering more than 10.5 million hectares of land, while an additional 30 conservancies were at various stages of development (Davis, 2008).

3.2.5 Empirical Evidence

Very few empirical studies have been performed on evaluating the impact of CBNRM policies on elephant populations. One of these studies, McPherson and Nieswiadomy (2000), argues that countries with property-rights-based policies have more rapid growth rates in elephant populations. Their paper uses annual data on elephant populations for 37 countries in Africa over 1969-1994.[18] The authors argue that countries with a national-level natural resource management program that assigned some property rights to local communities have higher growth rates of elephant populations.[19] The paper also claims that political instability and absence of representative governments are associated with signifi-

[18] Annual data on country level elephant populations is collected from different sources for the years 1969, 1970, 1973, 1976, 1978, 1981, 1989, 1994. Data for most countries (except Uganda and Kenya) is used only for the years 1979, 1981, 1989 and 1994.

[19] Property rights are modeled using two dummy variables. The first one indicates whether a country had a national-level natural resource management program which assigned some property rights to local communities and the other identifies countries that do not have national programs, but have localized CB-NRM programs. Regression results are reported only for the model which uses the first dummy variable and not the second one.

cantly lower elephant population growth.[20] The estimation does not, however, account for un-observable factors that may bias the results. For instance, countries could have poor institutions that make it difficult for them to set up and maintain CBNRM programs for management of their wildlife resources.[21] Now, with the availability of more current and disaggregated data on elephant counts published by the African Elephant Database, more thorough analyses can be performed.

3.3 Hypotheses

Analyzing the management of common pool resources, Elinor Ostrom argued that a key feature characterizing successful collective management of the commons is that individuals have the right to devise their own institutions and rules regarding deriving benefits from the resource (Ostrom, 1990). CBNRM programs are intended to put this into practice by facilitating development of community organizations that derive benefits from wildlife resources. A successful CBNRM program should limit depletion of the resource being managed – in this case wild elephants. The high levels of poaching recorded by the PIKE data can arguably characterize over-extraction and a CBNRM program should lead to an increase in elephant populations.

This rationale for setting up a CBNRM program is grounded in the significance of defining property rights appropriately for optimal utilization of a resource (Coase, 1960). In the context of wildlife, if property rights are defined such that the resource is privately owned, the owner(s) extracts the stock up to the point where marginal revenue equals marginal cost – the efficient level of extraction. However, if property rights are not defined (or not enforced) the situation is one of open access, where resource rents are dissipated and extraction moves beyond the level of maximum sustainable yield. If harvesting costs

[20] Political instability is measured by the average annual number of riots in a country and non-representativeness through the average number of political purges over the year being considered and five previous years.

[21] In addition, this paper uses elephant population data at the country level, with a total of 78 country-year observations which would limit explanatory power.

are sufficiently small, this can lead to extinction of the resource.[22]

Community-based management reduces transaction costs of establishing rights to use and share benefits from the utilization of elephants as a natural resource. The importance of transaction costs becomes clearer when one recognizes that elephants require a very large territory. In Africa, where land is either state-owned, or exists as small areas owned by individuals or communities, it is seldom the case that a single owner owns enough land to manage an entire herd. Therefore, individuals need to negotiate with each other and with the government to establish property rights and benefit-sharing rules. As argued in Lueck (1994), greater heterogeneity in social structure increases transaction costs associated with such negotiations, and lowers the net benefits from a community-based management program.

Skeptics argue that local communities may not have the expertise or resources to fight poaching, that they may be unable to cooperate successfully, or that central governments may not keep their commitments (Fabricius et al., 2004, Rihoy et al., 2007, Turner, 2004). Additionally, the markets in ivory that provide some of the incentive in CBNRM programs can provide cover for illegal markets in ivory, encouraging poaching (Bulte and Van Kooten, 1999, Hsiang and Sekar, 2016). Finally, the incentives provided by CBNRM policies can be ambiguous, for several reasons. First, de jure property rights do not guarantee protection of a given species: when the costs of enforcing rights exceed the benefits, open access conditions may continue (Anderson and Hill, 1983). Second, even if rights are enforced, extinction can be an economic outcome, if discount rates are high or growth rates low, with renewable resources effectively treated as depletable (Caughley, 1993, Hill, 2014). Third, the benefit-sharing rules of CBNRM policies and interactions between communities and parks complicate the incentives for communities in ways that make the returns to anti-poaching efforts ambiguous (Fischer et al., 2011).

The existing literature has explored other factors and policies influencing wildlife pop-

[22]See Hanley and White (2007) for the setup of the model for renewable resources.

ulations in general, and elephant populations in particular. Leader-Williams and Albon (1988) argues that though large nature reserves and protected areas could theoretically lower the risk of extinction, countries with limited resources to devote to monitoring large protected areas would do a better job of protecting its wildlife by limiting the size of these areas. In this paper, therefore, the percentage of land designated as "protected area" in a country for a year is accounted for.

Examining the effect of anti-poaching measures taken by governments with and without the international ban on ivory trade, Bulte and Van Kooten (1999) argues that the effect of the trade ban on equilibrium elephant populations is ambiguous, with the stock under the ban being higher than that without the ban for discount rates of around 5 percent or more. Although this analysis is useful in showing sensitivity of elephant stock to anti-poaching measures and imposition of a ban on international ivory trade, the actual value of parameters, such as the discount rate, are difficult to empirically validate at the country level. Although barriers to trade lower welfare in a first-best world, export and import controls may promote welfare in exporting countries if, for example, enforcement of property rights is imperfect (Bulte and Barbier, 2005). Using a dynamic model of an open access resource that can produce a storable good, Kremer and Morcom (2000) show that the cheapest way for governments to avoid extinction of elephants may be to commit to tough anti-poaching measures if the population falls below a threshold. Governments with less credibility should accumulate a sufficient stockpile of the storable good and threaten to sell it should the population fall. A recent empirical study using data on the Proportion of Illegally Killed Elephants (PIKE) finds that a one-shot legal sale of ivory stocks in the year 2008 corresponded to a 66% increase in illegal ivory production across Africa and Asia (Hsiang and Sekar, 2016). A reading of this literature shows that the effect of the ban on international trade in ivory is ambiguous, but it is clearly an important factor affecting individuals' incentives to engage in conservation or poaching of wildlife. Therefore, this paper controls for whether a country is a signatory to the CITES ban on international trade in ivory during a given year. Other factors that the existing literature examines that have been examined vis-a-vis their effect on wildlife populations include economic conditions (McPherson and Nieswiadomy, 2000), governance (Lemieux and Clarke, 2009) and the relative importances of forest resources in a country's GDP (Naidoo and Ricketts, 2006). These factors are also accounted for in this paper.

Despite the importance of the question, surprisingly little empirical evidence is available about the success or failures of CBNRM policies at protecting elephant populations. Case studies have generally supported the success of Zimbabwe's CAMPFIRE program and other CBNRM programs, especially in the early years (Taylor, 2009). However, many case studies focus more on economic than conservation outcomes (Fabricius et al., 2004). To the best of my knowledge, McPherson and Nieswiadomy (2000) provide the only quantitative evidence of the relationship between CBNRM programs and elephant populations. They used country-level data, regressing 1981-89 and 1989-94 changes in elephant populations on indicator variables for whether a country had CBNRM policies and other controls, with a total of 78 observations. They find that countries with CBNRM policies have more rapid growth rates in elephant populations. However, these data are now 25 years old, do not explain within-country differences, and came only at beginning of many CBNRM programs. Thus, the actual effect of CBNRM programs on wildlife like the African elephant is still an open question.

3.4 Data

Data on elephant populations has been collected at the area level from the African Elephant Database for the years 1985-2012. The full dataset includes survey counts at 589 areas across the 38 countries with recorded elephant populations (these countries are collectively referred to as elephant "range states"). The dataset has 1,136 area-year observations. 325 areas have observations for one year, 99 for two, and so on, as shown in Table 7 below.

Table 7: Frequency of Distinct Area-Year Observations

# of areas	%age of total # of areas	# of annual obs. for each
325	55.18	1
99	16.81	2
79	13.41	3
55	9.34	4
30	5.09	5
1	0.17	6
589	100	1,136

Elephant counts are generated using different survey methods that vary in their degree of reliability from A to E (best to worst). Category A surveys (28.35 percent of observations) have the highest degree of reliability and are conducted through aerial or ground total counts, or individual registration. Those in categories B (30.11 percent) and C (4.93 percent) mainly include aerial or ground sample counts or dung counts. Categories D and E primarily include counts generated through informed guesses or "other guesses" (Blanc et al., 2007).

The raw distribution of elephant counts is strongly positively skewed. Therefore, in order to make the OLS regressions in the empirical analysis appropriate, a log-transform (Figure 6) of this variable is used in the empirical analysis and the coefficients are interpreted accordingly.

There are a total of 56 area-year observations in which the number of elephants is recorded as 0. Thus, in the estimation all elephant counts are augmented by 1 to ensure that these observations do not drive the results.

Figure 6: Histogram of Log of Elephant Counts

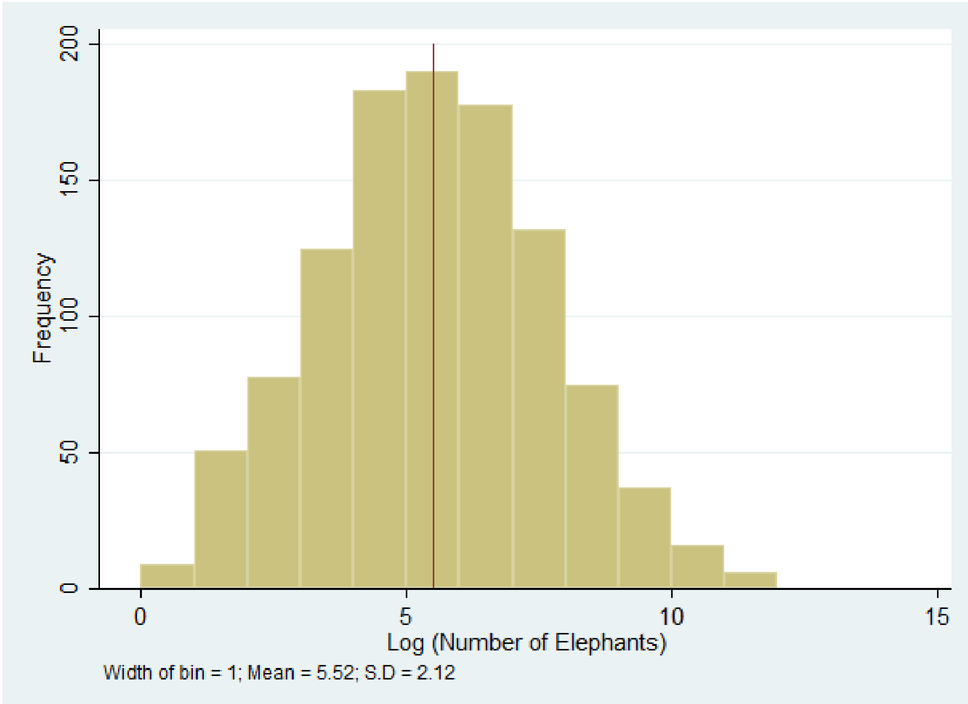
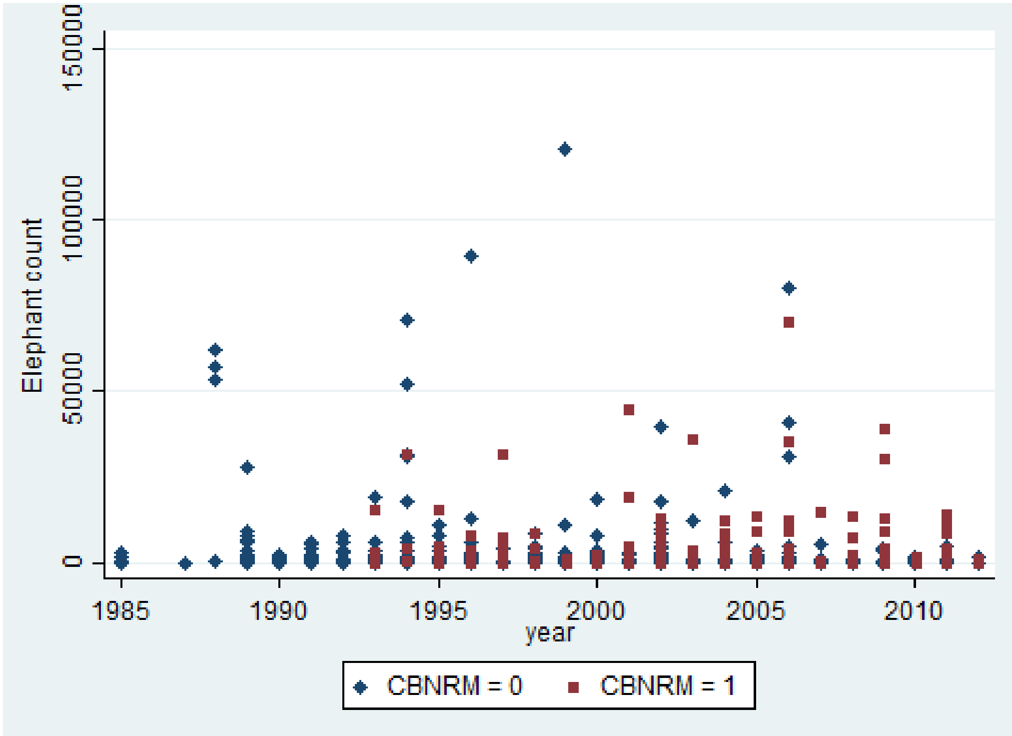


Figure 7 shows the full dataset of area-year elephant counts with blue diamonds marking area-year counts for which there are no CBNRM projects and red squares marking observations where CBNRM projects are present. From this figure, it is clear that the number of CBNRM projects have increased over the years, as more and more countries implement such programs. However, the effect on elephant counts is not apparent without more rigorous evaluation.

Figure 7: Area-level Elephant Counts Over Time



3.4.1 CBNRM

A number of published reports, case studies and articles have been used to codify whether an area with a recorded elephant population has had a CBNRM project implemented in or around it during a particular year. In the analysis, CBNRM is a dummy that varies at the area-year level. It takes on the value 1 if an area has a documented CBNRM program in a particular year, and 0 otherwise. Fifteen countries do not have a CBNRM project recorded in any of their areas for any year in the sample.[23]

Country-year controls

A dummy for the CITES ban on international ivory trade takes on a value of one if elephants are listed in Appendix I in a country during a given year, and zero otherwise.

[23]Countries without any recorded CBNRM projects in the area-year observations under consideration include Angola, Chad, Ivory Coast, Equatorial Guinea, Eritrea, Ethiopia, Gabon, Guinea, Liberia, Niger, Nigeria, Rwanda, Somalia, South Sudan, Sudan and Togo.

Data on gross domestic product, gross national income, protected area (as a percentage of total area), and forest rent (as a percentage of GDP) are collected at the country-year level from the World Bank's publicly available data. Protected areas refers to totally or partially protected areas of at least 1,000 hectares that are designated by national authorities as reserves with limited public access and is expressed as a percentage of total land acreage of a country. Marine areas, unclassified areas, littoral (intertidal) areas, and sites protected under local or provincial law are excluded. Forest rent (as a percentage of GDP) is measured as round-wood harvest times the product of average prices and a region-specific rental rate. The estimates of rents are calculated by estimating the world price of units of round-wood and subtracting estimates of average unit costs of extraction or harvesting cost. These unit rents are then multiplied by the physical quantities countries extract or harvest to determine the value of rent for each commodity.

Governance indicators have been obtained from World Bank's World Governance Indicators (WGI) and also from the Fraser Index of Economic Freedom of the World (EFW) database. The WGI are standardized variables centered at 0. The two WGI indicators used measure (i) the absence of corruption and (ii) the absence of violence or terrorism. The EFW index addresses five areas of freedom which are aggregated into a single summary index of economic freedom. These areas are (1) size of government; (2) legal structure and security of property rights; (3) access to sound money; (4) freedom to trade internationally; and (5) regulation of credit, labor, and business. The underlying component data are converted to a scale from 1 (representing the least free) to 10 (most free).

3.4.2 Time-invariant Factors

Fractionalization data is collected from Alesina's database (Alesina et al., 2003). This data is a measure of how heterogeneous a country is in terms of ethno-linguistic categories. For country j, fractionalization is calculated as $Frac_j = 1 - \sum_{i=1}^{N} s_{ij}^2$, where s_{ij} is the share of ethno-linguistic group i in the population of country j. Thus, $Frac_j \in [0, 1)$ and it increases with greater heterogeneity. Since fractionalization data does not vary with time, its effect can only be measured through an interaction with the CBNRM dummy variable.

Table 8: Summary Statistics

	Mean	S.D.	Min	Max	Count
Log(ElephantCount)	5.2730	2.3634	0	11.700	1136
Log(GDP$_{pc}$)	6.4762	1.0475	4.7143	9.2613	1131
Log(GNI$_{pc}$)	7.8291	0.8837	5.9789	9.9366	948
Forest Rent	6.2758	6.0887	0.2790	40.200	1122
Protected Area (% of land area)	16.0305	9.3258	0.5265	37.1897	1032
Fractionalization	0.7269	0.1599	0.0582	0.9302	1136
Gov(NoCorruption)	-0.5673	0.5634	-1.8995	1.0033	637
Gov(NoViolence)	-0.4883	0.7690	-2.9948	0.9631	636
Fraser Index of Governance	6.0129	1.1651	2.95	7.64	551
CBNRM	Yes(427)	No (709)			
CITES Ban	Yes(915)	No (221)			
Trophy Hunting	Yes(623)	No(513)			

3.5 Results

3.5.1 Average Effects

The effect of CBNRM programs on elephant populations is identified using a fixed-effects difference-in-differences specification that controls for area-level unobserved heterogeneity. Moreover, the long-term impacts of CBNRM programs are measured through an event-study analysis. The estimating equations are as follows:

$$\log(Y_{ijt}+1) = \beta_1 + CBNRM_{ijt} * \beta_2 + CITES_{jt} * \beta_3 + X_{jt} * \beta_7 + \lambda_t + \omega_i + \epsilon_{ijt} \qquad (10)$$

$$\begin{aligned}\log(Y_{ijt}+1) =& \beta_1 + YrsSinceCBNRM_{ijt} * \beta_2 + YrsBeforeCBNRM_{ijt} * \beta_3 \\ &+ CITES_{jt} * \beta_4 + X_{jt} * \beta_5 + \lambda_t + \omega_i + \epsilon_{ijt}\end{aligned} \qquad (11)$$

where Y_{ijt} is the elephant population at area i in country j in year t, $CBNRM_{ijt}$ indicates whether an area i in country j has a CBNRM project in or around it in year t, $YrsSinceCBNRM_{ijt}$ measures the number of years since the CBNRM project was implemented, and $YrsBeforeCBNRM_{ijt}$ measures the number of years before the project was implemented. $CITES_{jt}$ is an indicator for whether ivory export was disallowed in country j in year t, X_{jt} includes country-year covariates, λ_t are year dummies, and ω_i denotes area fixed effects in Tables 9 and 10.

Table 9: Fixed-effects Difference-in-differences Analysis

	(1) Log(Eleph+1)	(2) Log(Eleph+1)	(3) Log(Eleph+1)	(4) Log(Eleph+1)	(5) Log(Eleph+1)	(6) Log(Eleph+1)
CBNRM	0.344**	0.362**	0.341**	0.364**	0.232	0.235
	(0.167)	(0.165)	(0.167)	(0.163)	(0.281)	(0.279)
CITES Ban		-0.333		-0.473**		-0.660*
		(0.209)		(0.220)		(0.339)
Log(GDP$_{pc}$)			0.250	0.384*	-0.0657	-0.0759
			(0.227)	(0.232)	(0.479)	(0.477)
Forest Rent					0.0342	0.0212
					(0.0515)	(0.0535)
Gov(NoCorruption)					-0.366	-0.218
					(0.313)	(0.338)
Gov(NoViolence)					0.0401	-0.0234
					(0.271)	(0.282)
Constant	6.748***	6.652***	5.110***	4.084***	5.450	6.267*
	(0.352)	(0.359)	(1.514)	(1.571)	(3.397)	(3.443)
Observations	1136	1136	1131	1131	631	631
Adjusted R^2	0.071	0.075	0.073	0.081	0.041	0.044

Standard errors in parentheses

FE Diff in Diff. All Specs include Year Dummies

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 10: Fixed-effects Event-time Analysis

	(1) Log(Eleph+1)	(2) Log(Eleph+1)	(3) Log(Eleph+1)	(4) Log(Eleph+1)	(5) Log(Eleph+1)	(6) Log(Eleph+1)
Years Since CBNRM	-0.0249	-0.0249	-0.0271	-0.0275	0.0906*	0.0854*
	(0.0294)	(0.0294)	(0.0287)	(0.0286)	(0.0477)	(0.0507)
Years Before CBNRM	0.0324	0.0243	0.0470*	0.0299	-0.0862	-0.0853
	(0.0202)	(0.0282)	(0.0249)	(0.0290)	(0.0602)	(0.0598)
CITES Ban		-0.142		-0.369		-0.342
		(0.304)		(0.315)		(0.472)
Log(GDP_{pc})			0.453	0.572*	-0.940	-0.954
			(0.327)	(0.340)	(0.621)	(0.623)
Forest Rent					0.0390	0.0243
					(0.0708)	(0.0783)
Gov(NoCorruption)					0.173	0.249
					(0.403)	(0.416)
Gov(NoViolence)					-0.117	-0.123
					(0.354)	(0.359)
Constant	6.444***	6.525***	3.209	2.566	11.80***	12.33***
	(0.349)	(0.414)	(2.432)	(2.471)	(4.523)	(4.621)
Observations	600	600	600	600	371	371
Adjusted R^2	0.076	0.075	0.082	0.083	0.057	0.055

Standard errors in parentheses
FE Event Time Analysis with Placebo. All Specs include Year Dummies
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

The results from the fixed-effects specification shows that the effect of CBNRM on elephant populations is positive, with a park having such a project containing approximately 40% more elephants compared to one without a CBNRM project. The event-study analysis further indicates that the effect of CBNRM programs increases over time, with each additional year of existence of the project increasing the count of elephants by 9%, while the placebo coefficient testing the effect of years leading up to a CBNRM project not being statistically significant. Conversely, the ban on international ivory trade has negative effects on elephant counts.

3.5.2 Heterogeneous Effects

To identify heterogeneous impacts, the empirical approach is a difference-in-differences estimation of change in elephant populations at survey areas that have CBNRM programs situated around them and those that do not. See Hansen (2007) for an exposition on the method. The estimating equation is

$$\begin{aligned}\log(Y_{ijt}+1) =&\beta_1 + CBNRM_{ijt} * \beta_2 + CBNRM_{ijt} * CITES_{jt} * \beta_3 + CITES_{jt} * \beta_4 \\ &+ CBNRM_{ijt} * Frac_j * \beta_5 + CBNRM_{ijt} * TrophyEleph_j * \beta_6 \\ &X_{jt} * \beta_7 + \lambda_t + \omega_i + \epsilon_{ijt}\end{aligned} \tag{12}$$

where Y_{ijt} is the elephant population at area i in country j in year t, $CBNRM_{ijt}$ indicates whether an area i in country j has a CBNRM project in or around it in year t, $CITES_{jt}$ is an indicator for whether ivory export was disallowed in country j in year t, $Frac_{jt}$ is the level of ethno-linguistic fractionalization in country j, $TrophyEleph_j$ is an indicator for whether trophy hunting of elephants is permitted in country j, X_{jt} includes country-year covariates, and λ_t and ω_i are year and area fixed effects, respectively.

Table 11: Heterogeneous effects of CBNRM (Unrestricted Sample)

	(1) Log(Eleph+1)	(2) Log(Eleph+1)	(3) Log(Eleph+1)	(4) Log(Eleph+1)
CBNRM	1.182	1.182	0.883	0.883
	(1.626)	(1.315)	(1.239)	(1.249)
CBNRM#CITESBan	0.917**	0.917	1.151*	1.151*
	(0.437)	(0.588)	(0.598)	(0.603)
CBNRM#Fractionalization	-2.209	-2.209	-1.957	-1.957
	(1.983)	(1.791)	(1.698)	(1.712)
CBNRM#TrophyHuntingEleph	0.155	0.155	-0.0402	-0.0402
	(0.545)	(0.551)	(0.518)	(0.522)
Fraser Index of Governance	0.0265	0.0265	0.190	0.190
	(0.229)	(0.238)	(0.248)	(0.250)
Log(GNIpc)	1.258	1.258	0.915	0.915
	(0.932)	(0.783)	(0.776)	(0.782)
Protected Area (% of land area)	-0.0361	-0.0361	-0.0604	-0.0604
	(0.0751)	(0.0734)	(0.0680)	(0.0685)
Forest Rent (% of GDP)	0.104**	0.104**	0.0553	0.0553
	(0.0457)	(0.0469)	(0.0557)	(0.0561)
CITES Ban			-1.338*	-1.338*
			(0.763)	(0.769)
Constant	-5.182	-5.182	-1.275	-1.113
	(7.758)	(6.788)	(7.132)	(7.182)
Observations	459	459	459	359
Adjusted R^2	-1.738	0.091	0.112	0.099

Standard errors in parentheses; * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$; All specifications include year dummies and Area FEs

Column 1: No CITES Ban Dummy, No Robust SEs; Column 2: No CITES Ban Dummy, Robust SEs

Column 3: CITES Ban Dummy, Robust SEs

Column 4: Column 3 regression restricted to areas with observations for more than one year.

Table 12: Heterogeneous effects of CBNRM (Sample restricted to reliable surveys)

	(1) Log(Eleph+1)	(2) Log(Eleph+1)	(3) Log(Eleph+1)	(4) Log(Eleph+1)
CBNRM	1.685	1.685	1.500	1.500
	(1.348)	(1.134)	(1.112)	(1.121)
CBNRM#CITESBan	-0.122	-0.122	0.0630	0.0630
	(0.424)	(0.427)	(0.427)	(0.431)
CBNRM#Fractionalization	-1.504	-1.504	-1.422	-1.422
	(1.667)	(1.375)	(1.361)	(1.371)
CBNRM#TrophyHuntingEleph	-0.693	-0.693**	-0.739**	-0.739**
	(0.514)	(0.312)	(0.324)	(0.326)
Fraser Index of Governance	0.0624	0.0624	0.171	0.171
	(0.228)	(0.191)	(0.198)	(0.199)
Log(GNIpc)	1.232	1.232**	0.987	0.987
	(0.932)	(0.623)	(0.650)	(0.655)
Protected Area (% of land area)	-0.0999	-0.0999*	-0.105*	-0.105*
	(0.0661)	(0.0562)	(0.0547)	(0.0551)
Forest Rent (% of GDP)	0.0618	0.0618**	0.0262	0.0262
	(0.0418)	(0.0289)	(0.0254)	(0.0256)
CITES Ban			-0.810*	-0.810*
			(0.468)	(0.471)
Constant	-3.544	-3.544	-0.994	-0.766
	(7.917)	(5.500)	(5.847)	(5.867)
Observations	350	350	350	292
Adjusted R^2	-1.486	0.174	0.181	0.170

Standard errors in parentheses; * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$; All specifications include year dummies and Area FEs

Column 1: No CITES Ban Dummy, No Robust SEs; Column 2: No CITES Ban Dummy, Robust SEs

Column 3: CITES Ban Dummy, Robust SEs

Column 4: Column 3 regression restricted to areas with observations for more than one year.

The multiple specifications show the effects of: (1) including the CITES ban dummy in the specification in Columns 3 and 4, (2) including robust standard errors in Column 2, 3 and 4 and (3) including only those areas which have elephant counts for more than one year. Since area fixed effects are included in the specifications, Columns 3 and 4 have the same coefficients with slightly different standard errors. Column 3 in Table 12 includes results from reliable surveys only and has the highest adjusted R^2.

Alternative specifications focusing on different regions and using unadjusted elephant counts are reported in Appendix B (Tables 23, 24 and 25). Specifications testing for the different interaction effects in isolation are also included in Appendix B (Tables 26, 27 and 28).

3.6 Conclusions

The pooled OLS and fixed-effects difference-in-differences analyses show that on average CBNRM has positive effects which are not statistically significant when country-level covariates are included. The event-study analyses, on the other hand, reveal that the positive effects of CBNRM projects emerge over time, pointing towards the long-term benefits of these programs on elephant populations.

The analyses of heterogeneous impacts reveal that the positive impacts of CBNRM are mitigated as the level of ethno-linguistic fractionalization of a country increases. Intuitively, this indicates that it is more difficult to reap benefits of CBNRM if the project involves negotiating with more heterogeneous groups of people with different tastes and preferences. Moreover, the benefits of CBNRM are also mitigated by top-down policies like the CITES ban on international ivory trade.[24]

Joint hypothesis tests can help to draw meaningful conclusions regarding the magnitude of the effect of CBNRM on elephant populations conditional on values of the covariates interacting with the CBNRM dummy. For instance, if a country is a signatory to the CITES ban on international ivory trade, has a fractionalization level that is one standard deviation less than the mean ($Frac_j = 0.56$), and allows trophy hunting of elephants, the effect of CBNRM is positive and significant at the 10 percent level.[25] The net effect of a CBNRM project is a 2.9 percent increase in elephant counts.

The coefficients on other controls are in the expected directions. Higher GNI, better

[24]Looking at the impact of the CITES ban on ivory trade, the coefficient on the CITES ban dummy is negative and significant at the 10% level, and the interaction term indicates that this effect is somewhat mitigated in the presence of CBNRM activities.

[25]The null hypothesis is $H_0 : \beta_2 + \beta_3 + \beta_5 * 0.56 + \beta_6 = 0$ where β's represent coefficients from esimation equation (1).

governance, and higher forest rent (as a share of GDP) are associated with higher elephant populations, but the coefficients are not statistically significant. A one percent increase in share of land classified as Protected Area is associated with a 10.5 percent decrease in elephant populations, and this is significant at the 10 percent level.

Taken together, the results suggest that top-down measures like a ban on international ivory trade or designating land as Protected Area (which severely limits rights to benefit from forest resources) has a detrimental effect on elephant populations. CBNRM, as currently implemented, has had positive impacts. The magnitude of the impact is, however, lesser with higher heterogeneity in a country's social structure. The positive impact of CBNRM is lower in countries that allow trophy hunting, although the effect of trophy hunting alone is not interpretable in the current analysis because there is no temporal variation in the legal status of trophy hunting making it perfectly collinear with area fixed effects.

This analysis is the first step towards developing a strong empirical analysis of the effect of community-based programs on wildlife populations. Future work should focus on developing geo-spatial linkages between distinct elephant herds and contiguous community lands implementing benefit-sharing or devolution of property rights over wildlife. The linked data should also take into account the fractionalization of particular communities and institutional factors at a disaggregated level to have a better understanding of the intricacies of CBNRM projects. While current research is restricted mostly to field surveys and case studies at specific project sites, more comprehensive empirical analyses could lead to a better understanding of the big picture in terms of how this approach has performed over the last three decades.

4 Priming and Pro-social Behavior in Qatar[26]

4.1 Introduction

Non-pecuniary behavioral nudges designed to affect economic decisions and increase social welfare is now well recognized and commonly used by policymakers all over the world (Bank, 2014). In environment and energy policy in particular, the number of behavioral interventions has increased exponentially over the last two decades. Many seminal articles in this literature have focused on interventions in western and developed countries,[27] with relatively less attention being paid to how behavioral interventions can be adapted to suit different institutional and cultural norms.

Against this backdrop, this chapter reports the effectiveness of using messages priming different aspects of Qatari individuals' identity on increasing pro-social behavior; (i) religious values and (ii) national pride. The experiment's results are meant to inform priors regarding the effectiveness of similar priming messages that are currently being delivered in a randomized control trial on residential energy use in Qatar.

Charitable giving is a measure of pro-social behavior that has been tried and tested in both laboratory and field experiments. Within the context of the massive body of literature on charitable giving, this chapter examines the effects of priming. Benjamin et al. (2010) forms the basis for testable hypotheses by developing a simple theoretical model predicting the marginal effects of priming social category on preferences. In a later paper, the authors find that religious priming affects voluntary contributions to a public good (Benjamin et al., 2016). Lambarraa and Riener (2015) finds that individuals increase donations when religious identity is made salient. Kessler and Milkman (2016) shows evidence that appeals priming an individual's identity as a previous donor to a charity or as a

[26]I would like to thank Michael Price and Ahmed Khalifa for their guidance on this project. This research was made possible through grant number NPRP9-232-5-026 from the Qatar National Research Fund, Qatar Foundation. The statements and opinions expressed herein are those of the author's alone and do not necessarily reflect those of Qatar Foundation.

[27]See for example Allcott (2011); Allcott and Rogers (2014); Jessoe and Rapson (2014); Ferraro and Price (2013); Ayres et al. (2013); Schultz et al. (2007).

member of a local community generate more donations.

This experiment contributes to that body of work on three fronts. First, we use more direct religious primes than Benjamin et al. (2016). Instead of having subjects unscramble sentences containing words with a religious connotation, we use a passage taken directly from the Quran. Second, in addition to the religious prime, we also test the effect of priming national identity using a quote from the founder of Qatar emphasizing the importance of charity in the region. Finally, this is the first study of its kind in Qatar and builds evidence on the effect of priming in non-Western social and cultural contexts.

4.2 Experiment Design

A total of 226 subjects were invited to a computer laboratory in Qatar University to participate in experiments that were operationalized using zTree version 4.6.1 (Fischbacher, 2007). Out of the 226 subjects, 211 were recruited from the population of students and staff in Qatar University. This is referred to as the "QU Sample" in the analysis. The remaining 15 subjects participated from a sample of customers of the major utility company in Qatar who had previously responded to a telephonic survey. The experiments were run over March and April, 2019.

In each session, before beginning the experiment, subjects were requested to sign consent forms. They were provided instructions for the experiment which were projected on a screen and also read out to them in Arabic and English. The English version of the instructions are included in Appendix C.

Each subject participated in three choice tasks: (i) a dictator game where subjects had the choice to donate any part of a given endowment to a well-known charitable organization in Qatar, (ii) a risk-preference elicitation task (Eckel and Grossman, 2002), and (iii) a time-preference elicitation task where subjects indicated their preference over smaller-sooner or larger-later amounts of money – with a delay of three months and the sooner payment varying between "today" and "1 month from today" (Meier and Sprenger, 2010).

The specific choices and payoffs in the second and third task are specified in Tables 29 and 30 in Appendix C.

The stakes for each task are designed to be similar in expectation. After subjects had completed all their choices, one of the three tasks was selected randomly to determine their earnings from the experiment. If the dictator game was selected, the subject received the amount they had decided to keep, and the donation indicated by them was made to the charity. If the risk-preference task was selected, the smaller or larger amount corresponding to the option chosen by the subject was chosen randomly. Finally, if the time preference task was selected, one of the 20 rows was chosen at random and the subject received the earnings (at the time delay, if any) corresponding to their choice in the randomly chosen row.

In the dictator game, subjects had an endowment of 150 Qatari Rials (QR)[28] and asked to indicate how much of that endowment they wanted to donate. A between-subject design was used to identify differences in charitable contributions among individuals who saw either (i) a religious message containing a passage in the Qu'ran that emphasizes the norm of charitable donation in Islam, or (ii) a message priming national identity and the importance of charity in Qatar from the founder of the state of Qatar – Sheikh Jassim bin Mohammed Al Thani, or (iii) no message.

Figure 8: Religious Message

254. O you who believe! Spend of that with which We have provided for you, before a Day comes when there will be no bargaining, nor friendship, nor intercession. And it is the disbelievers who are the *Zâlimûn* (wrong-doers).

يَٰٓأَيُّهَا ٱلَّذِينَ ءَامَنُوٓاْ أَنفِقُواْ مِمَّا رَزَقْنَٰكُم
مِّن قَبْلِ أَن يَأْتِيَ يَوْمٌ لَّا بَيْعٌ فِيهِ وَلَا خُلَّةٌ
وَلَا شَفَٰعَةٌ وَٱلْكَٰفِرُونَ هُمُ ٱلظَّٰلِمُونَ ٢٥٤

[28]At the time, the exchange rate between Qatari Rial (QR) and US Dollars was QR3.64 = $1.

Figure 9: National Identity Message

After completing all choices in the experiment, subjects were requested to fill out a survey that included demographic questions as well as questions regarding beliefs about relative energy use (Byrne et al., 2018), their attitudes toward anthropogenic climate change, and the energy savings of several technologies (Attari et al., 2010). Additionally, subjects were given an incentive of QR 20 to provide the most recent copy of their electricity bill.

4.3 Results

As Figure 10 and Table 13 show, the average donation by subjects who saw the religious message was higher than that of subjects in the control group. Subjects who saw the national identity message also donated more on average than the control group, but less than the religious message treatment.

Figure 10: Average Donation by Treatment

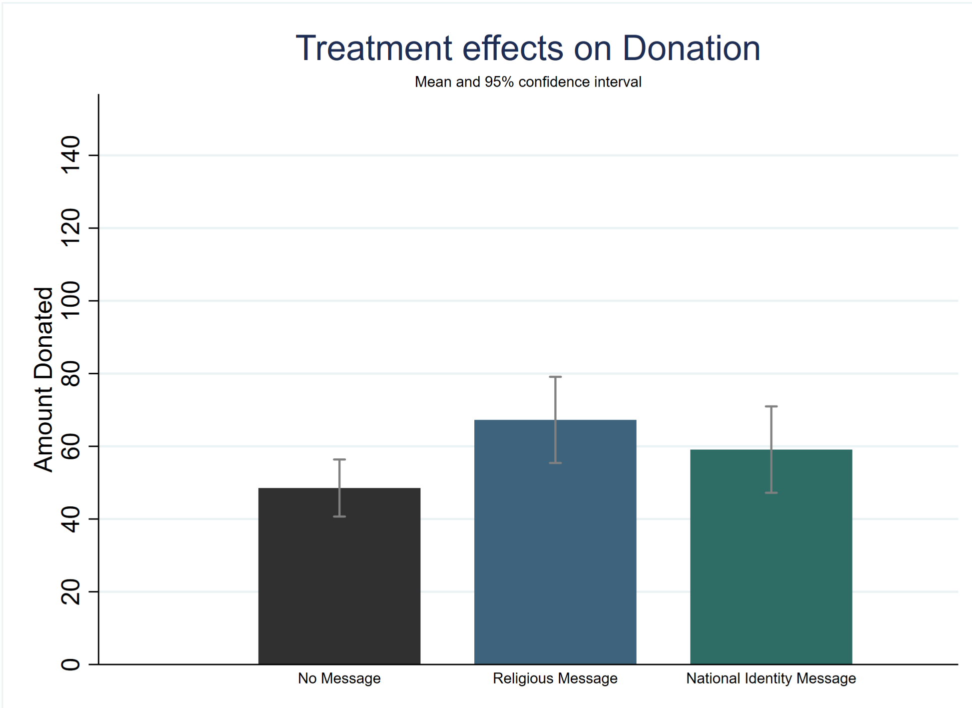


Table 13: Summary Statistics of Donation by Treatment

	Full Sample	Full with demographics	QU Sample	QU with demographics
No Message				
Average Donation	48.53	48.21	46.24	45.83
S.D.	(3.981)	(4.102)	(3.809)	(3.927)
Num. of Subjects	[94]	[91]	[90]	[87]
Religious Message				
Average Donation	67.26	66.88	65.10	65.86
S.D.	(6.012)	(6.498)	(6.197)	(6.791)
Num. of Subjects	[69]	[58]	[61]	[51]
National Identity Message				
Average Donation	59.10	58.53	58.38	58.53
S.D.	(6.028)	(6.598)	(6.107)	(6.598)
Num. of Subjects	[63]	[53]	[60]	[53]
Total Num. of Subjects	226	202	211	191

These overall results are further analyzed using OLS and two-limit Tobit regressions in Tables 14 through 17. In Column (2) of each table, individuals' degree of risk seeking (identified from the risk task) and an indicator for whether they are present-biased (identified from the time preference task) are included as covariates. In Column (3), (4), and (5), the sample is restricted to those individuals who provided demographic information on gender, education, religion, residence type (flat or villa), and nationality.

Table 14: Average Effects of Treatment on Donation (Full Sample)

	(1) Full	(2) Full	(3) Full with demog.	(4) Full with demog.	(5) Full with demog.
Religious Message	18.73**	18.34**	18.67**	21.86***	21.93***
	(7.211)	(7.306)	(7.683)	(7.880)	(7.897)
National Identity Message	10.56	9.676	10.32	11.87	10.42
	(7.220)	(7.507)	(7.762)	(8.032)	(8.512)
Degree of Risk Seeking		1.226			1.504
		(2.175)			(2.386)
Present Bias		-6.993			-7.351
		(7.812)			(7.692)
Female				5.399	7.123
				(7.457)	(7.698)
Non-Muslim				-46.91***	-46.81***
				(9.746)	(9.894)
Villa Resident				-9.674	-9.234
				(7.451)	(7.516)
Qatari National				19.33**	17.90**
				(7.602)	(7.755)
Education				4.523	4.426
				(3.043)	(3.062)
Constant	48.53***	46.63***	48.21***	29.29**	26.68**
	(3.986)	(7.159)	(4.110)	(11.71)	(12.74)
Observations	226	226	202	202	202
R^2	0.031	0.035	0.031	0.081	0.086

Robust standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 15: Tobit Average Marginal Effects (Full Sample)

	(1) Full	(2) Full	(3) Full with demog.	(4) Full with demog.	(5) Full with demog.
Religious Message	21.92**	21.50**	21.39**	24.87***	25.04***
	(8.617)	(8.687)	(9.102)	(9.260)	(9.247)
National Identity Message	12.47	11.40	11.90	14.08	12.30
	(8.472)	(8.773)	(9.042)	(9.302)	(9.845)
Degree of Risk Seeking		1.797			2.180
		(2.625)			(2.831)
Present Bias		-8.374			-8.440
		(9.203)			(9.088)
Female				5.183	7.359
				(8.663)	(8.902)
Non-Muslim				-47.39***	-46.82***
				(11.81)	(11.90)
Villa Resident				-9.063	-8.496
				(8.724)	(8.784)
Qatari National				21.99**	20.10**
				(8.884)	(9.025)
Education				5.117	4.938
				(3.625)	(3.643)
Observations	226	226	202	202	202

Robust standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 16: Average Effects of Treatment (QU Sample)

	(1) QU	(2) QU	(3) QU with demog.	(4) QU with demog.	(5) QU with demog.
Religious Message	18.85**	18.81**	20.04**	23.87***	24.19***
	(7.272)	(7.409)	(7.837)	(7.838)	(7.866)
National Identity Message	12.14*	11.66	12.70*	15.19*	14.12*
	(7.194)	(7.501)	(7.673)	(7.864)	(8.368)
Degree of Risk Seeking		1.478			2.153
		(2.195)			(2.450)
Present Bias		-3.915			-4.579
		(7.988)			(7.880)
Female				7.534	9.102
				(7.464)	(7.684)
Non-Muslim				-40.18***	-39.21***
				(9.068)	(8.960)
Villa Resident				-6.719	-6.415
				(7.260)	(7.290)
Qatari National				21.68***	20.19***
				(7.538)	(7.683)
Education				4.916	4.788
				(3.033)	(3.051)
Constant	46.24***	43.05***	45.83***	20.60*	15.96
	(3.815)	(7.114)	(3.935)	(11.42)	(12.18)
Observations	211	211	191	191	191
R^2	0.034	0.038	0.038	0.110	0.116

Robust standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 17: Tobit Average Marginal Effects (QU Sample)

	(1) QU	(2) QU	(3) QU with demog.	(4) QU with demog.	(5) QU with demog.
Religious Message	21.59**	21.62**	22.62**	26.78***	27.31***
	(8.519)	(8.646)	(9.167)	(9.096)	(9.111)
National Identity Message	14.07*	13.52	14.59	17.80*	16.50*
	(8.305)	(8.620)	(8.850)	(9.028)	(9.582)
Degree of Risk Seeking		2.098			2.958
		(2.583)			(2.867)
Present Bias		-4.474			-5.024
		(9.250)			(9.157)
Female				7.783	9.766
				(8.536)	(8.753)
Non-Muslim				-39.10***	-37.48***
				(10.89)	(10.68)
Villa Resident				-5.405	-5.051
				(8.425)	(8.452)
Qatari National				24.53***	22.61**
				(8.699)	(8.817)
Education				5.477	5.271
				(3.560)	(3.575)
Observations	211	211	191	191	191

Robust standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

The main results from the tables above are as follows:

Result 1: The religious message causes a statistically significant increase in donations in all specifications. The effect gets stronger as controls are included.

Result 2: The national identity message has positive effects on average, but statistically significant only in the sample of individuals recruited from Qatar University The effect gets stronger as controls are included.

Result 3: Qatari nationals and Muslims donate more on average.

4.4 Discussion

The experiment shows that priming religious values has strong positive impacts on pro-social behavior in Qatar, as measured by individuals' decision to contribute to a charity. This suggests that fundraising organizations in Islamic societies can use messages priming religious value to increase charitable contributions. In the context of earlier literature, the study shows that direct messages from the Quran are effective in increasing giving to a real charity whereas (Benjamin et al., 2016) find that giving to a paired recipient in the experiment does not change due to their religious prime instrument.

Additionally, the results of this experiment can inform priors regarding the effects of similar primes on energy conservation, which is a different domain of pro-social behavior. A particularly interesting aspect of energy use in Qatar is that Qatari nationals do not pay for the electricity. This allows the field experiment to block the cost-saving channel of response to behavioral interventions designed to reduce energy use.On April 30 2019, the first round of text messages were sent out to around 5,000 households in Qatar. The households were equally split into two treatment groups, (i) a message priming religious motivations to use less electricity, and (ii) a message priming national identity stating that Qatar's vision is to reduce emissions from burning fossil fuels. Given the findings in the laboratory experiment, and assuming that the effects on charitable giving occur in the same direction as energy conservation, the religious message is expected to affect a significant reduction in energy use.

5 Conclusion

The three chapters in this dissertation demonstrate that appropriately designed incentives and non-pecuniary nudges have a significant role to play in increasing pro-social behavior and mitigating social dilemmas. However, effects of incentives and nudges can depend crucially on institutional structure, cultural norms, and individual behavioral types. Explicitly identifying the margins on which treatments have heterogeneous effects on behavior can help policymakers tailor programs to groups or contexts in ways that make them more effective.

Several studies on the mitigation of social dilemmas using laboratory experiments lend themselves readily to replication using artefactual and framed field experiments providing promising avenues to build evidence on the external validity. With the proliferation of designing and testing nudges in specific contexts, one promising avenue of research that has gained some attention is the spillover effects of nudges across different decision domains. Another avenue of research that should be explored more is the application of experimental methods to understand firm behavior. For example, in terms of mitigating pollutant emissions, firms often have much higher levels of emissions than individual consumers. So, moderate percentage reductions in emissions by firms would have much larger environmental impacts.

Randomization is well understood as the perfect instrumental variable to identify and measure the causal effects of policies and incentive schemes. However, there are cases where randomized experiments cannot be performed or may not be scaled up sufficiently to provide actionable evidence in and of themselves. This should create strong preferences for complementing experimental tools with quasi-experimental empirical analyses to facilitate a deeper, and more generalizable understanding of environmental problems and their potential solutions.

6 Appendices

6.1 Appendix A

Theoretical Model

The expected value from the game is

$$EV_i = p\left[e + h_i + \frac{M}{N}\left[\sum_{j=1}^{N}(h_{max} - h_j)\right] - \alpha f(h_i)\right] + (1-p)\left[e + h_i + \frac{M}{N}\left[\sum_{j=1}^{N}(h_{max} - h_j)\right]\right] \tag{13}$$

Assuming $\frac{\partial h_j}{\partial h_i} = 0$, in the quota regimes given by 2 and 3, differentiating 13 with respect to h_i:

$$\frac{\partial EV_i}{\partial h_i} = 1 - M/N - \alpha p = \frac{N(1-\alpha p) - M}{N} \tag{14}$$

If $1 - \alpha p >, \ = \text{ or } < M/N$, the expected value maximizing harvest level is h_{max}, $h \in \{0, 1, 2, \cdots, 10\}$ or 0, respectively.

In the quota regime given by 4, differentiating 13 with respect to h_i:

$$\frac{\partial EV_i}{\partial h_i} = 1 - M/N + p/N - \alpha p = \frac{N(1-\alpha p) - M + p}{N} \tag{15}$$

If $1 - \alpha p >, \ = \text{ or } < \frac{M-p}{N}$, the expected value maximizing harvest level is h_{max}, $h \in \{0, 1, 2, \cdots, 10\}$ or 0, respectively.

Expected Utility

The corresponding expected utility from the game is

$$EU_i = pU_i\left[e + h_i + \frac{M}{N}\left[\sum_{j=1}^{N}(h_{max} - h_j)\right] - \alpha f(h_i)\right] + (1-p)U_i\left[e + h_i + \frac{M}{N}\left[\sum_{j=1}^{N}(h_{max} - h_j)\right]\right] \tag{16}$$

Assuming $\frac{\partial h_j}{\partial h_i} = 0$, in quota regimes 2 and 3,

$$\frac{\partial EU_i}{\partial h_i} = pU'(A)[1 - M/N - \alpha] + (1-p)U'(B)[1 - M/N] \tag{17}$$

where $A = e + h_i + \frac{M}{N}\left[\sum_{j=1}^{N}(h_{max} - h_j)\right] - \alpha f(h_i)$ *and* $B = e + h_i + \frac{M}{N}\left[\sum_{j=1}^{N}(h_{max} - h_j)\right]$

A is agent i's income level after sanction or reward and B is agent i's income level without sanctions or rewards.

$$\frac{\partial EU_i}{\partial h_i} = [1 - M/N][pU'(A) + (1-p)U'(B)] - p\alpha U'(A)$$

$$= [(N - M)/N][pU'(A) - Np\alpha U'(A) + (1-p)U'(B)]$$

$$= \frac{(N-M)}{N}\left[p(1 - N\alpha)U'(A) + (1-p)U'(B)\right]$$

Now, if $\frac{(N-M)}{N} > 0$, $\frac{\partial EU_i}{\partial h_i} \leq (>)0$ if

$$p(1 - N\alpha)U'(A) + (1-p)U'(B) \leq (>)0$$

$$(1-p)U'(B) \leq (>)p(N\alpha - 1)U'(A) \iff \frac{(1-p)}{p(N\alpha - 1)} \leq (>)\frac{U'(A)}{U'(B)}$$

Since $A < B$, assuming risk averse (seeking) preferences over outcomes, i.e. U"(.) ≤ 0, U'(A) $\geq$ U'(B).

If $p = 0$ (Baseline case with no sanctions), equation 17 implies

$$\frac{\partial EU_i}{\partial h_i} > 0 \ \forall \ h_i$$

So the Nash equilibrium harvest level in the baseline is

$$h_i^* = h_{max} \ \forall \ i \in \{1, 2...N\}$$

If $(p, \alpha) \equiv (1/8, 2)$ or $(p, \alpha) \equiv (1/4, 1)$,

$$\frac{1-p}{p(N\alpha - 1)} = 1 \leq (>) \frac{U'(A)}{U'(B)} \iff U'(A) \geq (<) U'(B)$$

If $(p, \alpha) \equiv (1/4, 2)$,

$$\frac{1-p}{p(N\alpha - 1)} = \frac{3}{7} \leq (>) \frac{U'(A)}{U'(B)} \iff U'(A) \geq (<) U'(B)$$

So, the Nash equilibrium harvest level assuming a risk-averse EU maximizer in the treatments with sanctions is always

$$h_i^* = 0 \; \forall \; i \in \{1, 2...N\}$$

.

In quota regime 4,

$$EU_i = pU_i\left[e + h_i + \frac{M}{N}\left[\sum_{j=1}^{N}(h_{max} - h_j)\right] - \alpha\left(h_i - \frac{\sum_{j=1}^{N} h_j}{N}\right)\right] + (1-p)U_i\left[e + h_i + \frac{M}{N}\left[\sum_{j=1}^{N}(h_{max} - h_j)\right]\right] \tag{18}$$

$$\frac{\partial EU_i}{\partial h_i} = pU'(A)\left[1 - M/N - \alpha\frac{N-1}{N}\right] + (1-p)U'(B)[1 - M/N] \tag{19}$$

$$\frac{\partial EU_i}{\partial h_i} = pU'(A)\left[\frac{N - M + \alpha - N\alpha}{N}\right] + (1-p)U'(B)\left[\frac{N-M}{N}\right] \tag{20}$$

$$\frac{\partial EU_i}{\partial h_i} = \frac{(N-M)}{N}\left[pU'(A) + (1-p)U'(B)\right] - \frac{(N-1)}{N}\alpha pU'(A) \tag{21}$$

$$\frac{\partial EU_i}{\partial h_i} = 1/N\left[(N-M)(pU'(A) + (1-p)U'(B)) - (N-1)\alpha pU'(A)\right] \tag{22}$$

$$\frac{\partial EU_i}{\partial h_i} = 1/N\left[pU'(A)(N - M - (N-1)\alpha) + (1-p)U'(B)(N-M)\right] \quad (23)$$

Now, if $p = 0$, $\frac{\partial EU_i}{h_i} = U'(B)(1 - M/N)$ which is positive since $N > M$. Therefore, in the baseline, $h_i^* = h_{max}$.

If $p = 1/8$, $\alpha = 2$, $N = 4$ and $M = 2$, $\frac{\partial EU_i}{\partial h_i} = 3/2U'(B) - 1/4U'(A) > (=)[<]0 \iff 6U'(B) > (=)[<]U'(A)$. Since $B = A + \alpha(h_i - H_0)$, where $H_0 = \frac{\sum_j^N = 1h_j}{N}$, A can be either less or greater than B depending on the endogenous quota. So the optimal harvest level would depend on others' decisions to harvest and the resultant quota level. The results are similar for $(p = 1/4; \alpha = 1)$ and $(p = 1/4; \alpha = 2)$.

Dual Expected Utility

Using the Dual Expected Utility model (Yaari, 1987) as an alternative to EUT (equation 24), rank alternatives from best to worst, consider the utility function to be linear in payoffs ($U(w) = w$) and transform probabilities using a weighting function $\omega \equiv \omega(p)$, where $\omega(0) = 0$ and $\omega(1) = 1$.

$$DEU_i = \omega_i(1-p).\left[e + h_i + \frac{M}{N}\left[\sum_{j=1}^{N}(h_{max} - h_j)\right]\right] + [1 - \omega_i(1-p)].\left[e + h_i + \frac{M}{N}\left[\sum_{j=1}^{N}(h_{max} - h_j) - \alpha f(h_i)\right]\right] \quad (24)$$

$$\frac{\partial DEU_i}{\partial h_i} = [1 - M/N][\omega_i(1-p)] + [1 - M/N - \alpha][1 - \omega_i(1-p)] \quad (25)$$

$$\frac{\partial DEU_i}{\partial h_i} \leq (>)0 \iff \frac{(N-M)}{N\alpha} \leq (>)[1 - \omega_i(1-p)]$$

If $p = 0$ (Baseline case with no sanctions), equation 25 implies

$$\frac{\partial DEU_i}{\partial h_i} > 0 \ \forall \ h_i$$

So the Nash equilibrium harvest level in the baseline is

$$h_i^* = h_{max} \ \forall \ i \in \{1, 2...N\}$$

If $(p, \alpha) \equiv (1/8, 2)$,

$$\frac{\partial DEU_i}{\partial h_i} = 1/2 + 2[\omega_i(1 - 1/8) - 1]$$

$$\frac{\partial DEU_i}{\partial h_i} \leq (>)0 \iff 1/4 \leq (>)1 - \omega_i(7/8) \iff \omega_i(7/8) \leq (>)3/4 \tag{26}$$

If $(p, \alpha) \equiv (1/4, 1)$,

$$\frac{\partial DEU_i}{\partial h_i} = 1/2 + [\omega_i(1 - 1/4) - 1]$$

$$\frac{\partial DEU_i}{\partial h_i} \leq (>)0 \iff 1/2 \leq (>)1 - \omega_i(3/4) \iff \omega_i(3/4) \leq (>)1/2 \tag{27}$$

If $(p, \alpha) \equiv (1/4, 2)$,

$$\frac{\partial DEU_i}{\partial h_i} = 1/2 + 2[\omega_i(1 - 1/4) - 1]$$

$$\frac{\partial DEU_i}{\partial h_i} \leq (>)0 \iff 1/4 \leq (>)1 - \omega_i(3/4) \iff \omega_i(3/4) \leq (>)3/4$$

In this treatment any $\gamma > 1$ would imply that $h^* = 0$.

Given equations 26 and 27, using a simple one-parameter probability weighting function $\omega(p) = p^\gamma$ which implies risk aversion in the probability space if $\gamma > 1$, there is a possible range of γ over which

$$\left.\frac{\partial DEU_i}{\partial h_i}\right|_{(p=1/8,\alpha=2)} > 0 \ \& \ \left.\frac{\partial DEU_i}{\partial h_i}\right|_{(p=1/4,\alpha=1)} < 0$$

This range is found to be $\gamma \in [2.15, 2.40]$, which implies that over this range of risk aversion in the probability space, $h^* = h_{max}$ in the Baseline and LowC-HighS treatment while $h^* = 0$ in the HighC-LowS and HighC-HighS treatment condition.

Rank Dependent Utility

The Rank Dependent Utility (RDU) model developed in Quiggin (1982) generalizes the expected utility and dual expected utility models by considering transformations over outcomes as well as probabilities. According to this model, the harvest problem is to maximize:

$$RDEU_i = \omega_i(1-p).U_i\left[e + h_i + \frac{M}{N}\left[\sum_{j=1}^{N}(h_{max} - h_j)\right]\right] + [1 - \omega_i(1-p)].U_i\left[e + h_i + \frac{M}{N}\left[\sum_{j=1}^{N}(h_{max} - h_j) - \alpha f(h_i)\right]\right] \quad (28)$$

$$\frac{\partial RDEU_i}{\partial h_i} = [\omega_i(1-p)]U'(B)[1 - M/N] + [1 - \omega_i(1-p)]U'(A)[1 - M/N - \alpha] \quad (29)$$

If $p = 0$ (Baseline case with no sanctions), equation 29 implies

$$\frac{\partial RDEU_i}{\partial h_i} > 0 \ \forall \ h_i$$

So the Nash equilibrium harvest level in the baseline is

$$h_i^* = h_{max} \ \forall \ i \in \{1, 2...N\}$$

If $p = 1/8$ and $\alpha = 2$, equation 29 implies

$$\frac{\partial RDEU_i}{\partial h_i} \geq (<) 0 \iff \omega_i(7/8) \geq (<) \frac{1}{1 + \frac{U'(B)}{3U'(A)}}$$

If $p = 1/4$ and $\alpha = 1$, equation 29 implies

$$\frac{\partial RDEU_i}{\partial h_i} \geq (<) 0 \iff \omega_i(3/4) \geq (<) \frac{1}{1 + \frac{U'(B)}{U'(A)}}$$

If $p = 1/4$ and $\alpha = 2$, equation 29 implies

$$\frac{\partial RDEU_i}{\partial h_i} \geq (<) 0 \iff \omega_i(3/4) \geq (<) \frac{1}{1 + \frac{U'(B)}{3U'(A)}}$$

If $U'(B) = U'(A)$, i.e. marginal utility is constant, then the model reduces to the Dual Expected Utility theory model, and if $\omega_i(p) = p \ \forall p \in [0,1]$ then it reduces to the Expected Utility theory model. However, the general case with RDU preferences can rationalize divergent behavior in the low-probability high-severity and high-probability low-severity cases with a combination of both probability weighting and a moderate degree of risk seeking behavior in the experiment.

Relative Effects of Certainty and Severity in CPR game with sanctions

By finding elasticity of harvest h_i with respect to the certainty and severity parameter values, p and $alpha$,

$$\frac{\partial EU_i}{\partial p} = U_i\left[e + h_i + \frac{M}{N}\left[\sum_{j=1}^{N}(h_{max} - h_j)\right] - \alpha f(h_i)\right] - U_i\left[e + h_i + \frac{M}{N}\left[\sum_{j=1}^{N}(h_{max} - h_j)\right]\right] \quad (30)$$

$$\frac{\partial EU_i}{\partial p} \leq 0 \iff U' \geq 0 \quad (31)$$

$$\frac{\partial EU_i}{\partial \alpha} = -pU_i'\left[e + h_i + \frac{M}{N}\left[\sum_{j=1}^{N}(h_{max} - h_j)\right] - \alpha f(h_i)\right]h_i \quad (32)$$

$$\frac{\partial EU_i}{\partial \alpha} \leq 0 \iff U' \geq 0 \tag{33}$$

Assuming positive marginal utility, an increase in p or α, reduces expected utility.

$$-\frac{\partial EU_i}{\partial p}\frac{p}{EU_i} \geq (\leq) - \frac{\partial EU_i}{\partial \alpha}\frac{\alpha}{EU_i} \tag{34}$$

$$\iff \frac{U_i\left[e+h_i+\frac{M}{N}\left[\sum_{j=1}^{N}(h_{max}-h_j)\right]\right] - U_i\left[e+h_i+\frac{M}{N}\left[\sum_{j=1}^{N}(h_{max}-h_j)\right]-\alpha f(h_i)\right]}{\alpha h_i} \geq (\leq) U_i'\left[e+h_i+\frac{M}{N}\left[\sum_{j=1}^{N}(h_{max}-h_j)\right]-\alpha f(h_i)\right] \tag{35}$$

The term on the left of the equation (L.H.S) is the average change in utility between the outcomes in the reviewed and not-reviewed state while the term on the right (R.H.S) is the marginal utility in the reviewed state. If the agent is risk averse (seeking) then $U''(w) < (>) 0$ and L.H.S $<$ ($>$) R.H.S. Thus, for risk averse agents, conditional on a harvest level h_i, harvest is more responsive to changes in severity of sanctions (α) than to equivalent changes in certainty of review (p).

Effect of Earnings in CPR game on lottery choice in risk task?

Table 18 shows how accumulated earnings in the extraction game affect the probabilities of making each lottery choice in the risk task. The OLS model used to estimate the effect of accumulated earnings in the extraction game on lottery choice in the subsequent risk task is:

$$Y_{ij} = \alpha + \beta EarningsinCPRGame_{ij} + Gender_{ij} + Session_j + \epsilon_{ij}$$

In the OLS model, Y_{ij} is the observed choice in the risk task numbered from 1 through 6. In the ordered logit model, the predicted outcome is an unobserved latent variable, y^*_{ij} representing the risk attitude of subject i in session j. Higher y^*_{ij} represents lower risk aversion.

$Gender_{ij}$ and $Session_j$ indicate the gender of subject i in session j, and session IDs respectively. None of the choices are statistically significantly affected by accumulated earnings in the extraction game, validating the use of observed lottery choices as estimates of individuals' risk attitudes.

Table 18: Effect of Earnings in CPR Game on Lottery Choice in Risk Task

	OLS Coefficients	**Ordered Logit Odds Ratios**[a]
TotalProfit	0.00372	0.00352
	(0.0047)	(0.0052)
Male	0.0574	0.116
	(0.2274)	(0.2517)
Session IDs	Yes	Yes
Constant	1.480	
	(2.2595)	
Observations (Subjects)	256	256

Standard errors in parentheses.

$^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

a: Approximate likelihood-ratio test fails to reject proportionality of odds across response categories: $\chi^2(4) = 2.99; p = 0.5588$.

Instructions

Fixed Quota with Fine

WELCOME!

Please do not talk. If you have a question, please raise your hand and someone will come over to answer you. The decisions you make in this experiment and your earnings will remain anonymous.

TASK 1

In this task, you will be matched with 3 other people to form a group with 4 members. You will make decisions over many rounds and your group members will be chosen randomly at the start of each round. In each round you will be transferring tokens from a shared Group Fund into your Individual Fund. You will earn experimental currency units (ECU) in this task. Your ECUs will be converted into U.S. dollars at the rate 1 ECU = $0.05 at the end of the task.

Rules

In each round, you start with 10 tokens, worth 1 ECU each, in your Individual Fund. Your group starts with 40 tokens, worth 2 ECU each, in the Group Fund. The amount in the Group Fund at the end of each round will be divided equally between all members of your group. A token in your Individual Fund is worth 1 ECU to you alone. A token in the Group Fund is worth 0.50 ECU to you and to each other person in the group, for a total value of 2 ECU in the Group Fund.

Decision

You will decide how many tokens you want to transfer from the Group Fund to your Individual Fund. You can move any number from 0 to 10 tokens into your Individual Fund. For example, suppose you transfer 1 token from the Group Fund to your Individual Fund. Then, the value of the shared Group Fund is reduced by 2 ECU, while the value of your Individual Fund is increased by 1 ECU.

Review

You may see numbers highlighted in blue in the box on the top left, marked "Your decision will be reviewed if 8-sided die roll is". These numbers are picked randomly for each group. After you make your decision in each round, the experimenter will roll an 8-sided die. If the experimenter's die roll matches any one of the numbers displayed, your decision will be reviewed.

If your decision is reviewed, you pay a fine depending on the number of tokens you have moved into your Individual Fund. The amount of the fine increases as you transfer more tokens to your Individual Fund. At the start of each round, you will be informed whether the amount of the fine equals either the number of tokens you transferred, or twice that number. The fine (if any) will be subtracted from your earnings in that round.

Your Earnings

Your earnings from both Individual Fund and Group Fund will be shown after each round. Your earnings in each round will be the value of your Individual Fund plus one-fourth of the value of the Group Fund minus any fine.

- For instance, suppose you and everyone else in your group takes out 3 tokens each from the Group Fund and your decision is NOT reviewed. Then, your earnings will be: [10 + 3] (from Individual Fund) + [80 - (3x2x4)]/4 (from Group Fund) = 13 + 14 = 27 ECU.

- If you and everyone else in your group takes out 3 tokens each, and your group's decision IS reviewed and the fine is the amount you transfer, then your earnings will be: [10 + 3] (from Individual Fund) + [80 - (3x2x4)]/4 (from Group Fund) - (3) (Penalty) = 13 +14 - 3 = 24 ECU.

- If you and everyone else in your group takes out 3 tokens each, and your group's decision IS reviewed and the fine is double the amount you transfer, then your earnings will be: [10 + 3] (from Individual Fund) + [80 - (3x2x4)]/4 (from Group Fund)

- (2x3) (Penalty) = 13 +14 - 6 = 21 ECU.

Your total earnings in this task will be the sum of your earnings in each round.

Variable Quota with Fine

WELCOME!

Please do not talk. If you have a question, please raise your hand and someone will come over to answer you. The decisions you make in this experiment and your earnings will remain anonymous.

TASK 1

In this task, you will be matched with 3 other people to form a group with 4 members. You will make decisions over many rounds and your group members will be chosen randomly at the start of each round. In each round you will be transferring tokens from a shared Group Fund into your Individual Fund. You will earn experimental currency units (ECU) in this task. Your ECUs will be converted into U.S. dollars at the rate 1 ECU = $0.05 at the end of the task.

Rules

In each round, you start with 10 tokens, worth 1 ECU each, in your Individual Fund. Your group starts with 40 tokens, worth 2 ECU each, in the Group Fund. The amount in the Group Fund at the end of each round will be divided equally between all members of your group. A token in your Individual Fund is worth 1 ECU to you alone. A token in the Group Fund is worth 0.50 ECU to you and to each other person in the group, for a total value of 2 ECU in the Group Fund.

Decision

You will decide how many tokens you want to transfer from the Group Fund to your Individual Fund. You can move any number from 0 to 10 tokens into your Individual Fund. For example, suppose you transfer 1 token from the Group Fund to your Individual Fund.

Then, the value of the shared Group Fund is reduced by 2 ECU, while the value of your Individual Fund is increased by 1 ECU.

Review

You may see numbers highlighted in blue in the box on the top left, marked "Your decision will be reviewed if 8-sided dice roll is". These numbers are picked randomly for each group. After you make your decision in each round, the experimenter will roll an 8-sided die. If the experimenter's dice roll matches any one of the numbers displayed, your decision will be reviewed. If your decision is reviewed, you may pay a fine if you have transferred more than the average transfer in your Group in the previous round. The average transfer by your currently assigned group in the previous round will be displayed on your screen. At the start of each round, you will be informed whether the amount of the fine equals either the difference between the number of tokens you have transferred and the average transfer in the previous round, OR twice that difference. The fine (if any) will be subtracted from your earnings in that round.

Your Earnings

Your earnings from both Individual Fund and Group Fund will be shown after each round. Your earnings in each round will be the value of your Individual Fund plus one-fourth of the value of the Group Fund minus any fine.

- For instance, suppose you and everyone else in your group transfers 3 tokens each from the Group Fund and your decision is NOT reviewed. Then, your earnings will be: [10 + 3] (from Individual Fund) + [80 - (3x2x4)]/4 (from Group Fund) = 13 + 14 = 27 ECU.

- Suppose your group's average transfer in the previous round is 1 token. If you and everyone else in your group takes out 3 tokens each, and your group's decision IS reviewed and the fine is the difference between your transfer and the average transfer in the previous round, then your earnings will be: [10 + 3] (from Individual Fund) + [80 - (3x2x4)]/4 (from Group Fund) - (3-1) (Penalty) = 13 +14 - 2 = 25 ECU.

- Suppose your group's average transfer in the previous round is 1 token. If you and everyone else in your group takes out 3 tokens each, and your group's decision IS reviewed and the fine is twice the difference between your transfer and the average transfer in the previous round, then your earnings will be: [10 + 3] (from Individual Fund) + [80 - (3x2x4)]/4 (from Group Fund) - (2x3) (Penalty) = 13 + 14 - 2x(3-1) = 23 ECU.

Your total earnings in this task will be the sum of your earnings in each round.

Variable Quota with Feebate

WELCOME!

Please do not talk. If you have a question, please raise your hand and someone will come over to answer you. The decisions you make in this experiment and your earnings will remain anonymous.

TASK 1

In this task, you will be matched with 3 other people to form a group with 4 members. You will make decisions over many rounds and your group members will be chosen randomly at the start of each round. In each round you will be transferring tokens from a shared Group Fund into your Individual Fund. You will earn experimental currency units (ECU) in this task. Your ECUs will be converted into U.S. dollars at the rate 1 ECU = $0.05 at the end of the task.

Rules

In each round, you start with 10 tokens, worth 1 ECU each, in your Individual Fund. Your group starts with 40 tokens, worth 2 ECU each, in the Group Fund. The amount in the Group Fund at the end of each round will be divided equally between all members of your group. A token in your Individual Fund is worth 1 ECU to you alone. A token in the

Group Fund is worth 0.50 ECU to you and to each other person in the group, for a total value of 2 ECU in the Group Fund.

Decision

You will decide how many tokens you want to transfer from the Group Fund to your Individual Fund. You can move any number from 0 to 10 tokens into your Individual Fund. For example, suppose you transfer 1 token from the Group Fund to your Individual Fund. Then, the value of the shared Group Fund is reduced by 2 ECU, while the value of your Individual Fund is increased by 1 ECU.

Review

You may see numbers highlighted in blue in the box on the top left, marked "Your decision will be reviewed if 8-sided dice roll is". These numbers are picked randomly for each group. After you make your decision in each round, the experimenter will roll an 8-sided die. If the experimenter's dice roll matches any one of the numbers displayed, your decision will be reviewed. If your decision is reviewed, you may pay a fine if you have transferred more than the average transfer in your Group in the previous round. You may get a reward if you have transferred less than the average transfer in your Group in the previous round. The average transfer by your currently assigned group in the previous round will be displayed on your screen. At the start of each round, you will be informed whether the amount of the fine or reward equals either the difference between the number of tokens you have transferred and the average transfer in the previous round, OR twice that difference. The fine (if any) will be subtracted while rewards (if any) will be added to your earnings in that round.

Your Earnings

Your earnings from both Individual Fund and Group Fund will be shown after each round. Your earnings in each round will be the value of your Individual Fund plus one-fourth of the value of the Group Fund minus any fine plus any reward.

- For instance, suppose you and everyone else in your group transfers 3 tokens each from the Group Fund and your decision is NOT reviewed. Then, your earnings will be: [10 + 3] (from Individual Fund) + [80 - (3x2x4)]/4 (from Group Fund) = 13 + 14 = 27 ECU.

- Suppose your group's average transfer in the previous round is 1 token. If you and everyone else in your group takes out 3 tokens each, and your group's decision IS reviewed and the fine/reward is the difference between your transfer and the average transfer in the previous round, then your earnings will be: [10 + 3] (from Individual Fund) + [80 - (3x2x4)]/4] (from Group Fund) - (3-1) (Penalty) = 13 + 14 - 2 = 25 ECU.

- Suppose your group's average transfer in the previous round is 3 tokens. If you and everyone else in your group takes out 1 token each, and your group's decision IS reviewed and the fine/reward is twice the difference between your transfer and the average transfer in the previous round, then your earnings will be: [10 + 1] (from Individual Fund) + [80 - (1x2x4)]/4 (from Group Fund) + (2x2) (Reward) = 11 + 18 + 4 = 33 ECU.

Your total earnings in this task will be the sum of your earnings in each round.

Endogenous Quota with Feebate

WELCOME!

Please do not talk. If you have a question, please raise your hand and someone will come over to answer you. The decisions you make in this experiment and your earnings will remain anonymous.

TASK 1

In this task, you will be matched with 3 other people to form a group with 4 members. You will make decisions over many rounds and your group members will be chosen randomly at the start of each round. In each round you will be transferring tokens from a shared Group Fund into your Individual Fund. You will earn experimental currency units (ECU) in this task. Your ECUs will be converted into U.S. dollars at the rate 1 ECU = $0.05 at the end of the task.

Rules

In each round, you start with 10 tokens, worth 1 ECU each, in your Individual Fund. Your group starts with 40 tokens, worth 2 ECU each, in the Group Fund. The amount in the Group Fund at the end of each round will be divided equally between all members of your group. A token in your Individual Fund is worth 1 ECU to you alone. A token in the Group Fund is worth 0.50 ECU to you and to each other person in the group, for a total value of 2 ECU in the Group Fund.

Decision

You will decide how many tokens you want to transfer from the Group Fund to your Individual Fund. You can move any number from 0 to 10 tokens into your Individual Fund. For example, suppose you transfer 1 token from the Group Fund to your Individual Fund. Then, the value of the shared Group Fund is reduced by 2 ECU, while the value of your Individual Fund is increased by 1 ECU.

Review

You may see numbers highlighted in blue in the box on the top left, marked "Your decision will be reviewed if 8-sided dice roll is". These numbers are picked randomly for each group. After you make your decision in each round, the experimenter will roll an 8-sided die. If the experimenter's dice roll matches any one of the numbers displayed, your decision will be reviewed. If your decision is reviewed, you will pay a fine if you have transferred more than the average transfer level in your Group. You will get a reward if you have transferred less than the average transfer level in your Group. At the start of each round, you will be informed whether the amount of the fine or reward equals either the difference between the number of tokens you have transferred and the average transfer level, OR twice that difference. The fine (if any) will be subtracted while rewards (if any) will be added to your earnings in that round.

Your Earnings

Your earnings from both Individual Fund and Group Fund will be shown after each round. Your earnings in each round will be the value of your Individual Fund plus one-fourth of the value of the Group Fund minus any fine plus any reward.

- For instance, suppose you and everyone else in your group transfers 3 tokens each from the Group Fund and your decision is NOT reviewed. Then, your earnings will be: [10 + 3] (from Individual Fund) + [80 - (3x2x4)]/4 (from Group Fund) = 13 + 14 = 27 ECU.

- Suppose your group's average transfer in the round is 1 token. If you have taken out 3 tokens, and your group's decision IS reviewed and the fine/reward is the difference between your transfer and the average transfer level, then your earnings will be: [10 + 3] (from Individual Fund) + [80 - (4x2)]/4] (from Group Fund) - (3-1) (Penalty) = 13 + 18 - 2 = 29 ECU.

- Suppose your group's average transfer in the round is 3 tokens. If you have taken out 1 token, and your group's decision IS reviewed and the fine/reward is twice the difference between your transfer and the average transfer level, then your earnings will be: [10 + 1] (from Individual Fund) + [80 - (12x2)]/4 (from Group Fund) + (2x(3-1)) (Reward) = 11 + 14 + 4 = 29 ECU.

Your total earnings in this task will be the sum of your earnings in each round.

Risk Task

TASK 2

This is an individual task. No other person's choice will affect your earnings in this task. You will be asked to select ONE out of six different options. The six different options are listed below. You will see the same options on your screen. You can make your choice by clicking the button to the left of your preferred option.

	Heads	**Tails**
Option 1	$1.80	$1.80
Option 2	$1.40	$2.40
Option 3	$1.00	$3.00
Option 4	$0.60	$3.60
Option 5	$0.20	$4.20
Option 6	$0.00	$4.40

Each option has two possible outcomes that each have an equal chance of occurring. After you choose your preferred option, the experimenter will flip a coin to determine the outcome from your chosen option. For example, if you choose Option 3 and the coin toss is Heads, you will earn $1.00 from this task. If coin toss is Tails, you get $3.00. Your earning from this task will be added to your earnings from Task 1 to determine your total earnings for this session.

Please raise your hand if you have any questions.

Results Without Controls

Table 19: RE GLS without Controls

Quota Regime	Fixed Quota Fines Only	Variable Quota Fines Only	Variable Quota Fee-bate	Endogenous Quota Fee-bate
Low-P#High-S (1)	-0.455	0.172	-0.659*	-0.147
	(0.3176)	(0.2218)	(0.2643)	(0.2864)
High-P#Low-S (2)	-1.537***	-0.256	-1.878***	-1.453***
	(0.2789)	(0.2157)	(0.3283)	(0.3377)
(2) - (1)	-1.082***	-0.428***	-1.219***	-1.306***
	(0.2524)	(0.1561)	(0.2820)	(0.2517)
High-P#High-S	-1.870***	-0.167	-1.970***	-1.293**
	(0.3412)	(0.2472)	(0.3164)	(0.4119)
Constant	6.413***	6.227***	6.673***	5.986***
	(0.3158)	(0.3159)	(0.2764)	(0.3694)
Observations	1600	1200	1200	1120

Standard errors in parentheses
$^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Effects by All & Risk Averse Subjects

Table 20: RE GLS: Effects on Harvest on All & on Risk Averse Subjects

Quota Regime Subjects (All/Risk-Averse)	QR1 All	QR2 All	QR3 All	QR4 All	QR1 RA	QR2 RA	QR3 RA	QR4 RA
Deterrence Factors								
Low-P#High-S (1)	-0.681*	-0.489	-1.008**	-0.877*	-0.949**	-0.509	-1.393***	-1.160**
	(0.3174)	(0.3105)	(0.3365)	(0.3968)	(0.3416)	(0.4539)	(0.4159)	(0.4444)
High-P#Low-S (2)	-1.630***	-0.788**	-1.774***	-1.999***	-1.821***	-0.965*	-1.826***	-2.214***
	(0.2870)	(0.2786)	(0.3630)	(0.4188)	(0.3326)	(0.4176)	(0.4076)	(0.5072)
High-P#High-S	-2.102***	-1.095*	-2.427***	-2.490***	-2.482***	-1.375*	-2.477***	-2.814***
	(0.3485)	(0.4615)	(0.5268)	(0.6216)	(0.4044)	(0.6172)	(0.6597)	(0.7471)
Risk Seeking	0.178	0.154	0.253*	0.364*				
	(0.1457)	(0.1810)	(0.1007)	(0.1521)				
Harvest Quota		0.321***	0.429***			0.328***	0.499***	
		(0.0556)	(0.0468)			(0.0772)	(0.0572)	
Reviewed$_{t-1}$	-1.304***	-0.180	0.0784	-0.237	-1.252***	-0.167	0.0483	0.202
	(0.2494)	(0.1539)	(0.2374)	(0.3053)	(0.2919)	(0.1891)	(0.2130)	(0.3414)
Fine$_{t-1}$	0.162***	0.104^{+}	0.172**	0.0902	0.175***	0.0568	0.128	0.0906
	(0.0283)	(0.0631)	(0.0593)	(0.0862)	(0.0350)	(0.0707)	(0.1030)	(0.0947)
Reward$_{t-1}$			-0.0481	-0.0718			-0.0343	-0.0430
			(0.0559)	(0.0931)			(0.0630)	(0.0872)
Accumulated Earnings$_{t-1}$	0.0193*	0.0144	0.0447***	0.0280**	0.0240**	0.0251*	0.0342**	0.0238^{+}
	(0.0082)	(0.0102)	(0.0096)	(0.0108)	(0.0087)	(0.0099)	(0.0111)	(0.0122)
Period	-0.453*	-0.293	-1.023***	-0.608*	-0.580**	-0.529*	-0.753**	-0.501
	(0.1903)	(0.2430)	(0.2429)	(0.2650)	(0.2015)	(0.2282)	(0.2812)	(0.3052)
Demog. Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Session IDs	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1520	1140	1140	1064	1140	722	741	608
Subjects	80	60	60	56	60	38	39	32

Robust standard errors in parentheses
$^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Demographic Summary Statistics

Table 21: Demographic Characteristics of Experimental Sample

	Number	**Proportion**
Gender		
Male	77	30.08%
Female	178	69.53%
Other	1	0.39%
Race		
Asian	46	17.97%
Black or African American	161	62.89%
Hispanic	13	5.08%
Multiracial	8	3.13%
Prefer Not to Answer	6	2.34%
White or Caucasian	22	8.59%
Age		
18-20	164	64.06%
21-23	49	28.13%
24-26	12	4.69%
27-29	3	1.17%
30-35	3	1.17%
Above 35	2	0.78%

Effects of Sanctions and Rewards by Subject Type

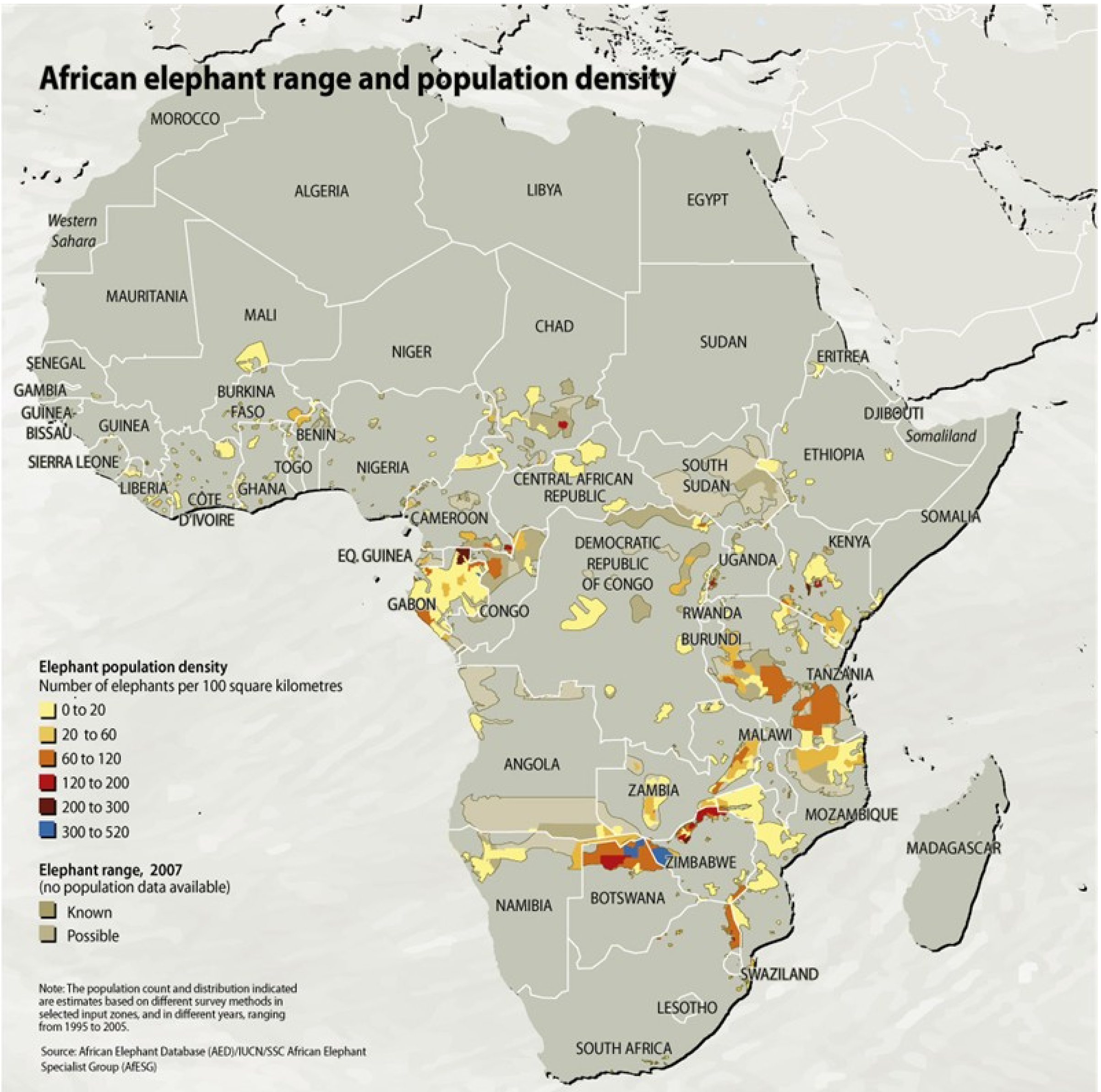
Table 22: Conditional Effects: Heterogeneities by Agent Type

	Fixed Quota Fines Only	Variable Quota Fines Only	Variable Quota Feebate	Endogenous Quota Feebate
Low-P#High-S	-0.465	0.275	-2.454***	-0.269
	(0.4738)	(0.4027)	(0.7457)	(0.5902)
High-P#Low-S	-1.662**	-0.243	-2.386***	-0.439
	(0.5730)	(0.5889)	(0.5159)	(0.7167)
High-P#High-S	-1.646**	-0.184	-2.584***	-1.703**
	(0.5438)	(0.6714)	(0.7262)	(0.6585)
FreeRider	0.609	0.264	1.644***	3.393***
	(0.4335)	(0.3495)	(0.4438)	(0.6735)
Altruist	-2.032**	-1.453**	-1.628+	-0.00406
	(0.6657)	(0.5013)	(0.8403)	(0.7100)
ConditionalCooperator	-0.248	-0.123	0.699*	1.472**
	(0.3006)	(0.3097)	(0.3080)	(0.5250)
Low-P#High-S × FreeRider	-1.947*	-1.420*	1.054	-2.337**
	(0.7621)	(0.6031)	(0.7850)	(0.7868)
Low-P#High-S × Altruist	4.330***	-0.428	1.892**	0.493
	(1.1354)	(0.5505)	(0.7212)	(0.7345)
Low-P#High-S × ConditionalCooperator	0.197	-0.701	1.522+	-0.233
	(0.5633)	(0.4605)	(0.8025)	(0.6828)
High-P#Low-S × FreeRider	-1.090	-1.575*	-0.646	-3.825***
	(0.7671)	(0.6686)	(0.8314)	(0.9105)
High-P#Low-S × Altruist	3.012***	0.416	3.690***	0.440
	(0.7850)	(0.7117)	(0.5416)	(0.7536)
High-P#Low-S × ConditionalCooperator	0.359	-0.307	1.022+	-1.611*
	(0.6930)	(0.6177)	(0.6023)	(0.8027)
High-P#High-S × FreeRider	-2.423**	-1.802**	-1.503+	-2.724**
	(0.8577)	(0.6694)	(0.8196)	(0.8302)
High-P#High-S × Altruist	4.260***	0.211	2.749***	1.140+
	(0.9217)	(0.9443)	(0.4730)	(0.5893)
High-P#High-S × ConditionalCooperator	0.0107	-0.994	0.679	-0.555
	(0.6787)	(0.6213)	(0.7092)	(0.8618)
Baseline Withdrawal	0.585***	0.722***	0.417***	0.414***
	(0.0872)	(0.0952)	(0.1003)	(0.1160)
Risk Seeking	0.0999	-0.0308	0.172*	0.387**
	(0.1148)	(0.1062)	(0.0713)	(0.1237)
Reviewed in t-1	-1.293***	-0.164	-0.00355	-0.170
	(0.2507)	(0.1460)	(0.2384)	(0.2916)
Harvest Quota		0.328***	0.416***	
		(0.0548)	(0.0495)	

Robust standard errors in parentheses
+ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

6.2 Appendix B

Map of African Elephant Range and Population Density



Results for Different Regions

Table 23: Results Excluding West Africa

	(1) log_eleph_adj	(2) log_eleph_adj	(3) log_eleph_adj	(4) log_eleph_adj
CBNRM	0.753	0.753	1.468	1.468*
	(1.567)	(0.860)	(1.336)	(0.822)
CITES Ban	-1.066	-1.066*	-1.018	-1.018**
	(0.738)	(0.512)	(0.710)	(0.455)
CBNRM#CITESBan	1.302***	1.302*	0.469	0.469*
	(0.469)	(0.689)	(0.503)	(0.222)
CBNRM#Fractionalization	-1.810	-1.810	-1.112	-1.112
	(1.910)	(1.433)	(1.645)	(1.027)
CBNRM#TrophyHuntingEleph	-0.00564	-0.00564	-0.863	-0.863***
	(0.559)	(0.437)	(0.535)	(0.246)
Fraser Summary Index of Governance	0.184	0.184	0.0982	0.0982
	(0.240)	(0.239)	(0.254)	(0.146)
Log(GNIpc)	0.628	0.628	0.328	0.328
	(0.934)	(0.575)	(1.010)	(0.529)
Protected Area	-0.0579	-0.0579	-0.121*	-0.121**
	(0.0741)	(0.0458)	(0.0662)	(0.0503)
Forest Rent	0.0756	0.0756***	0.0205	0.0205
	(0.0513)	(0.0223)	(0.0517)	(0.0294)
Area Fixed Effects	YES	YES	YES	YES
Year Fixed Effects	YES	YES	YES	YES
SEs clustered at country level	NO	YES	NO	YES
Surveys included	All	All	Reliable only	Reliable only
Observations	426	426	329	329
Adjusted R^2		0.149		0.209

Standard errors in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 24: Results for Countries in Southern Africa only

	(1) log_eleph_adj	(2) log_eleph_adj	(3) log_eleph_adj	(4) log_eleph_adj
CBNRM	2.263	2.263*	2.808	2.808
	(2.326)	(1.110)	(2.163)	(1.684)
CITES Ban	-1.111	0	-0.493	-1.611
	(1.503)	(.)	(1.472)	(1.183)
CBNRM#CITESBan	2.270*	2.270**	0.485	0.485
	(1.331)	(0.589)	(1.225)	(0.628)
CBNRM#Fractionalization	2.005	2.005	1.694	1.694**
	(3.748)	(1.039)	(2.900)	(0.581)
CBNRM#TrophyHuntingEleph	-3.562	-3.562***	-3.928	-3.928**
	(2.329)	(0.637)	(2.533)	(1.488)
Fraser Summary Index of Governance	-0.592	-0.592**	-0.141	-0.141
	(0.424)	(0.162)	(0.397)	(0.235)
Log(GNIpc)	1.759	1.759	2.943	2.943
	(3.399)	(1.739)	(4.486)	(3.505)
Protected Area	-0.167	-0.167**	-0.185**	-0.185**
	(0.122)	(0.0574)	(0.0917)	(0.0503)
Forest Rent	-0.461	-0.461	-0.0416	-0.0416
	(0.483)	(0.361)	(0.527)	(0.544)
Area Fixed Effects	YES	YES	YES	YES
Year Fixed Effects	YES	YES	YES	YES
SEs clustered at country level	NO	YES	NO	YES
Surveys included	All	All	Reliable only	Reliable only
Observations	223	223	192	192
Adjusted R^2		0.260		0.347

Standard errors in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Results for Unadjusted Log of Elephant Counts

Table 25: Results with unadjusted log(elephant counts)

	(1) log_eleph	(2) log_eleph	(3) log_eleph	(4) log_eleph
CBNRM	1.286	1.286	1.437	1.437*
	(1.455)	(1.152)	(1.245)	(0.700)
CITES Ban	-0.762	-0.762	-0.863	-0.863**
	(0.658)	(0.455)	(0.662)	(0.368)
CBNRM#CITESBan	0.945**	0.945	0.0212	0.0212
	(0.402)	(0.675)	(0.414)	(0.268)
CBNRM#Fractionalization	-2.451	-2.451	-1.350	-1.350
	(1.769)	(1.592)	(1.533)	(0.951)
CBNRM#TrophyHuntingEleph	-0.155	-0.155	-0.782*	-0.782***
	(0.493)	(0.375)	(0.470)	(0.217)
Fraser Summary Index of Governance	0.0616	0.0616	0.184	0.184
	(0.225)	(0.218)	(0.233)	(0.152)
Log(GNIpc)	1.000	1.000*	1.052	1.052*
	(0.847)	(0.540)	(0.878)	(0.603)
Protected Area	-0.0649	-0.0649	-0.105*	-0.105**
	(0.0677)	(0.0564)	(0.0605)	(0.0400)
Forest Rent	0.0810*	0.0810***	0.0259	0.0259
	(0.0472)	(0.0181)	(0.0478)	(0.0250)
Area Fixed Effects	YES	YES	YES	YES
Year Fixed Effects	YES	YES	YES	YES
SEs clustered at country level	NO	YES	NO	YES
Surveys included	All	All	Reliable only	Reliable only
Observations	428	428	324	324
Adjusted R^2		0.135		0.226

Standard errors in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Alternative Specifications

Table 26: Alternative Specifications: Testing for Interaction of CBNRM and CITES Ban

	(1) Log(Eleph+1)	(2) Log(Eleph+1)	(3) Log(Eleph+1)	(4) Log(Eleph+1)	(5) Log(Eleph+1)	(6) Log(Eleph+1)
CBNRM	-0.0883	0.158	0.0723	-0.545*	-0.580	-0.117
	(0.173)	(0.209)	(0.167)	(0.294)	(0.370)	(0.221)
CITES Ban	-0.383*	-0.616**	-0.785**	-0.129	-1.404*	-0.754
	(0.222)	(0.288)	(0.315)	(0.430)	(0.740)	(0.505)
CBNRM#CITESBan	0.258	0.312	0.396*	1.364***	1.167*	0.168
	(0.172)	(0.225)	(0.223)	(0.413)	(0.595)	(0.400)
Fraser Index of Governance				-0.472***	0.119	0.0755
				(0.145)	(0.242)	(0.187)
Log(GNIpc)				1.036***	0.597	0.144
				(0.258)	(0.813)	(0.585)
Protected Area (% of land area)				0.0246	-0.0190	-0.0404
				(0.0173)	(0.0557)	(0.0356)
Forest Rent (% of GDP)				0.131***	0.0498	0.0168
				(0.0349)	(0.0501)	(0.0261)
Area FEs	NO	YES	YES	NO	YES	YES
Constant	5.907***	6.449***	6.530***	-2.483	1.064	5.287
	(0.444)	(0.412)	(0.380)	(2.283)	(7.510)	(5.391)
Observations	1136	1136	720	459	459	350
Adjusted R^2		0.077	0.065		0.110	0.168

Robust standard errors in parentheses
Columns 3 and 6 restrict the sample to reliable surveys only.
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 27: Alternative Specifications: Testing for interaction of CBNRM and Fractionalization

	(1) Log(Eleph+1)	(2) Log(Eleph+1)	(3) Log(Eleph+1)	(4) Log(Eleph+1)	(5) Log(Eleph+1)	(6) Log(Eleph+1)
CBNRM	0.315	0.461	-0.0981	-0.763	1.616	0.841
	(0.346)	(0.400)	(0.368)	(0.747)	(1.416)	(0.970)
CBNRM#Fractionalization	-0.381	-0.159	0.501	0.840	-2.326	-1.139
	(0.477)	(0.533)	(0.479)	(1.101)	(2.033)	(1.341)
Fraser Index of Governance				-0.197	0.238	0.0228
				(0.201)	(0.291)	(0.151)
Log(GNIpc)				0.487**	1.623**	0.562
				(0.212)	(0.730)	(0.544)
Protected Area (% of land area)				0.0327*	-0.0392	-0.0582
				(0.0178)	(0.0752)	(0.0495)
Forest Rent (% of GDP)				0.0701**	0.0668	0.0518
				(0.0300)	(0.0421)	(0.0323)
Area FEs	NO	YES	YES	NO	YES	YES
Constant	6.015***	6.739***	6.206***	0.991	-8.645	1.485
	(0.460)	(0.358)	(0.356)	(2.093)	(6.888)	(4.694)
Observations	1132	1132	719	459	459	350
Adjusted R^2		0.070	0.053		0.068	0.165

Robust standard errors in parentheses
Columns 3 and 6 restrict the sample to reliable surveys only.
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 28: Alternative Specifications: Testing for interaction of CBNRM and Governance

	(1)	(2)	(3)	(4)	(5)	(6)
	Log(Eleph+1)	Log(Eleph+1)	Log(Eleph+1)	Log(Eleph+1)	Log(Eleph+1)	Log(Eleph+1)
CBNRM	-2.051*	-1.424	-2.598*	-2.005*	-1.636	-0.324
	(1.107)	(1.450)	(1.571)	(1.192)	(1.713)	(1.234)
Fraser Index of Governance	-0.415***	-0.160	-0.325	-0.314*	-0.0174	-0.0664
	(0.155)	(0.212)	(0.204)	(0.166)	(0.221)	(0.191)
CBNRM#Governance	0.318*	0.272	0.419*	0.292	0.249	0.0567
	(0.175)	(0.214)	(0.236)	(0.187)	(0.254)	(0.193)
Log(GNIpc)				0.453**	1.145	0.342
				(0.222)	(0.752)	(0.594)
Protected Area (% of land area)				0.0272	0.00638	-0.0370
				(0.0175)	(0.0678)	(0.0356)
Forest Rent (% of GDP)				0.0625**	0.0570	0.0484
				(0.0307)	(0.0406)	(0.0320)
Area FEs	NO	YES	YES	NO	YES	YES
Constant	8.255***	7.617***	6.975***	1.882	-4.325	3.367
	(0.794)	(1.071)	(1.175)	(2.239)	(6.881)	(5.453)
Observations	551	551	405	459	459	350
Adjusted R^2		0.063	0.126		0.064	0.162

Robust standard errors in parentheses
Columns 3 and 6 restrict the sample to reliable surveys only.
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

6.3 Appendix C

Instructions

General Instructions

- Please do not talk among yourselves during this research study. You will participate in computerized tasks. Your decisions in these tasks will determine your earnings.
- These tasks do not require you to have knowledge of "correct" responses. Please make your decisions according to what you would like to choose.
- You have instructions for each task. After you have completed your decisions, one of the tasks that you have participated in will be used to determine your earnings from today's research study.
- Your decisions and your earnings will remain anonymous. No other person participating in this study will be told of your decision or your earnings.
- Please raise your hand if at any point you have any questions, and one of the researchers will come to you and answer your question in private.
- After you have finished the computerized tasks, you will be asked to fill out a questionnaire. After filling out the questionnaire, if you have your electricity bill available, please hand it over to one of the researchers to receive an additional amount of money.

Task 1

In this Task, you have QR 150 allocated to you. Out of this allocation, you can choose how much, if any, to transfer to Qatar Charity.

Please choose any amount you wish to transfer by entering the number. Your earnings from this task will be QR 150 minus the amount you decide to transfer to Qatar Charity.

Task 2

Please choose ONE out of the six Options available on your screen. Each Option represents the chance of earning one of two possible amounts. You can choose an Option by clicking on the box to the left of your preferred option. After you have made your choices, the computer will pick either the orange or the blue column at random. Your earnings from this task will be the number corresponding to the option you have chosen, and the column chosen by the computer.

For example, if you choose Option 5, and the computer picks ORANGE, your earnings from this task will be QR 82.

Task 3

Please choose either the ORANGE or the BLUE column for each decision row. In each row, you choose between a smaller amount of money to be paid sooner and a larger amount of money to be paid later.

Please click the appropriate box to make your choice. After you have made your decision, the computer will randomly select one of the decision rows at random. Your choice for that decision row will determine your earnings for this task.

For example, if the computer chooses decision row 4 at random, and you have selected the ORANGE column in decision row 4, you will receive QR 117 today. If the computer chooses decision row 15 at random, and you have selected the BLUE column in decision row 15, you will receive QR 148 in 4 months.

Risk and Time Preference Choices

Table 29: Risk Task: Payoffs and Implied Intervals of Risk Aversion

x1	x2	EV	r ($U(x) = x^{1-r}/(1-r); r \neq 1$)
138	138	138	r $\leq$ 3.56549
124	160	142	1.9168 $\leq$ r $\leq$ 3.56549
110	182	146	0.719315 $\leq$ r $\leq$ 1.9168
96	204	150	0.51193 $\leq$ r $\leq$ 0.719315
82	226	154	0 $\leq$ r $\leq$ 0.51193
68	240	154	r $\leq$ 0

Table 30: Time Preference Task: Payoffs and Implied Discount Rates

x1	x2	Monthly interest rate	Monthly δ
117	118	0.284900285	0.997167124
117	126	2.564102564	0.975599956
117	133	4.558404558	0.95817479
117	140	6.552706553	0.941931401
117	148	8.831908832	0.92464434
117	155	10.82621083	0.910510003
117	162	12.82051282	0.897202102
117	169	14.81481481	0.884639619
117	176	16.80911681	0.872752426
117	184	19.08831909	0.859915967

Table 31: Outcome donation: Heterogeneous Effects Full Sample

	(1) Nationals	(2) Nationals with Controls
Religious Message	18.70**	21.80**
	(9.453)	(10.38)
National Identity Message	11.79	10.03
	(9.512)	(10.76)
Qatari National=1	16.61**	18.40**
	(7.865)	(9.219)
Religious Message × Qatari National=1	-2.602	-0.433
	(14.42)	(16.33)
National Identity Message × Qatari National=1	-0.609	1.466
	(14.49)	(15.71)
Present Bias=1		-7.164
		(7.421)
Female=1		6.368
		(7.825)
Non-Muslim=1		-48.11***
		(10.36)
Villa Resident=1		-9.271
		(7.822)
Education		4.516
		(3.102)
Constant	39.40***	30.53**
	(5.463)	(12.08)
Observations	219	202
R^2	0.052	0.084

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 32: MEs of Treatment by Nationality

	(1) Nationals	(2) Nationals with Controls
Religious Message		
National=0	18.70**	21.80**
	(9.453)	(10.38)
National=1	16.10	21.36*
	(10.89)	(12.46)
National Identity Message		
National=0	11.79	10.03
	(9.512)	(10.76)
National=1	11.18	11.50
	(10.94)	(12.25)
Observations	219	202

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 33: Outcome donation: Heterogeneous Effects QU Sample

	(1) Nationals	(2) Nationals with Controls
Religious Message	21.54**	25.30**
	(9.029)	(10.08)
National Identity Message	19.12**	16.55
	(9.172)	(10.11)
Qatari National=1	22.99***	23.25***
	(6.999)	(8.766)
Religious Message × Qatari National=1	-5.440	-3.069
	(14.15)	(16.16)
National Identity Message × Qatari National=1	-7.940	-4.326
	(14.28)	(15.28)
Present Bias=1		-4.891
		(7.635)
Female=1		7.995
		(7.842)
Non-Muslim=1		-39.68***
		(9.011)
Villa Resident=1		-6.396
		(7.560)
Education		4.838
		(3.078)
Constant	33.03***	20.49*
	(4.114)	(11.41)
Observations	206	191
R^2	0.078	0.112

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 34: MEs of Treatment by Nationality

	(1) Nationals	(2) Nationals with Controls
Religious Message		
National=0	21.54**	25.30**
	(9.029)	(10.08)
National=1	16.10	22.23*
	(10.89)	(12.44)
National Identity Message		
National=0	19.12**	16.55
	(9.172)	(10.11)
National=1	11.18	12.22
	(10.95)	(12.24)
Observations	206	191

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Figure 11: Histogram of Donation Amounts

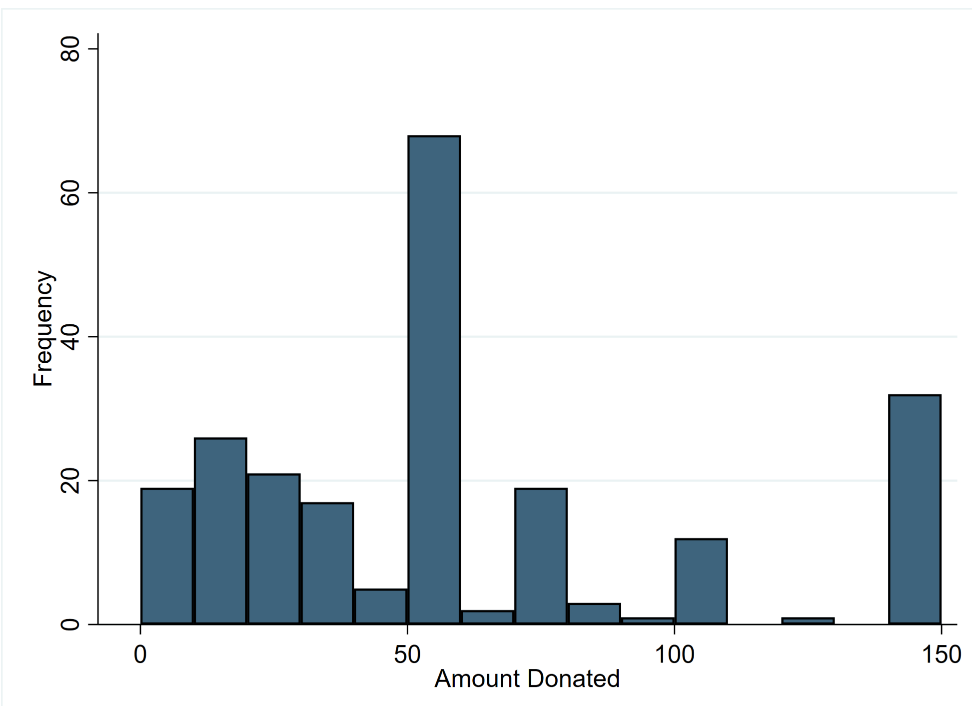
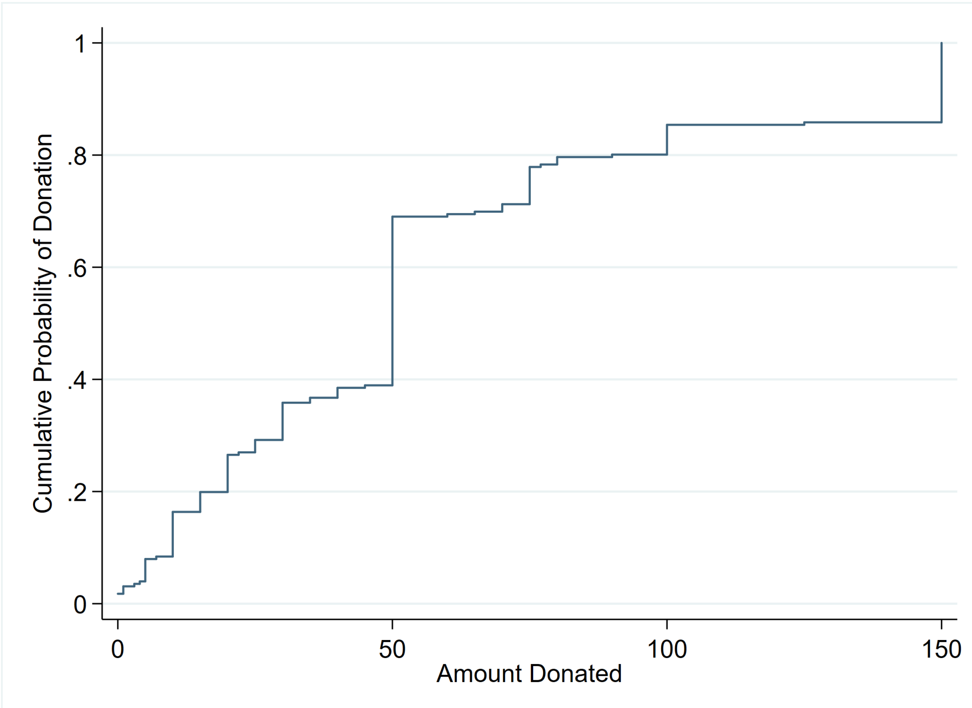


Figure 12: CDF of Donation Amounts



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Vita

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