Corruption, Incentives, and Deterrence in Common Pool Resource Scenarios:

An Experimental Approach

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Abstract

I study corruption as a coordination game and how social costs and collective risk influence individual corruptibility. Corruption is a fundamental issue in developing countries, with the World Bank identifying it as the primary obstacle to economic and social development. The first chapter of my dissertation investigates the various economic theories, such as principal-agent models, that have been employed to analyze corruption. I also discuss an alternative view, framing systemic corruption as a 'collective action problem.' This perspective suggests that corruption is akin to a social trap, where individuals are motivated by the expected strategies of others in society. Unlike incentive-based solutions, addressing corruption as a collective action problem requires destabilizing the corrupt equilibrium for effective anti-corruption policies. My dissertation introduces a novel approach by investigating corruption as a common resource dilemma, emphasizing horizontal interdependencies among individuals engaged in corrupt acts.

The second chapter examines a theoretical model and a novel experiment design inspired by coordination games and voluntary contribution mechanisms to study corruption in the lab. In my experiment, public officials, instead of accepting bribes, engage in petty corruption by stealing from a common pool, leading to a higher payoff but with the risk of being caught. The presence of an auditor tasked with uncovering corrupt officials introduces a risky element, and the number of corrupt officials inversely affects the probability of detection. Theoretical calculations predict two equilibria – one where no one is corrupt and another where everyone is corrupt. Changing the penalties associated with corrupt behavior, I have observed how different groups of individuals gravitate towards different equilibria in controlled laboratory settings.

The third chapter analyzes the incentives associated with current decisions that may alter both future incomes and future opportunities for corruption enrichment (Golden Goose Effect). While the chance of being caught in a specific act may be low, the chance of being caught at any point during a career is much larger and may be significant. Since the act of corruption is a gamble, I use the knowledge of the Golden Goose to design an intertemporal punishment to test if it reduces corruption over all the periods or only in the current period. I observe that there is a displacement effect of corruption from the current to the future period.

The experimental design and theoretical model are discussed, along with the analysis of results, providing insights into risk attitudes, pro-social behavior, and the dynamics of corruption over time. The study offers a comprehensive understanding of corruption, moving beyond traditional economic models and incorporating collective action perspectives for more effective policy recommendations.

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Keywords: Corruption, Game Theory, Experimental Economics, Public Economics, Risk Attitude

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Chapter 1

1. INTRODUCTION

Corruption is one of the fundamental problems plaguing many developing countries. The World Bank declared that it "has identified corruption as the single greatest obstacle to economic and social development." Corruption affects the distribution of wealth and also generates many distortions in an economy. Designing policies to eliminate and alleviate corruption has been a prominent goal for development economists. Economic theory can be used to generate predictions of decisions made by rational individuals.

Corruption occurs when a public servant prioritizes personal gain over the public good. It includes situations where an official exploits their power for self-benefit or to favor their close associates. Also, corruption arises when a policy-maker trades monetary or non-monetary rewards for political backing. Various forms of corruption, such as bribery, embezzlement, clientelism, nepotism, and vote-buying, all stem from this core issue. These acts share two key characteristics: firstly, they involve public officials breaking rules to attain illicit personal benefits, and secondly, they are typically conducted in secrecy.

1.1 Forms of Corruption

"When once a Republic is corrupted, there is no possibility of remedying any of the growing evils but by removing the corruption and restoring its lost principles; every other correction is either useless or a new evil." – Thomas Jefferson

This section aims to provide a clear definition of corruption and its different forms. By doing so, the chapter lays the groundwork for the detailed examination and analysis that will make up the main part of my doctoral study. This foundational understanding is essential for readers to comprehend the background and intricacies of the research findings that will be presented in later sections of the thesis.

The word corruption has its roots in the Latin term "corruptus," and it has always referred to a state of moral decay and ethical erosion. Initially, corruption was used to describe the debasement of something pure, including ideals, language, and even bloodlines. As societies evolved, the term began to focus on the public sphere, and it referred to the abuse of entrusted power for private gain. Over time, the definition of corruption has changed to reflect the complexities of societal norms and legal frameworks that define corrupt behavior. Today, corruption is a broad spectrum term that ranges from grand political corruption to everyday bureaucratic graft. Corruption is deeply entangled in systemic failures and individual misconduct. As civilizations have advanced, the recognition of corruption has grown alongside the development of legal and political institutions. Corruption is now seen as a central concern for the sustained health of any society.

Jain (2001, p.73) gives a general definition of corruption “corruption refers to acts in which the power of the public office is used for personal gains in a manner that contravenes the rules of the game.”

My doctoral research is centered on the study of petty corruption and theft, typically the most pervasive form of commonplace corruption. However, it represents merely one facet of the broader spectrum of corrupt practices. In the following paragraphs, I clarify corrupt behaviors with precise terminology.

I primarily differentiate among forms of corruption based on the level of the institution at which it occurs. These categorizations are well-established within corruption studies and facilitate a nuanced understanding of each type. It is worth noting that corrupt activities often straddle multiple categories, exhibiting characteristics that intersect various criteria, such as the institutional location, nature of transaction, systemic framework etc., thus demonstrating the multifaceted nature of corruption.

i) **Petty Corruption**: refers to minor forms of corruption that are commonplace. Often termed bureaucratic corruption in literature, it signifies the type of corruption that manifests at the practical application stage of public policies and political processes, for example, in many small places such as registration offices, police stations, and state licensing boards; this form of corruption typically affects the general public when they interact with various public institutions such as city halls, hospitals, schools, and tax offices for different services. While the monetary value involved in each instance might be relatively low, the total accumulated amount can be significant. This concept has been explored in studies by Andvig et al. (2000), Lambsdorff (2007), and Morris (2011). The most common form of petty corruption studied in literature is bribery. Bribery involving a public official refers to the act of private benefit or special treatment given to a citizen provided by the public official abusing their office.

ii) **Grand Corruption**: also known as political corruption, affects the top levels of public institutions. It involves high-ranking civil servants, government politicians, or parliament members exploiting their power nationally or internationally. This type of corruption typically involves substantial monetary transactions or considerable advantages for public figures. Political corruption may also manifest as alterations in legislation or policymaking, influenced by external entities, or illicit political interference in judicial proceedings. In the literature, this kind of corruption is often referred to as "upper level" corruption, a term explored in works by Andvig et al. (2000) and Morris (2011).

1.2 The Economics of Corruption

Corruption has existed with our society since its origins; however, corruption as a research topic of economics emerged only recently. The pivotal moment in examining corruption within economics occurred with the 1975 publication of "The economics of corruption" by Rose-Ackerman. In this work, Rose-Ackerman explores various market structures and their relation to corruption in public procurement. She provides a theoretical analysis of three different market structures, drawing attention to policy implications that reveal the ineffectiveness of traditional methods used by authorities to combat corruption, including the fine system and other related issues. Furthermore, the article presents the first economic model of corruption, marking a significant transformation in economic research. This model has been referenced extensively in numerous other scholarly works. Subsequent models of corruption have evolved over time. In 1986, Lui introduced a model depicting corruption as a widespread societal issue, highlighting the challenges in auditing officials already engaged in corruption. Other studies have explored various aspects of corruption: Cadot (1987) viewed it as a risk taken by an official in granting a permit to a briber, while Andvig et al. (1990) focused on bureaucratic corruption escalating with more frequent bribe offerings, and Groenendijk (1997) analyzed it as a principal-agent dilemma.

Additionally, Shleifer et al. (1993) examined the structure and stability of institutions involved in corruption, particularly in explaining the high costs of corruption in developing nations.

These theoretical models primarily address the causes of corruption, or the institutions involved. They have been instrumental in research in this field, paving the way for empirical studies that examine the outcomes of corrupt practices. As noted in the introduction of this thesis, the impacts of corruption are wide-ranging. One of the early studies on its consequences, conducted by Mauro (1995), investigated the relationship between corruption and capital investments, finding that corruption reduces investment and thus economic growth in the affected country. Mauro also developed an index to measure such impacts. Other identified consequences include a decline in direct investment (Wei, 2000), increased public spending (Mauro, 1998), and greater income inequality (Gupta et al., 2002). Furthermore, corruption has been linked to increased pollution, particularly in developing countries (Cole, 2007), societal harm (Fisman et al., 2007), and the undermining of institutions (Jong-sung et al., 2005), legal systems (Treisman, 2000), and more.

Rothstein (2018) puts out a theoretical alternative, namely that systemic corruption should be seen as a 'collective action problem'. Rothstein & Ulaner (2005) coins the term 'social trap', where agents are not motivated by utility maximization but by what they perceive will be the most likely strategy of most other agents in their society.

In contrast to the incentive-based solutions drawn from principal-agent theory, understanding corruption as a problem of collective action or as a social trap leads to quite different policy responses. Destabilizing the corrupt equilibrium is a requirement for effective anticorruption policies. Andvig & Moene (1990) modeled corruption as a multiplayer coordination game. In their model, public officials can choose between a corrupt or an honest strategy, and best response of each player is affected by the decisions of the other player or public officials. Berninghaus et al. (2010) designed their corruption experiment similar to Andvig & Moene's (1990) theoretical model, where public officials are faced with a decision of whether or not to accept bribes. In order to depict this risk, they added a government agency tasked with the task of finding corrupt public officials.

Empirical studies generally form the basis for observing the consequences of corruption, often focusing on cross-national comparisons. While such comparisons can reveal these consequences, they are less effective in investigating the behavior of corrupt individuals.

1.3 Experimental Research on Corruption

The difficulty in quantifying corruption due to its illegal and secretive nature poses a significant challenge. Historically, research on corruption relied on country-level indexes based on perceptions gathered from citizens, businessmen, or experts. Early studies, like Mauro's 1995 research, used cross-country regression analysis to explore the impact of perceived corruption on economic growth. These studies correlated perceived corruption with various economic, political, and sociocultural factors. However, they were limited by the biases of perception-based indexes and the challenges in establishing causality with observational data susceptible to endogeneity bias.

In recent years, experimental approaches have revolutionized corruption research by overcoming these measurement and causality issues. Experiments have greatly enhanced our understanding of the mechanisms of corruption and how individuals react to different incentives.

This methodological shift is highlighted in recent research, which focuses on laboratory, field, and natural experiments. Introduced around the year 2000, economic experiments in corruption research remain one of the most comprehensive methods for examining corrupt behaviors. However, publications utilizing this approach are still relatively few.

These experiments primarily utilize two game types: trust games and ultimatum games. Trust games simulate real corruption scenarios, where the performance and reciprocal service between two participants create a trust-based interaction. If this trust is violated, both parties earn less than if the trust is maintained. Rational expectations theory suggests that trust breaches are likely. Ultimatum games, on the other hand, present the option to accept or reject an offer. Here, one player proposes a share of a total amount, and the other can accept or deny it, illustrating the dynamics of bribe offers and their rejection or acceptance.

Abbink et al (2002) made significant strides in the field of experimental studies on corruption and bribery, notably with the design of the bribery game. This experiment simulates a typical corruption scenario where one participant plays the role of a government official, and the other represents a business, offering a bribe to the official. The game begins with the business player deciding whether to offer a bribe and determining its amount along with associated transaction costs. The official can then choose to accept or reject the bribe. Acceptance increases the official's income, while rejection keeps it the same, with the business player bearing the transaction costs. Additionally, the experiment includes a scenario where the official weighs two actions, each slightly favoring one party over the other.

They also investigated the impact of language on corruption by comparing the effects of explicitly labeling actions as corrupt versus using neutral terminology. Their findings reveal that the phrasing of instructions does not influence corrupt behaviors, indicating no direct correlation between the language used in the experiment and the participants' actions.

González et al (2002) adopt a unique approach to studying corruption by using an "ultimatum game" involving two officials and a third player seeking a specific permit. In this setup, each official has the option to accept or reject the offer. However, only the second official has the advantage of knowing the others' decisions and can delay the process of extracting a bribe. The findings indicate that participants seeking permits tend to bribe officials swiftly, while officials are more likely to exploit their power when dissatisfied with the bribe size.

Schulze et al (2003) expanded upon this by introducing a risk of detection into their experiment. They simulated a scenario where a company attempts to recover an envelope full of money from the sanitation system. The introduction of dice rolls to determine if a controller would expose any corrupt actions significantly altered participant behavior. The presence of a risk of exposure led to a marked decrease in corruption levels, highlighting the impact of potential oversight. Additionally, the study observed gender differences in response to the risk of detection, with female participants showing less propensity to accept bribes compared to male participants, especially under the threat of control. This difference, however, diminished with the introduction of control measures, reaffirming the influence of oversight on reducing corrupt practices.

Abbink (2004) focused on applying experimental designs to propose anti-corruption strategies. One practical anti-corruption measure is rotating employees in roles commonly associated with corruption. Abbink's experiment replicated this by repeatedly conducting the corruption game, with new pairings of participants as the official and the company each round. He also included a control group where pairs remained the same throughout the game. The findings from this experiment indicated that rotating workers significantly reduced corrupt behavior, supporting the rationale behind implementing such policies in public administration, though quantifying the actual impact remains challenging.

Abbink's approach and the anti-corruption measures he tested have provided valuable insights for further research. The policy not only shows promise in reducing corruption but also suggests potential benefits for the personal development of public officials. This aspect of Abbink's work has served as a source of inspiration for ongoing research in the field.

Abbink et al (2006) shifted their focus from modifying their corruption experiment to examining how the formal use of language influences participant behavior. Specifically, they investigated whether explicitly using terms associated with corruption, such as 'corruption' or 'bribe,' which generally carry negative connotations, could promote more ethical behavior. Conversely, they considered whether employing neutral language might have a different effect.

The underlying hypothesis was that mentioning words like 'corruption' or 'bribe' might instinctively encourage participants to act more ethically. However, this anticipated effect might only occur if participants were aware they were part of a corruption experiment. Their study found only minor differences in behavior based on the language used, indicating that the specific terms employed had a relatively insignificant impact on participants' actions. This outcome suggests that the awareness of being in a corruption experiment does not substantially alter behavior, regardless of the language used to describe it.

Negative externalities have also been demonstrated to impact corrupt behavior. Barr and Serra (2009) conducted a corruption experiment where citizens could offer bribes to government officials, who could choose to accept or reject them. In their study, they introduced an additional participant referred to as 'another society member.' This individual's rewards were influenced by the actions of others in the experiment but did not actively participate in it. When it came to corrupt behavior and the occasional pursuit of higher income by citizens and public officials, the income of this 'another society member' decreased. The authors explained this as a negative externality. Barr and Serra (2009) found that when citizens were informed about potential negative externalities, they were inclined to offer bribes less frequently. Similarly, the more the externality affected this 'another member of society,' the less likely the public official was to accept the bribe. This demonstrates that people do not base their decisions solely on profit maximization; they also consider the social implications of their choices.

Armantier & Boly (2008), explores the external validity of corruption experiments by transitioning from laboratory settings in developed countries to field environments in developing countries. It specifically investigates whether increasing graders' wages affects their likelihood of accepting bribes in both settings. The study finds that key treatment effects, such as the impact of wage increases on bribe acceptance, are statistically similar in both lab and field environments. The experiment involves a scenario where a candidate offers a bribe to a grader for a better grade, with findings indicating that both age and religious fervor among graders reduce their propensity to accept bribes, with no significant gender effect observed. The research contributes to understanding corruption's micro-determinants and suggests that lab experiments can offer valuable insights applicable in real-world settings, especially in the context of developing countries.

1.4 Motivation and Outline of the Thesis

I investigate corruption as a common dilemma by means of stealing from a common pool in which a risk of collective sanction of the public officials is determined by how much corruption/stealing each of the public officials decided to engage in. In a group setting, individuals have the incentive to free ride, i.e., maximize one's individual payoff instead of the whole group benefiting from the common pool.

Leaving moral issues aside, choosing to act corruptly is a gamble (Cadot, 1987). The bureaucrat makes his decision under partial equilibrium assumptions in the scenario of petty corruption when he receives modest sums of bribes from the public, i.e., he regards the detection probability as given. Consequently, the choice made by the government official is equivalent to the one made when playing a compound lottery. While numerous studies have shown that risk and the fear of punishment have a substantial impact on corrupt conduct, little has been done to comprehensively address the unique characteristics of risk in relation to petty corruption. A corrupt official who is discovered in the act will suffer harsh penalties, including termination of employment and/or pension benefits, in addition to fines and prison terms.

Corruption in the shadow of detection and punishment involves risk, and the proposed experiment will implement a multi-period extension of a simple "bomb" task that has been used by experimental economists to study risky (but potentially lucrative) activities. Crosetto & Filippin (2013) used the "Bomb Risk Elicitation Task" (BRET) to infer risk preferences from subjects' decisions. In this task, subjects are provided with a fixed number of "boxes" that each contain a specified amount of cash, e.g., a dollar, with the knowledge that a bomb has been located in a randomly selected box. Therefore, a subject who opens more boxes has a higher chance of encountering the bomb, which results in zero earnings. With 100 boxes and $1 in each, a person who decides to open x boxes will earn $0 with probability x/100 and will earn $x with probability: 1 – x/100. The BRET task allows the measurement of risk aversion while avoiding the effects of loss aversion since there are no negative earnings that would be coded as losses. Loss aversion is based on the intuition of Markowitz (1952) that the pain of losing is larger than the pleasure of comparable gains. Loss aversion is an important feature of most strategic decisions (Kahneman & Tversky, 1979), especially those involving corruption.

Consider the following simple model of corruption with k clients and a public official. The public official can provide a service (worth $V) or transfer a deserved payment ($V) to each of the clients. Or the official can keep the $V (or save $V by not providing the effort required) for some subset of the k deserving clients. An auditor then selects one of the k clients at random for an audit, and if non-payment is discovered, the audit is expanded, and the official has to repay the amounts improperly kept. But this is exactly the structure of a simple "bomb" risk elicitation task used in experimental economics, where the decision maker faces k boxes, each with a fixed amount of cash, e.g., $1, and can "take" the cash from some subset x of the boxes, where $0 \leq x \leq k$. And similar to facing an audit at random, one of the boxes may contain the ink bomb and can result in the player losing all of his income.

Getting caught just once can have dire consequences such a getting fired, regardless of the timing. This could result in an anomaly. While the chance of being caught in a specific act may be low, the chance of being caught at any point during a career is logically much larger and may be significant. According to an earlier study (Abbink, et al 2002), decision-makers may underestimate the overall risk because of the modest single probabilities, even if the overall risk is what counts most. Niehaus and Sukhtankar (2013) take this analysis a step further by considering incentives associated with current decisions that may alter both future incomes and future opportunities for corrupt enrichment. They focus on a 'Golden Goose' effect where corrupt officials refrain from corruption today, fearing detection and consequent dismissal as they believe there could be potentially more gains to be had from corrupt activities tomorrow. The term 'Golden Goose' comes from the famous fable where the goose lays golden eggs, and by killing it the farmer destroys his own source of wealth. By analogy, officials who engage in current illegal enrichment may risk losing the 'Golden Goose' that may provide a 'golden egg' in the future. Neither in the literature on corruption nor in the more general studies on decision-making under risk and uncertainty has there been an attempt to systematically analyze risk-taking behavior under these conditions.

The main aim of this thesis is thus to analyze corruption in terms of a common dilemma and to investigate how collective risk affects individuals' corruptibility. The novelty of my contribution complements the traditional approach to corruption inspired by Becker and Stigler (1974) and Rose-Ackerman (1975), which relies on a cost-benefit analysis and on the agency theory. I can take into account the horizontal interdependencies among corruptible people by viewing corruption as a common dilemma problem. Due to the allure of personal gain, everyone is motivated to steal from the common pool, but everyone is also a victim of others' corruption. This viewpoint reveals a fundamental driving force behind behavior—the group's overarching interests—that was largely ignored in earlier research on corruption (see surveys by Aidt, 2003 and Abbink and Serra, 2012).

Jain (2001, p.73) gives a general definition of corruption "corruption refers to acts in which the power of the public office is used for personal gains in a manner that contravenes the rules of the game." Inspired by Andvig & Moene (1990), I have designed a coordination game; however, instead of accepting bribes, the public officials have the opportunity to indulge in petty corruption by stealing from a common pool they oversee, leading to a higher payoff which is connected to the risk of being caught. And the remaining funds in the common pool are then distributed amongst the public officials who were not detected in the audit. This can be looked upon as corruptibility destroys the public good, and corrupt officials are also affected negatively as citizens. To represent the risk of getting caught, I introduced an auditor from a government agency charged with the responsibility of uncovering corrupt public officials. However, due to the government agency's assumed budgetary constraints, the number of corrupt public officials is inversely proportional to their individual probabilities of being caught. In other words, if there are more corrupt officials, the chances of being detected are lower, and vice versa. In this kind of scenario, it might be rational for a profit-maximizing public official or utility-maximizing agent to act in a corrupt manner (Tirole, 1996). In the structure of a common pool corruption game when multiple parties are corrupt, and the auditor can only select a subset of individuals to audit. As more officials become corrupt, individually, they have a lesser chance of being detected, i.e., there is "safety in numbers." In this setting there will be two equilibria; one where no one is corrupt and another where everyone is corrupt. The two equilibria are very important to understanding policies that can disincentivize corruption destabilize corrupt equilibrium.

Due to multiple agents, the probability of being caught after a corrupt act is unknown. Hence the situation is not only risky but also subject to uncertainty. Cadot (1987) showed that risk is a parameter of the decision to engage in corrupt acts; accordingly, I elicited the risk attitudes of the players in our experiment by using BRET (Crosetto & Filippin, 2013).

In this experiment, I also study the intertemporal consequences of corruption. My treatment with a linkage between odd and even rounds shows a significant effect when there is asymmetry of punishment. Asymmetry of punishment means that in the linked rounds, getting caught in the odd period precluded the subject from participating in the even periods. I observe that there is a displacement effect of corruption. Studying corruption as a long game has important implications for anticorruption policy, as discussed above.

I also make a minor contribution to the existing literature of gender and risk attitude and pro-sociality. I observe no significant difference between males and females in their risk attitude and pro-social behavior.

The goal of this thesis is to make a contribution to the separate literature on experimental and development economics. A key innovation will be the adaptation of the bomb task to a multi-period and a coordination game.

Chapter 2

2. EXPERIMENT SETUP AND THEORETICAL MODEL

Introduction to the Theoretical Model

In my experiment, I simulate an environment where a group of individuals, acting as public officials, oversee a common pool of funds. The size of the common pool is directly proportional to the number of officials overseeing the funds. This setup models a scenario where each official's actions can deplete the shared resource, mimicking real-world dynamics of public fund management.

Model Framework

Corruption Mechanism: Within the framework of the experiment, corruption is modeled as the act of opening boxes, which symbolically increases an official's private income by one unit (such as a dollar) for each box opened. However, this gain comes at a collective cost. Every dollar taken corruptly reduces the common pool by more than a dollar, representing the social cost of corruption. This factor encapsulates the negative externality of corruption, highlighting the paradox where individuals' corrupt actions harm the collective welfare, including their own.

Risk of Detection: The model introduces an element of risk associated with corrupt actions. This risk is quantified through the presence of an auditor, a computer program designed to detect the opening of boxes. Due to resource constraints, akin to underfunded anti-corruption agencies, the auditor's ability to detect corruption is limited to instances where there's an indication of malpractice, such as a complaint, and only one instance of corruption can be detected per period. This limitation models the real-world challenge of enforcement under resource constraints. The probability of an individual getting caught for corruption decreases as more officials engage in corrupt acts, introducing a "safety in numbers" dynamic. This aspect of the model explores the strategic calculations individuals make when deciding whether to engage in corruption, balancing personal gain against the risk of detection.

Intertemporal Punishment and the Golden Goose Effect: The 'Golden Goose' effect is where corrupt officials refrain from corruption today, fearing detection and consequent dismissal as they believe there could be potentially more gains to be had from corrupt activities tomorrow. Drawing on the concept of the Golden Goose, the model tests an intertemporal punishment strategy. This strategy aims to examine whether the threat of future penalties can deter corruption in the present and over time, addressing the experiment's central question regarding the effectiveness of delayed punishment in curbing corrupt practices.

The subsequent sections will delve deeper into the theoretical model associated with the experiment, exploring the Nash Equilibria and other strategic considerations within this model. The main aim of this thesis is to understand how the interplay of individual incentives, collective costs, and enforcement constraints shapes the dynamics of corruption in a controlled setting.

2.1 Common Pool Corruption with Unlinked or Independent rounds

In the proposed model, I examine a corruption scenario within a common pool resource framework. Key components of the model include:

- Agents 'N': Public officials responsible for the common pool.

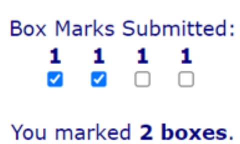
- Common Pool 'αN': The initial size of the pool, proportional to the number of agents N by a factor α.

- Corrupt action 'x_i': The number of boxes opened by agent $i \in \{1, N\}$, increasing their private income but decreasing the common pool.

- Social cost of corruption 'δ': The impact of each corrupt action on the common pool. For every box x_i that is opened the common is destroyed by δx_i. Therefore, the common pool that gets divided among the $N - 1$ undetected agents is given by $\alpha N - \delta \sum_{i=1}^{N} x_i$.

- Detection probability: The chance of an agent's corrupt action being audited and penalized.

The N agents acting as public officials oversee the common pool, whose initial size is determined by a factor α multiplied by the total number of agents N. Each of the N agents can open x_i boxes where $i \in \{1, N\}$. Each box opened gives them a unit of private income. Each box opened destroys δx_i funds from the common pool. The parameter δ determines the penalty of stealing. It deducts from the common pool αN by δx_i for every x_i box opened by each agent. It can also be thought of as the 'cost of corruption.' After each round ends when the agents have made their decisions, an audit occurs which checks one of the open boxes at random. The audit then identifies the agent to whom the checked open box belongs to, and they then lose all of their earnings. At the end of the audit, the remaining common pool gets divided equally between the undetected agents.



The probability of getting caught for agent i who decides to open x_i boxes is $\frac{x_i}{\sum_{j=1}^{N} x_j}$, where the total number of boxes opened by the whole group is given by $\sum_{j=1}^{N} x_j$. If agent i who decides to open x_i boxes does not get caught as given by the above probability, their private earnings from the open boxes is x_i. The probability of *not* getting caught for agent i who decides to open x_i boxes and all the other agents open $\sum_{j\neq i} x_j$ boxes is given by $\frac{\sum_{j\neq i} x_j}{\sum_{j=1}^{N} x_j}$. The size of the common pool is determined by the number of players N and a factor α, i.e., the value of the common pool is αN. Therefore, the common pool that gets divided among the $N-1$ undetected agents is given by $\alpha N - \delta \sum_{i=1}^{N} x_i$. The destruction of the common pool due to stealing by all agents remains unchanged even when one agent is caught and does not receive any share of the common pool or their private earnings. If nobody stole anything, each player would get α as their income, since the common pool αN gets divided by N .

Equation 1 below denotes the expected payoff (EP_i) of agent i when no one steals. In other words, 0 boxes are opened. In this event the common pool is divided equally among all the N players.

$$EP_i = \alpha N / N \qquad\qquad x_j = 0 \text{ for all } j \in \{1, N\} \qquad (1)$$

The expected payoff for agent i , denoted by EP_i , is given in equation (2) for the second case. The boxes opened by agent i will be denoted by x_i. Equation (2) represents the case where agent i can choose to open boxes $x_i \geq 0$ and everyone else opens at least one box in total, i.e., $\sum_{j\neq i} x_j > 0$. The first term on the right is the probability of *not* getting caught for agent i who decides to open x_i boxes and all the other agents open $\sum_{j\neq i} x_j$ boxes, is given by $\frac{\sum_{j\neq i} x_j}{\sum_{j=1}^{N} x_j}$. It is multiplied by the sum of agent $i's$ earnings by the number of boxes opened x_i and the share of the common pool. The common pool, after all boxes are opened, is given by $\alpha N - \delta \sum_{j=1}^{N} x_j$. Since one player will be detected, the remaining common pool will get divided among $N - 1$ players.

$$EP_i = \frac{\sum_{j \neq i} x_j}{\sum_{j=1}^{N} x_j}\left(x_i + \frac{\alpha N - \delta \sum_{j=1}^{N} x_j}{N-1}\right) \qquad \sum_{j \neq i} x_j > 0 \text{ for all } j \neq i \qquad (2)$$

Nash Equilibrium

In the context of this experiment and the theoretical model, discussing the Nash equilibria in pure strategies, particularly "all steal or open all boxes" and "no steal or open no boxes," involves examining the strategic choices made by agents (public officials) within the common pool corruption game. Nash equilibrium, in this setting, refers to a situation where no agent has an incentive to deviate from their chosen strategy, given the strategies chosen by all other agents.

Pure Strategy Equilibrium

There will be *two* Nash Equilibria in Pure Strategies.

i) No Steal Equilibrium: This equilibrium is where all agents choose not to engage in corruption (i.e., open no boxes), not stealing maximizes their payoff given the strategies of others. The decision to abstain from corruption altogether stems from a strategic consideration of the audit mechanism's consequences—losing all earnings for the round if caught—and a collective understanding of the common pool's value. Intuitively, when no one is stealing, opening even *one* box puts a target on the agent's back and they get detected in the audit, since the audit only checks open boxes. In this equilibrium, the common pool gets distributed evenly between all the players. Nobody has an incentive to defect unilaterally, since anyone who opens one or more boxes will be detected and receive lower earnings ($0) as a result.

ii) All Steal Equilibrium: This equilibrium occurs when all agents decide to open all boxes available to them (i.e., engage in maximum corruption), and none of them can increase their payoff by unilaterally changing their strategy to opening fewer boxes or none at all. Given the game's structure, where players are aware that their corrupt actions dilute the common pool but also increase their private income, the decision to "all steal" might be driven by a perception that the benefits of opening more boxes outweigh the risks (reduced common pool size and the risk of being audited). The "safety in numbers" concept applies here, as the more agents engage in corruption, the lower the individual probability of being audited and penalized, thus making the corrupt act seemingly more attractive. This equilibrium is stable under the assumption that the perceived benefit of stealing one more box (personal gain) is greater than or equal to the expected loss due to the potential reduction in the common pool and the risk of audit. This calculation depends heavily on the structure of payoffs and the enforcement mechanism (audit probability).

Calculations to check for Interior Solution

Even though box opening decisions in the experiment will be discrete integer values, it is useful to consider a continuous model where x_i is a real number, so that calculus methods can be used to identify a Nash equilibrium. Consider a continuous model to identify values of N , α and δ for which there is a Nash equilibrium that is "interior" and not at a corner.

Consider $Y = (N-1)x^*$where x^* presents the equilibrium number of boxes opened by each participant, assumed to be positive in a symmetric equilibrium. In this framework, an individual player, i, seeks to maximize their payoff, represented by:

$$EP_i = \frac{Y}{Y + x_i}\left[x_i + \frac{\alpha N - \delta x_i - \delta Y}{N-1}\right] \tag{4}$$

For simplification, define $\frac{\alpha N}{N-1} = \phi$, which naturally leads to a more intuitive presentation when considering the expected payoff function as:

$$EP_i = Y \left[\frac{x_i + \phi}{Y + x_i} - \frac{\delta}{(N-1)}\right] \tag{5}$$

Taking partial derivative of (5) with respect to EP_i with respect to x_i and setting it to zero enables the identification of a symmetric equilibrium condition. This simplifies to:

$$Y \left[\frac{\phi - Y}{(Y + x_i)^2}\right] = 0 \tag{6}$$

Analyzing the numerator $Y(\phi - Y) = (N-1)Y - N\alpha$, it is directly proportional to Y. As Y goes down it is decreasing and as Y goes up it is increasing. Which means if $x_{\{max\}}$ is too large or there are a lot of boxes to be stolen from, the equilibrium will be 'All Steal'. There is also a symmetric interior and unstable equilibrium.

In a symmetric equilibrium every player would choose to open the same number of boxes, regardless of their position or other individual characteristics. This is considered symmetric because all players are essentially mirrors of each other in terms of their strategies. In a symmetric equilibrium where $Y = \phi$, the equation simplifies further, providing a clear solution for x^* in the continuous model.

$$x^* = \frac{\alpha N}{(N-1)^2} \tag{7}$$

The model suggests that in a symmetric equilibrium, the individual decision x^* is related to the total size of the common pool αN and the number of players N. Equation (7) indicates that each player's strategy in equilibrium (i.e., the number of boxes they decide to open) is determined by the total available common pool and the number of other players, adjusted for the effect of one player's action on the pool. The symmetry comes from the fact that each player is doing the same thing, assuming they all have the same valuation of the common pool and the same aversion to risk (of being caught in corruption).

In this experiment the parameters are set to: $N = 8,\ \alpha = 8,\ \delta = 2.$ Equation (7) gives:

$$x^* = \frac{64}{49} \tag{8}$$

This result raises a pertinent question regarding the integer nature of decision-making in the experiment, given that x^* is not an integer. In a Nash Equilibrium, each player's strategy is the best response to the strategies of all other players. However, this equilibrium is 'unstable' when a small deviation by any player leads to a situation where other players can improve their payoff by changing their strategies. This instability arises due to the interdependent payoff structure.

In examining the graphical representation of the expected payoffs in my model, it becomes apparent that when the average number of boxes opened by other players is approximately 1.3 (refer to figure 1 below), the payoff function's slope at that point is flat. This flatness in the payoff curve signifies a critical juncture: here, the individual's payoff is insensitive to a change in their own number of boxes opened, making the equilibrium unstable. Figure 1 represents the payoff when each and every player chooses 1.3.

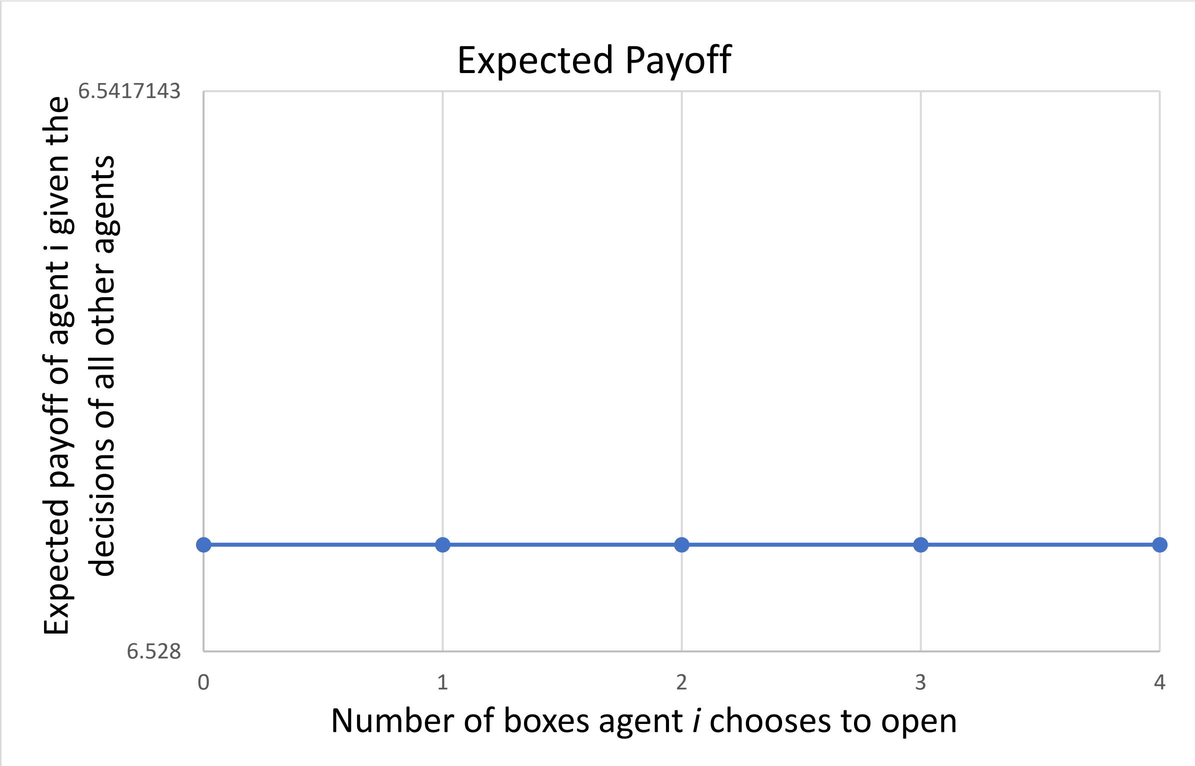


Figure 1 The expected payoff for agent i who chooses $x_i \in \{0, 1, 2, 3, 4\}$ when $x_j = x^* = \frac{64}{49}\ for\ all\ i \neq j$. Each player is choosing 1.3 in the above graph. The payoff appears constant regardless of x_i, indicating that when others adhere to the equilibrium strategy, a player's choice has little impact on their expected payoff, signaling a flat payoff function at this point and an unstable equilibrium.

This instability arises because when a player deviates from opening 1.3 boxes—either by opening more or fewer—the incremental change in their expected payoff is minimal. Therefore, such an equilibrium is unstable; it is vulnerable to deviations as players seek strategies that could potentially increase their payoffs, even marginally. This behavior can trigger a cascade of strategic adjustments by other players in response, further disrupting the equilibrium.

In figure 2 each player chooses $x_j = x^* < \frac{64}{49}\ for\ all\ i \neq j$. The best response of agent i is to open zero boxes. Intuitively referring to eq (6), if Y is too small 'no steal' is an equilibrium.

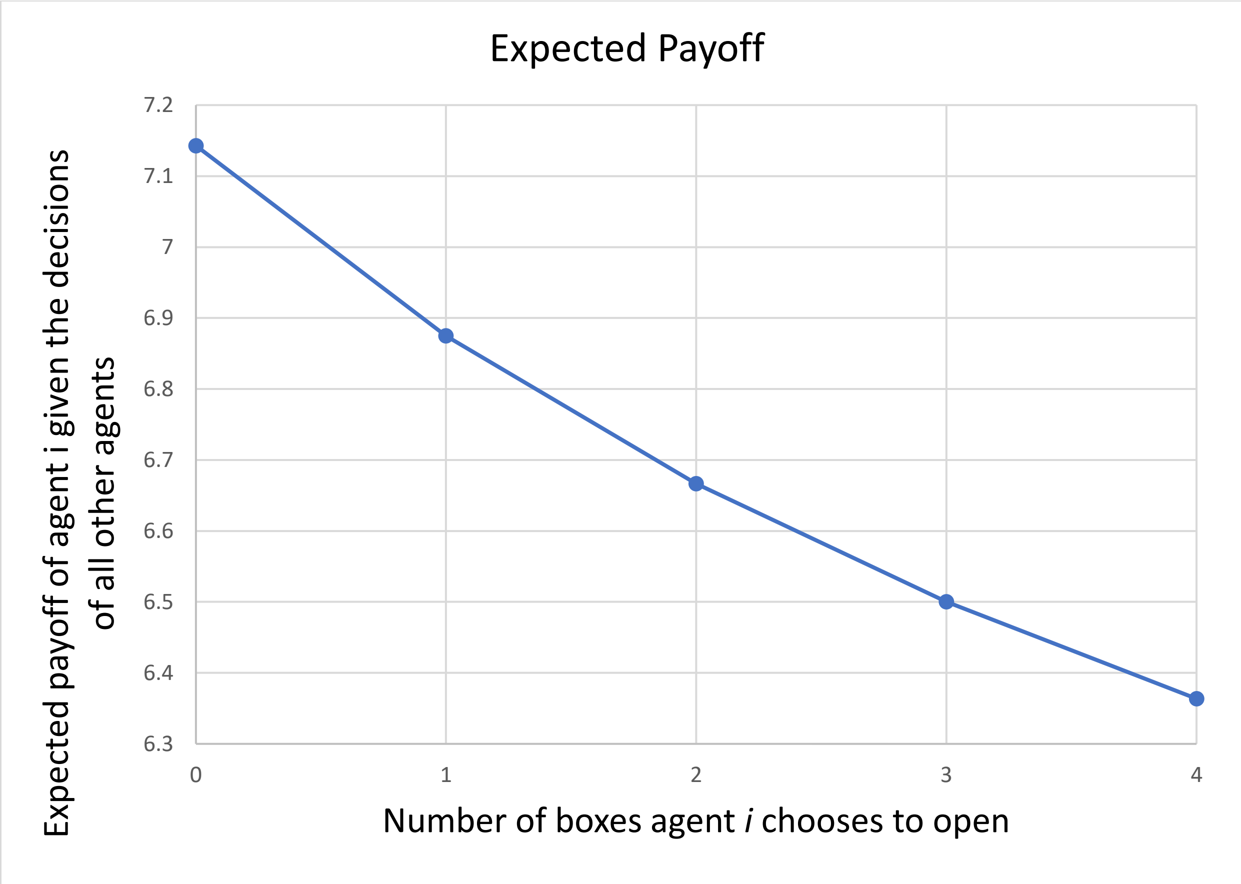


Figure 2 The expected payoff for agent i who chooses $x_i \in \{0, 1, 2, 3, 4\}$ when $x_j = x^* < \frac{64}{49}\ for\ all\ i \neq j$. Each player chooses 1 in the above graph. For this example, let $x^* = 1$. The expected payoff decreases as agent i opens more boxes, suggesting that as others contribute less to corruption (opening boxes), the cost of opening additional boxes for agent i increases, leading to a lower payoff as they open more boxes.

In figure 3 each player chooses $x_j = x^* > \frac{64}{49}\ for\ all\ i \neq j$. The best response of agent i is to open zero boxes. Intuitively referring to eq (6), if Y is too big 'all steal' is an equilibrium.

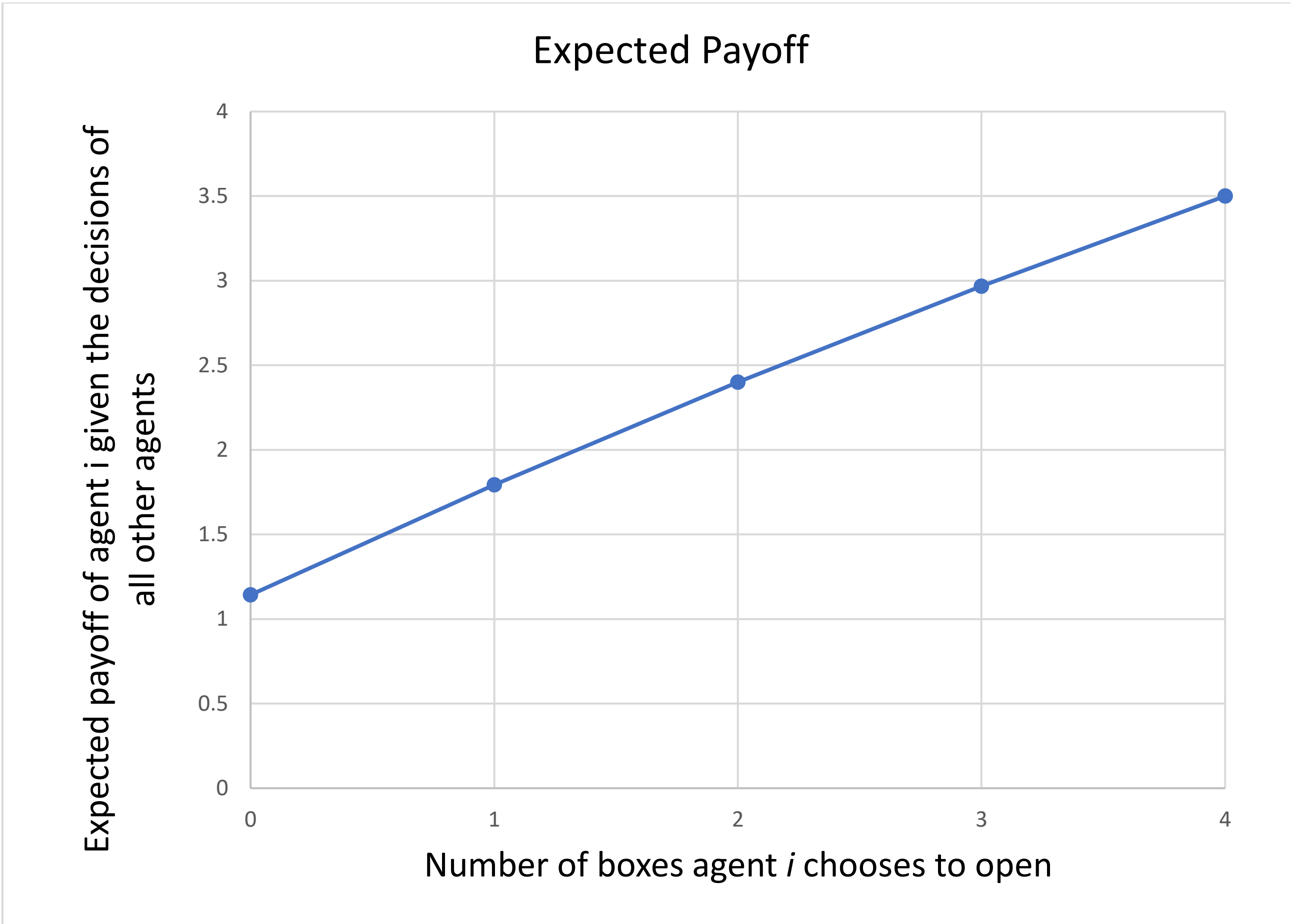


Figure 3 The expected payoff for agent i who chooses $x_i \in \{0, 1, 2, 3, 4\}$ when $x_j = x^* > \frac{64}{49}\ for\ all\ i \neq j$. For this example, let $x^* = 4$. Each player chooses 4 in the above graph. The expected payoff increases as agent i opens more boxes, which might imply that when others are highly corrupt, there is less to lose from the common pool for agent i, and more to gain from joining in on the corruption, hence the higher individual payoff for opening more boxes.

In summary, $x_{\{max\}} > x^*$ for an All Steal equilibrium to arise, and for $x^* = \frac{64}{49}$, which would be the symmetric decision for every player, is unstable because any deviation from x^* for agent i, increase the expected payoff for agent i. The only stable Nash Equilibrium for the game is at the corners of ‘no steal’ and ‘all steal’.

2.2 Common Pool Corruption with Linked Rounds

The following model examines a variation of the common pool resource model introduced in section 2.1. The key components of the model are exactly the same, in addition I now have superscripts 'o' and 'e' denoting odd and even rounds, respectively. The main variation is the introduction of TWO linked rounds and a different audit mechanism.

- Agents 'N': Public officials responsible for the common pool.
- Common Pool 'αN': The initial size of the pool, proportional to the number of agents N by a factor α.
- Corrupt action 'x_i': The number of boxes opened by agent $i \in \{1, N\}$, increasing their private income but decreasing the common pool.
- Social cost of corruption 'δ': The impact of each corrupt action on the common pool. For every box x_i that is opened the common is destroyed by δx_i. Therefore, the common pool that gets divided among the $N-1$ undetected agents is given by $\alpha N - \delta \sum_{i=1}^{N} x_i$.
- Detection probability: The chance of an agent's corrupt action being audited and penalized. In the common pool corruption model with linked rounds after the audit in the odd round, the public official who is caught stealing is then "fired" and does not get to participate in the even round.

Note: I will now use the superscript $'o'$ to denote odd round and $'\mathrm{e}'$ to denote even round. The probability of getting caught for agent i who decides to open x_i^o boxes is $\frac{x_i^o}{\sum_{j=1}^{N} x_j^o}$. The probability of *not* getting caught for agent i in the *odd* round who decides to open x_i^o boxes and all the other agents open $\sum_{j\neq \mathrm{i}} x_j^o$ boxes is given by $\frac{\sum_{j\neq i} x_j^o}{\sum_{j=1}^{N^o} x_j^o}$, where the total number of boxes opened by the whole group is given by $\sum_{j=1}^{N} x_j^o$. If agent i who decides to open x_i^o boxes does not get caught as given by the above probability their private earnings from the open boxes is x_i^o . After the audit in the odd round, the common pool that gets divided among the $N-1$ undetected agents, is given by $\alpha N - \delta \sum_{j=1}^{N} x_j^o$. The destruction of the common pool due to stealing by all agents remains unchanged even when one agent is caught and does not receive any share of the common pool or their private earnings. The probability of not getting caught in the even period for opening x_i^e boxes is given by $\frac{\sum_{j\neq i} x_j^e}{\sum_{j=1}^{N-1} x_j^e}$ and the probability of actually making to the even round is $\frac{\sum_{j\neq i} x_j^o}{\sum_{j=1}^{N} x_j^o}$.

Prior to characterizing the symmetric equilibria in pure strategies for the two-linked periods, it is useful to specify some expected payoff functions for the experiment parameters being used. Equation (9) represents the case where no one steals in both the odd and even periods. The expected payoff (EP_i) of agent i is given the sum of the equal common pool earnings in both the periods.

$$EP_i = \left(\frac{\alpha N}{N}\right) + \left(\frac{\alpha N}{N}\right) = 2\alpha$$

$$\text{with } x_j^o, x_j^e = 0 \qquad \text{for all } j \in \{1, N\} \qquad (9)$$

Equation (10) represents the case where agent i chooses to open $x_i^o \geq 0$ boxes and at least one box is opened by the rest of the group in both the odd and even periods, $\sum_{j\neq i} {x^o}_j > 0, \sum_{j\neq i} {x^e}_j > 0$. Since one player will always be detected whenever at least one person opens a box, the common pool will get divided among $N-1$ players in the odd period.

And the common pool will get divided between $N-2$ players in the even period, since the player detected in the odd period does not participate in the even period. The first term on the right is the probability of not getting caught in the odd period. The product of the two probabilities in the second term of equation (10) determines the probability that the agent i is not caught either period.

$$EP_i = \frac{\sum_{j\neq i} x_j^o}{\sum_{j=1}^{N} x_j^o}\left(x_i^o + \frac{\alpha N - \delta\sum_{j=1}^{N} x_j^o}{N-1}\right) + \frac{\sum_{j\neq i} x_j^o}{\sum_{j=1}^{N} x_j^o}\left(\frac{\sum_{j\neq i} x_j^e}{\sum_{j=1}^{N} x_j^e}\right)\left(x_i^e + \frac{\alpha N - \delta\sum_{j=1}^{N} x_j^e}{N-2}\right)$$

$$\sum_{j\neq i} x^o{}_j > 0, \sum_{j\neq i} x^e{}_j > 0 \quad for\ all\ j \neq i \tag{10}$$

The expected payoff for agent i , denoted by EP_i , given in equation (11) represents the case where no one steals in the odd period. Equation (11) gives the expected payoff (EP_i) of agent i who chooses to open $x_i^o = 0$ boxes and everyone also chooses 0 boxes in the odd period, $\sum_{j=1}^{N} x_j^o$. Therefore, the common pool is divided equally among all the N players in the odd period and everybody earns α. Since no player steals, all N players participate in the even period. In the even round agent i opens $x_i^e \geq 0$ and their probability of *not* getting caught is $\left(\frac{\sum_{j\neq i} x_j^e}{\sum_{j=1}^{N} x_j^e}\right)$. All the other players open at least one box, $\sum_{j\neq i} \mathrm{x}_\mathrm{j}^\mathrm{e} > 0$, and therefore one person will be detected, and the common pool will be divided among $N-1$ players.

$$EP_i = \frac{\alpha N}{N} + \left(\frac{\sum_{j\neq i} x_j^e}{\sum_{j=1}^{N} x_j^e}\right)\left(x_i^e + \frac{\alpha N - \delta\sum_{j=1}^{N} x_j^e}{N-2}\right)$$

$$x_j^o = 0 \text{ for all } j \in \{1, N\} \text{ and } \sum_{j\neq i} x^e{}_j > 0 \text{ for all } j \neq i \tag{11}$$

The following equation (12) represents the case where no one steals in the even period. Equation (12) gives the expected payoff (EP_i) of agent i who chooses to open $x_i^o \geq 0$ boxes and at least one box is opened by the rest of the group in the odd period, $\sum_{j \neq i} x_j^o > 0$. One person will get detected and the common will be evenly divided between $N-1$ remaining players. In the even period only the undetected $N-1$ players get to participate. Since no one opens any boxes, the common pool gets divided evenly among $N-1$ players.

$$EP_i = \frac{\sum_{j \neq i} x_j^o}{\sum_{j=1}^{N} x_j^o} \left(x_i^o + \frac{\alpha N - \delta \sum_{j=1}^{N} x_j^o}{N-1} \right) + \frac{\sum_{j \neq i} x_j^o}{\sum_{j=1}^{N} x_j^o} \left(\frac{\alpha N}{N} \right)$$

$$\text{With } \sum_{j \neq i} {x^o}_j > 0 \text{ for all } j \neq i \tag{12}$$

Nash Equilibrium

In the linked rounds treatment of the experiment, there are four potential pure strategy Nash equilibria, which are based on the corner solutions where all players either decide to steal (open boxes) or not to steal (leave boxes unopened). Since the game is played over two rounds with the potential for intertemporal consequences (linked rounds), the equilibrium strategies would consider the potential future penalties of being caught in the current round.

There will be *four* Nash Equilibria in Pure Strategies.

i. No Steal in Every Round: No player opens any boxes in any round. This is an equilibrium because the risk and penalty of being caught (and the associated future round consequences) are so high that no one is willing to engage in corruption.

ii. All Steal in Every Round: Every player chooses to open all boxes in every round. This is an equilibrium since the benefit of stealing outweighs the risk of being caught, even considering future rounds.

iii. All Steal in Only Even Rounds, No Steal in Odd Rounds: Players open all boxes in rounds that do not have immediate future repercussions (Even Rounds) but choose not to open any boxes in rounds where they would suffer in the next round (Odd Rounds) if caught. This strategy could be an equilibrium if the players perceive a high enough risk of being penalized in the future rounds to deter them from stealing in odd rounds.

iv. All Steal in Only Odd Rounds, No Steal in Even Rounds: This strategy is less intuitive, as it involves taking higher risks in rounds where future consequences are at stake. It's less likely to be an equilibrium but could occur if players valued immediate gain over future rounds.

In all these scenarios, the assumption of a pure strategy Nash equilibrium involves each player believing that their strategy is the best response to the strategies of others, and no one has an incentive to unilaterally deviate. The first and second equilibria are straightforward and rest on the collective assessment of the risk-reward balance. The third and fourth are more nuanced and would depend on specific perceptions of risk and reward during linked versus unlinked rounds.

Chapter 3

METHODOLOGY

Following the description given in Section 2, I ran a neutrally framed experiment. Abbink & Henning-Schmidt (2006) found no significant differences in a bribery experiment run in both a loaded and unloaded frame. I used an unloaded frame to avoid framing effects.[1]

The experiment will used a 2x2 design as follows:

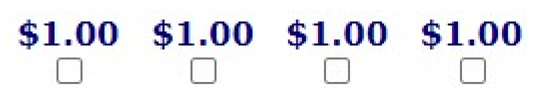
Cost of Corruption	**$\delta = 2$**	**$\delta = 1.5$**
Unlinked/Independent Rounds	Number of Rounds = 20 32 subjects = 4 groups	Number of Rounds = 20 32 subjects = 4 groups
Linked Rounds	Number of Rounds = 20 32 subjects = 4 groups	Number of Rounds = 20 32 subjects = 4 groups

In total *four* treatments were conducted: the Baseline Treatment, consisting of the Common Pool Corruption Game with *Unlinked* or *Independent Rounds for* (1) **$\delta = 2$ and** (2) **$\delta = 1.5$**, and

[1] The literature on framing effects in corrupt interactions provides evidence for determining the degree of influence on decisions, but as far as I know, only for the briber's behavior, not the agent's (see Barr & Serra, 2009; Lambsdorff & Frank, 2010). In our experiment, since I only had the corrupt agent, I concentrated on the agents and used neutral language.

the Common Pool Corruption Game with *Linked Rounds* (3) **δ = 2 and** (4) **δ = 1.5**. Before each treatment, I also conducted a risk elicitation task and a pro-sociality elicitation task. In the experiment the parameters set are as follows: number of players in each group $N = 8$, α is the factor which decides the size of the common pool, $\alpha = 8$, the rate of destruction of the common pool or the cost of corruption $\delta = 2$ and $\delta = 1.5$, the total of boxes that any player can open is always 4. The common pool size at any given time is αN, whenever there are 8 players remaining it equals \$64, and when 7 undetected players remain, it equals \$56. Note when the cost of corruption parameter $\delta = 2$ is such that if all players choose to open all boxes, the common pool is completely destroyed. And when $\delta = 1.5$ the common pool never goes to zero. Below is a snapshot of the instructions that participants saw, explaining the common pool parameters to them.

- Box Decisions: Each person in your group will see 4 boxes as shown below, and each box contains \$1.00 that can be extracted by marking the box with your curser in this manner. You will not be able to see their box marks while choosing yours, and vice versa.



- Common Pool: In addition to any money that you extract from your boxes, there is a pool of \$64.00 that will be divided equally between you and the 7 others, but each box marked by anyone in the group will reduce this common pool by \$2.00.

- Random Audit: Finally, only one of the marked boxes will be selected at random to be audited, and the person who marked that box will earn nothing in that round from extractions or from a pool share. Each marked box is equally likely to be audited, so if a total of N boxes marked by those in the group, then each of those marked boxes has a 1/N chance of being the one that is audited.

The experiment was performed in the VeconLab, the experimental laboratory at the University of Virginia, from September 2022 to April 2023. A total of 128 students participated in the experiment. I ran four sessions for each treatment, with sixteen participants in each session. Since each group had 8 participants, I had 32 students per treatment. The participants were recruited using the Veconlab Sona-System from a pool of students from various undergraduate courses at the University of Virginia. I used a program written in PHP. No communication was allowed among the participants at any time during the experiment. Each session lasted between forty-five minutes to an hour. The experiment provided a riskless payment of 16 dollars in both the treatments i.e., no one opened any box or the 'no corruption equilibrium'. The payoffs were calculated using cumulative earnings over all the rounds in lab dollars and converted into a payoff percentage of ten percent at the end of the session. The participants were informed of this earning scale in the instructions prior to the start of the game. The participants were paid a show-up fee of $10, and they also earned money performing additional pro-sociality and risk assessment tasks. The average payout across all the sessions was around $\$30 - \$32$.

3.1 Common Pool Corruption Game

The common pool corruption game in each session was preceded by two tasks conducted to elicit the subjects' pro-sociality and risk aversion, these will be discussed in sections 3.2 and 3.3.

In the common pool corruption game, each player was told they would be matched at random with seven other people in the room. And they would be part of the same group for the whole session. They were told that in every round, they would have four boxes, as shown on their screen. They could decide how many of the four boxes to open by clicking on them. They could always review their decision before submitting. The instructions also explained to them how their decisions to open boxes would affect the common pool for the whole group. And finally, after the players submit all the decisions, one of the open boxes gets audited by the computer at random. And the player to whom the box belongs loses their earnings. After each round, the players are able to see their own and their group members' decisions with the anonymity of identity retained. They can also see which ID number in their group got audited.

In the Baseline treatment, the game is repeated for twenty rounds. After each round, the players can see their earnings. And irrespective of whether they got audited for that round or not, they move on to the next round.

In the linked treatment, the game is repeated for twenty rounds. After each round, the players can see their earnings and their group's decisions. During the instructions, I highlight the distinction between the odd and the even rounds and how the linkage between the two works. And if they were the ones audited in the odd round, they only see crosses instead of boxes as they wait for the other players to finish their decisions in the subsequent even round. And the game resets again in the next odd-numbered rounds.

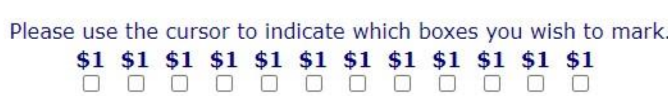
3.2 Pro-Sociality Elicitation Task

To elicit the players' pro-sociality, the sessions for both treatments, (the Baseline and the Linked Treatment) started with a Dictator Game. This was performed as a pen-and-paper task.

Everyone was given a piece of paper to make a decision. Their task was to decide how much money to divide between themself and another person to whom they would be randomly matched. They were endowed with $5; the recipient was endowed with $0. They had to decide how much of their $5 endowment to transfer to the recipient. They could choose any amount between $0 and $5. The recipient would receive the amount that the dictator decided to transfer to him/her, and the dictator received the amount they decided not to transfer and thus keep. After everyone had made their decision, the papers were collected from all the subjects in the room. And I moved on to the next stage of the session. One of the RAs used a randomized method to assign half of the players the role of the dictator, and the other half was assigned the role of the recipient. And then, the dictators and recipients were randomly matched to each other. Their roles and, thus, their earnings were revealed to them at the end of the session. They were paid dollar for dollar for this task.

3.3 Bomb Risk Elicitation Task

To elicit the players' risk attitudes, they performed a Bomb Task before the Corruption game commenced on screen. In this part, participants were asked to choose any number of boxes between zero to twelve out of twelve boxes. Each box that they chose gave them a one for one dollar payout in this task as well. They were also informed that one box at random contained the ink bomb and selecting that would result in a zero payout. Each box had an equal probability of containing the ink bomb. The participants could select the boxes as shown below in any order they liked.



With 12 boxes and \$1 in each, a person who decides to open 'a' boxes will earn \$0 with a probability $a/12$ and will earn \$ a with probability: $(1- a)/12$. Selecting no boxes or all 12 would result in a zero payout for certain. The numerical association between the marked boxes and their corresponding payoff probabilities offers a distinct advantage. It enables the determination of an implied coefficient of relative risk aversion (CRRA) for each possible number of marked boxes. This means that by examining the relationship between the choices made (marking boxes) and the associated probabilities of receiving certain payoffs, I can estimate how risk-averse or risk-tolerant individuals are in different decision scenarios. Suppose the utility function that exhibits constant relative risk aversion (CRRA) is given by $u(w) = \frac{w^{1-r}}{1-r}$ for money income w and risk aversion r. The relationship between the number of boxes checked $'a'$ and $'r'$ is sketched as follows. If the total number of boxes is 12, the ink bomb will be randomly placed in a box. With 12 boxes total, if $'a'$ boxes are marked, then the probability of avoiding the bomb is $\frac{12-a}{12}$ and the associated utility is $\frac{a^{1-r}}{1-r}$. Since the utility of the 0 payoff is 0, the expected utility can be written as a product of the payoff probability and the utility: $\frac{12-a}{12}\ \frac{a^{1-r}}{1-r}$ Maximizing the expected utility, which is setting the derivative of expected utility to zero, I can classify the relation between the number of boxes checked $'a'$ and risk aversion $'r'$. It is given by $r = \frac{12-2a}{12-a}$. Note that, if half the boxes are checked i.e., $a = 6, r = 0$, which means a risk neutral person would mark half the boxes. A risk averse person would open less than six boxes, and a risk loving person would open more than six boxes. The BRET task allows the measurement of risk aversion while avoiding the effects of loss aversion since there are no negative earnings that would be coded as losses.

4. RESULTS

In the remainder of the paper, I will first analyze the pro-sociality and Bomb Task choices in order to relate the players' social and risk attitudes to their behavior as observed in our Common Pool Corruption Game, as well as in our Linked Common Pool Corruption Game. Afterwards, I examine if there were any significant differences between the baseline treatment and the linked treatment.

4.1 Decisions in Baseline and Linked Treatment

4.1.1 Baseline or Unlinked Treatment

In the Common Pool Corruption game[2], players were asked to make a decision where they could choose to open between 0 to 4 boxes. And if they chose 0 boxes, they would an equal share of the common pool $8.00 at the most (no one else also opened any boxes) or $1.14 at the least (everyone else opened all of their boxes). As described in Section 2 the probability of being detected if subject 'i' opens x_i boxes in any given round is given by $\frac{x_i}{\sum_{i=1}^{N} x_i}$. On average, the number of boxes opened in the baseline. The average number of boxes opened in the unlinked treatment with $\delta = 2$ was around 2 boxes per round. After the initial learning rounds 1 to 2, I observe that the average number of boxes opened increases from around 1 to steadily above 2 and hovers there. I also do not observe any difference between the odd and even rounds. The count of boxes opened

[2] Veconlab sessions under Common Pool Corruption: cpcz7, cpcz8, cpcz9, cpcz10.
Treatment: **Unlinked, $\boldsymbol{\delta = 2}$**

Veconlab sessions under Common Pool Corruption: cpcz15, cpcz16, cpcz 17, cpcz18.
Treatment: **Unlinked, $\boldsymbol{\delta = 1.5}$**

each round stays between 1-2.5 boxes, as evidenced by the table below.   However, in the unlinked treatment with $\delta = 1.5$, I observed convergence to the "No Steal" equilibrium, in one graph and the other 3 groups are increasing in their decisions as the rounds go on.

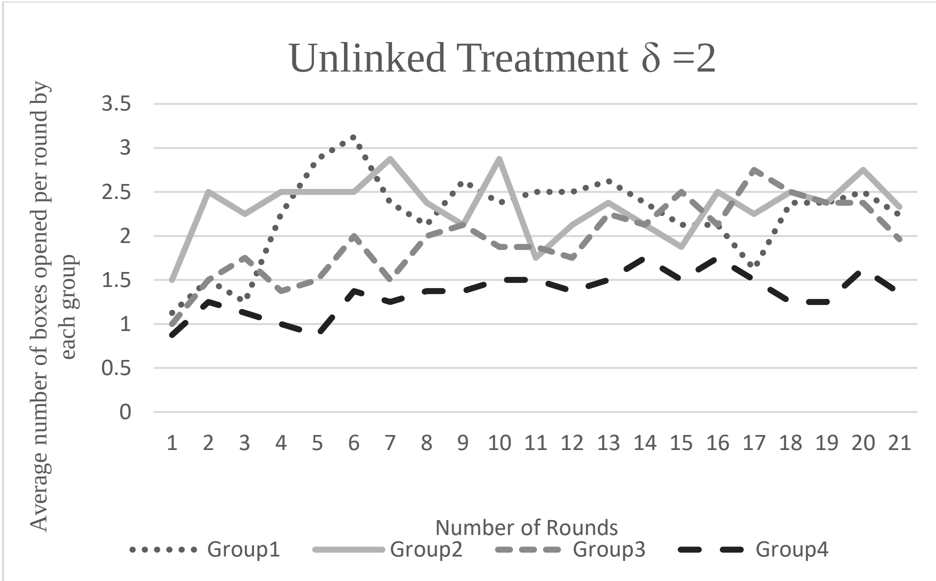


Figure 5: The above figure shows the shows the average number of boxes opened in each round across the four groups in the Unlinked Treatment with $\delta = 2$.

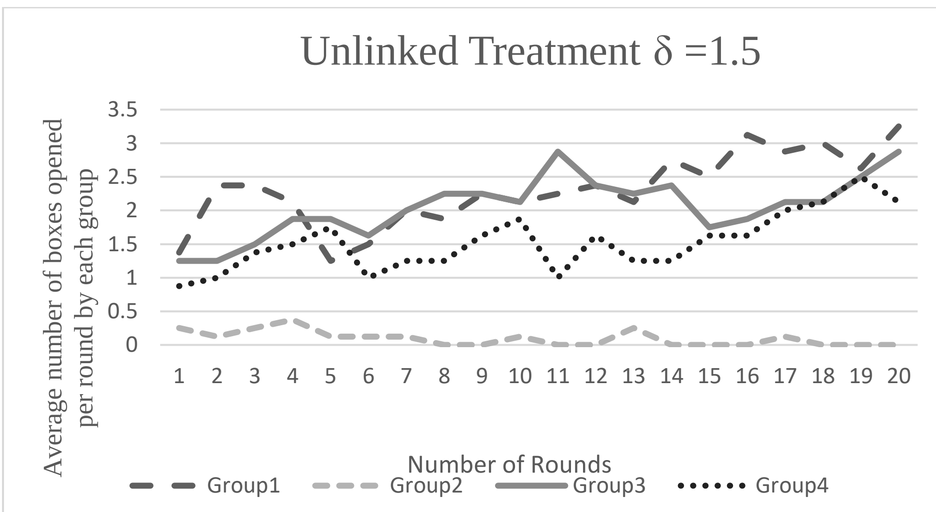


Figure 6: The above figure shows the shows the average number of boxes opened in each round across the four groups in the Unlinked Treatment with $\delta = 1.5$.

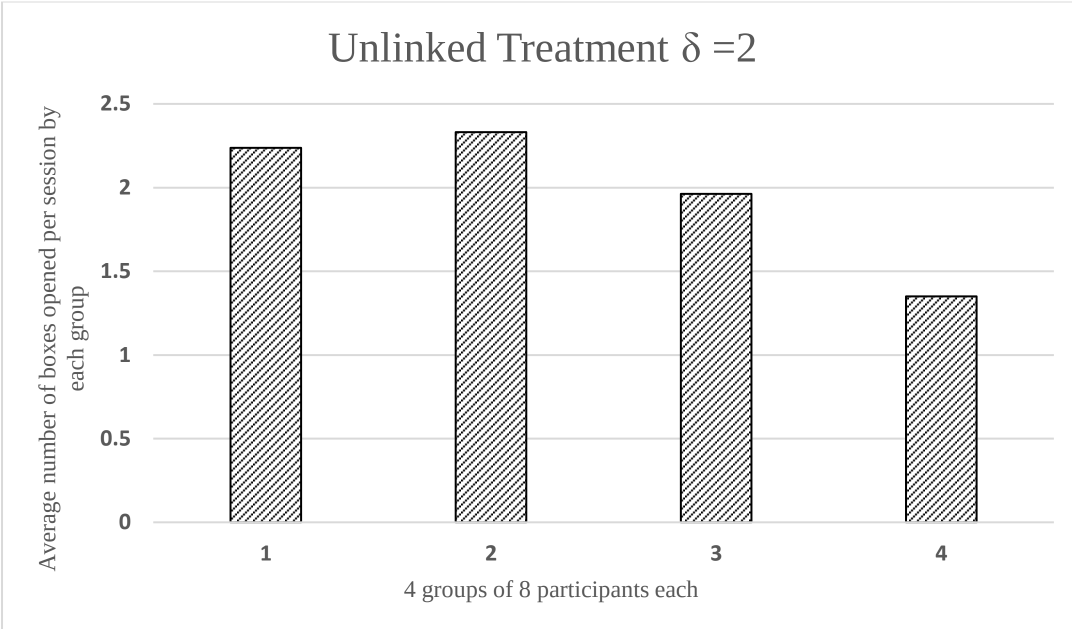


Figure 7: shows the average number of boxes opened by each group in the whole session.

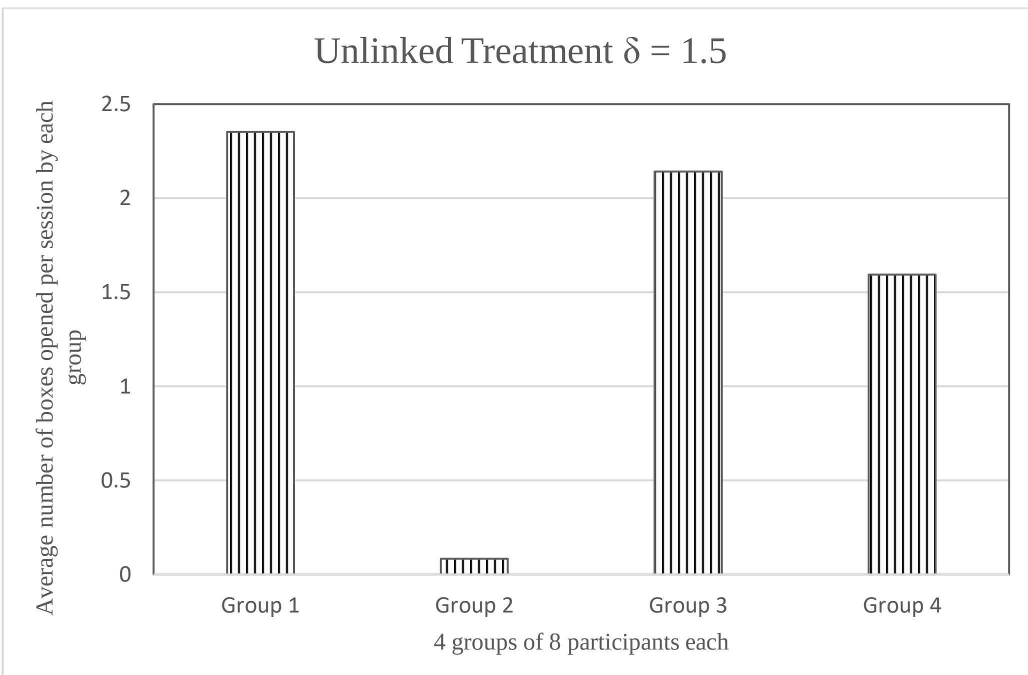


Figure 8: shows the average number of boxes opened by each group in the whole session.

4.1.2 Linked Treatment

In the Linked treatment of the Common Pool Corruption Game[3], players were asked to make a decision between 0 to 4 boxes, and their decisions in the odd round would have consequences for the even rounds. As described in Section 2, the probability of being detected in an odd round if subject 'i' opens x_i^o boxes is given by $\frac{x_i^o}{\sum_{i=1}^{N} x_i^o}$. Moreover, the probability of not being detected in the odd round and being detected in the even round is given by $[\frac{\sum_{j\neq i} x_j^o}{\sum_{j=1}^{N} x_j^o}\left(\frac{x_i^e}{\sum_{i=0}^{N} x_i^e}\right)]$. The probability of not being detected in the odd round and not being detected in the even round is given by $[\left(\frac{\sum_{j\neq i} x_j^o}{\sum_{i=0}^{N} x_i^o}\right)\left(\frac{\sum_{j\neq i} x_j^e}{\sum_{i=0}^{N} x_i^e}\right)]$. The average number of boxes opened in the linked treatment was around 1.5, which is less than the baseline treatment. Opening fewer boxes in the linked treatment is in line with our hypothesis that when corruption is studied as a long game, it is generally less than corruption in a one-shot game. The corrupt actors are more conservative with their decisions that have intertemporal consequences.

For the linked treatment with $\delta = 2$ after the initial learning rounds, I observe that the average number of boxes increases from 0 to 1 to 1 to 2. There is also a clear distinction between the odd and even rounds. The number of boxes opened in the odd rounds is always lower than the number of boxes opened in the even round. For the linked treatment with $\delta = 1.5$ Groups 1 and 2 actually converge to "No steal" Equilibrium and Group 3 and Group 4 approach the "All Steal"

[3] Veconlab sessions under Common Pool Corruption: cpcz2, cpcz5, cpcz 11, cpcz12.
Treatment: **Linked, $\boldsymbol{\delta = 2}$**
Veconlab sessions under Common Pool Corruption: cpcz13, cpcz14, cpcz 19, cpcz20.
Treatment: **Linked, $\boldsymbol{\delta = 1.5}$**

equilibrium. As opposed to the treatment with $\delta = 2$ where after an initial slight increase in the average decisions, there is a plateau reached.

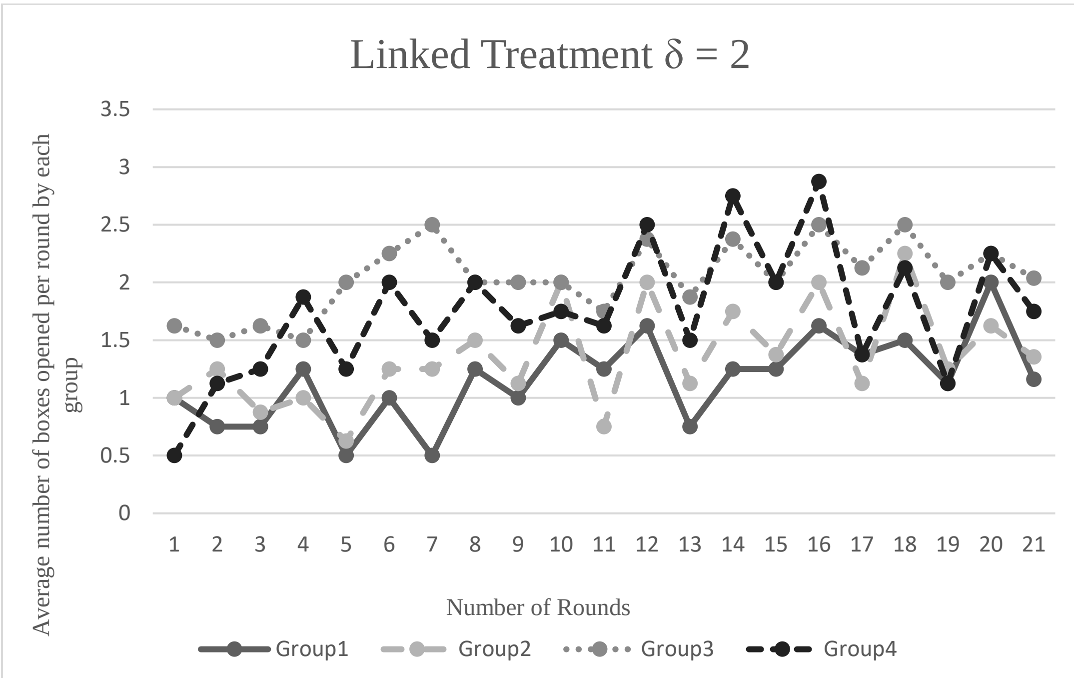


Figure 9: shows the average number of boxes opened in each round across the four groups in the linked treatment with $\delta = 2$.

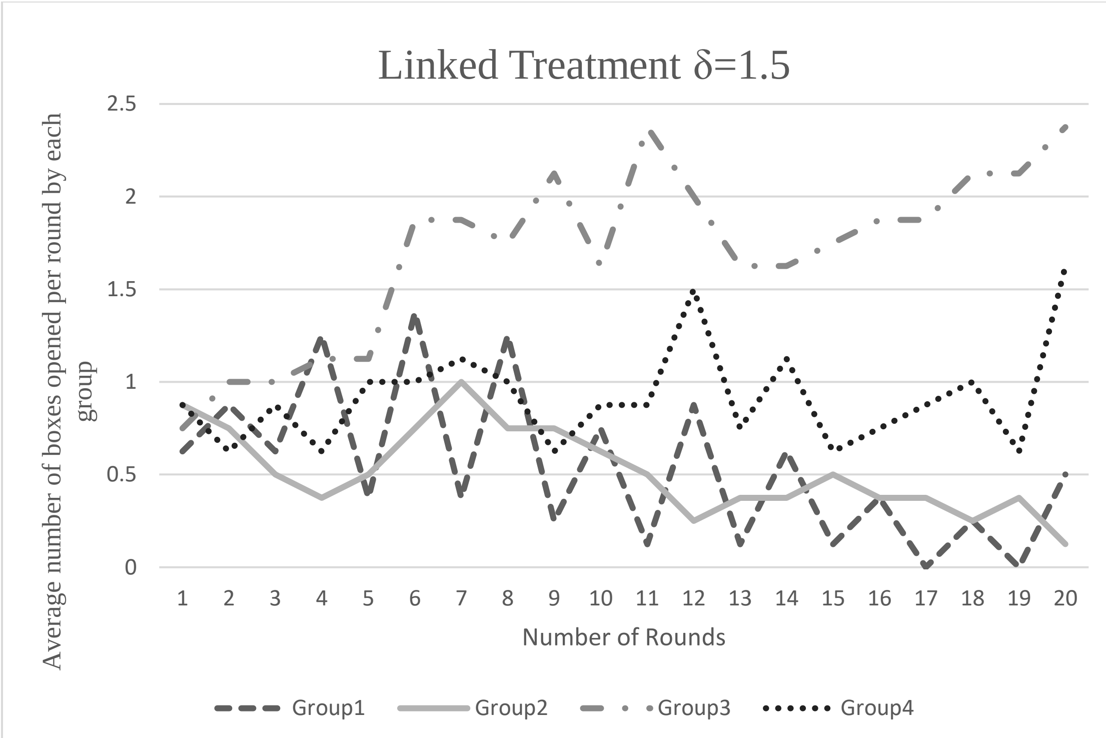


Figure 10: shows the average number of boxes opened in each round across the four groups in the linked treatment with $\delta = 1.5$.

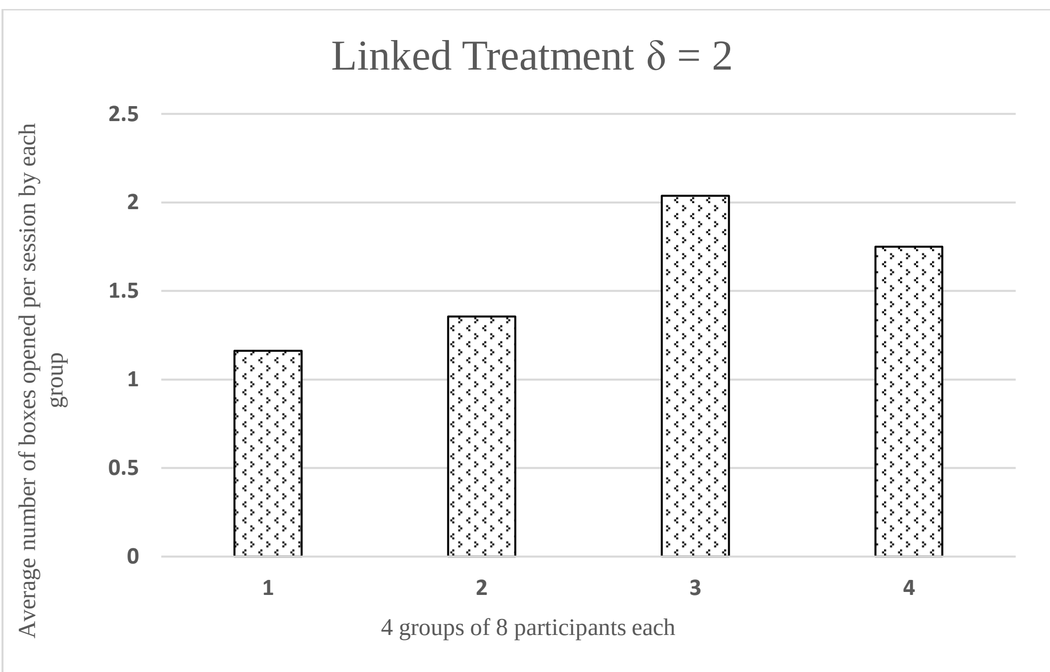


Figure 11: shows the average number of boxes opened by each group in the whole session.

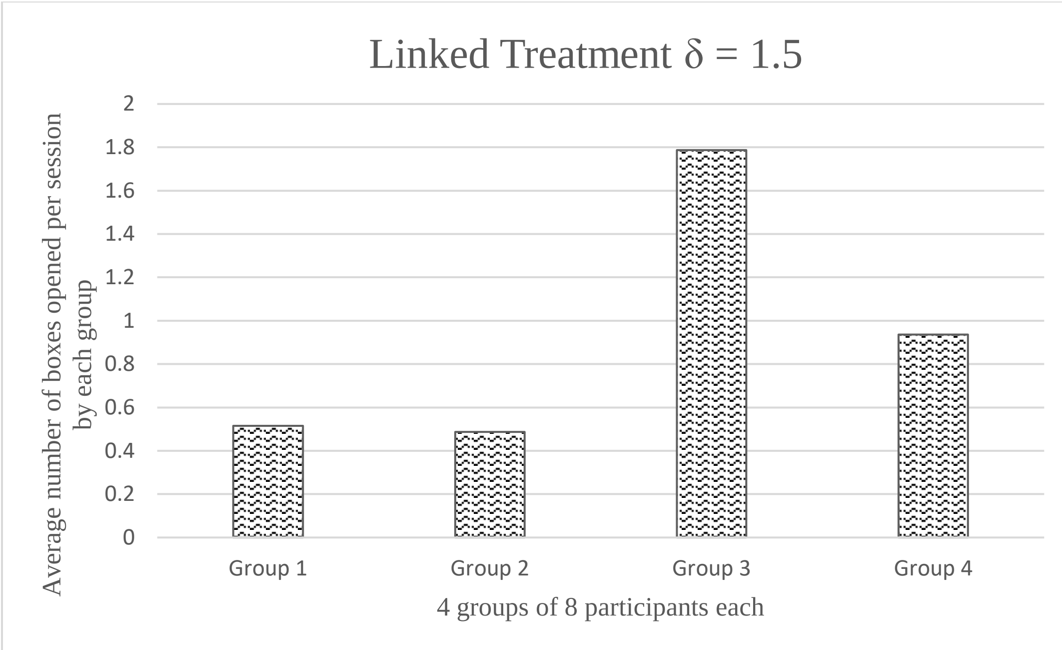


Figure 12: shows the average number of boxes opened by each group in the whole session.

4.2 Determinants of players' decisions – Regressions

I use regression models (see Table 1) to evaluate the factors that influence decisions in the game. As for explanatory variables, I use pro-sociality, which was characterized by the modified dictator game, the risk attitude characterized by bomb risk elicitation task at the beginning of the experiment, and gender which was self-identified. I use a variation of an ordered logit or a proportional odds model with clustering at subject level to analyze the effect of various factors on players' decisions. Keep in mind that decision here means number of boxes selected between 0 to 4. And I attribute opening more boxes to being more corrupt. The treatment variable here is the 'Linked' round where being caught in the odd rounds leads to earning 0 dollars in the odd and the subsequent even round. The results show a highly significant difference between the linked and the independent rounds. Which means if a player is in the linked round treatment, they open few boxes. Or being in the linked round treatment has an inverse effect on opening boxes. I also observe if a player is in an odd round and in the linked treatment there is a highly significant effect on their decision. Being in the linked rounds treatment has the effect of opening fewer boxes in the odd round as opposed to the baseline. This behavior of opening less boxes in the odd-linked rounds makes us reject the null hypothesis in favor of the alternative as stated in Section 2.

The two hypotheses that I will test for this experiment are as follows:

Hypothesis 1: Is there a significant change in corruption (decision) when the social cost of corruption (δ) changes?

When δ is changed from 2 to 1.5 in the experiment, corruption could *i)* increase: as the common pool never goes to zero when $\delta = 1.5$, so the guilt associated with negative externality of corruption goes down *ii)* corruption decreases: the risk averse actors who didn't want to indulge in corruption before but forced to supplement their income can now not participate in corruption as the pool never goes to zero when $\delta = 1.5$.

Hypothesis 2: Can the intertemporal cost of punishments effectively mitigates corruption over an extended period? Specifically, does the implementation of such measures lead to the displacement of corruption from the present to the future?

Logit Regression on Decision (number of boxes opened)

Explanatory Variables	Estimate	Standard Error
Pro-Sociality	0.02745	0.06673
Risk Aversion	-0.63181	0.19737**
Gender (Male)	0.02894	0.15706
Unlinked (**δ = 1.5**)	-0.63990	0.23252
Linked (**δ = 2**)	-0.36464	0.22882**
Linked (**δ = 1.5**)	-1.14424	0.22738***
Odd Round	-0.15312	0.07655*
Unlinked: Odd (**δ = 1.5**)	0.07812	0.10825
Linked:Odd (**δ = 2**)	-0.33750	0.10825**
Linked:Odd (**δ = 1.5**)	-0.02188	0.10825

*Significant codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1*

Table 1: Regression coefficients to predict the effect of unlinked and linked treatment, risk attitudes, pro-sociality and gender on decsions. The dependant variable here which is the 'Decision' variable or the number of boxes opened by each player represents corruptions. The more boxes that are openned represent more corruption. An ordered logit was used to to regress decision on the various independent variables. Gender and pro-socialty had no significant effects on decision were observed. Risk Aversion is negatively effects the decision. This means the more risk averse one is, less boxes they open. There is a highly significant effect of the Linked treatment, which means when there is an intertemporal cost to corruption, corruption goes down or in other words it becomes a long game. And when the participant is in the linked treatment in an odd round there is a highly significant negative effect on decision to be corrupt. Since, being corrupt in the odd period has a stricter punishment in the even period of the linked treatment as opposed to the unlinked treatment.

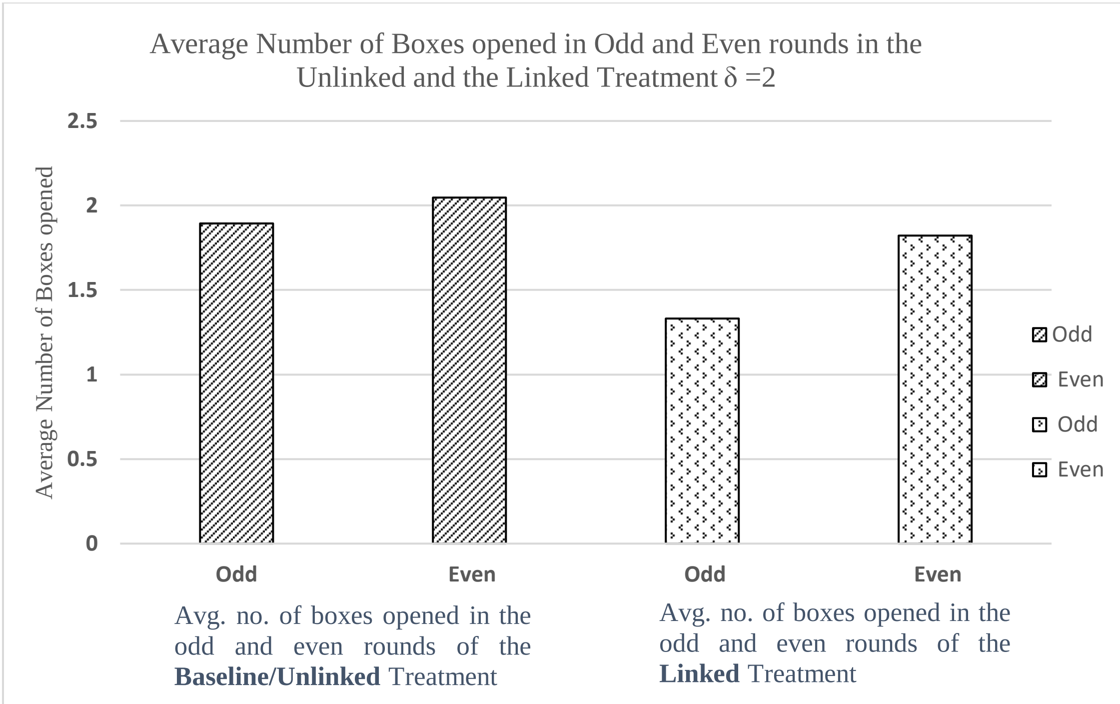


Figure 13: Average Number of Boxes opened in odd rounds of the linked treatment $\delta = 2$.

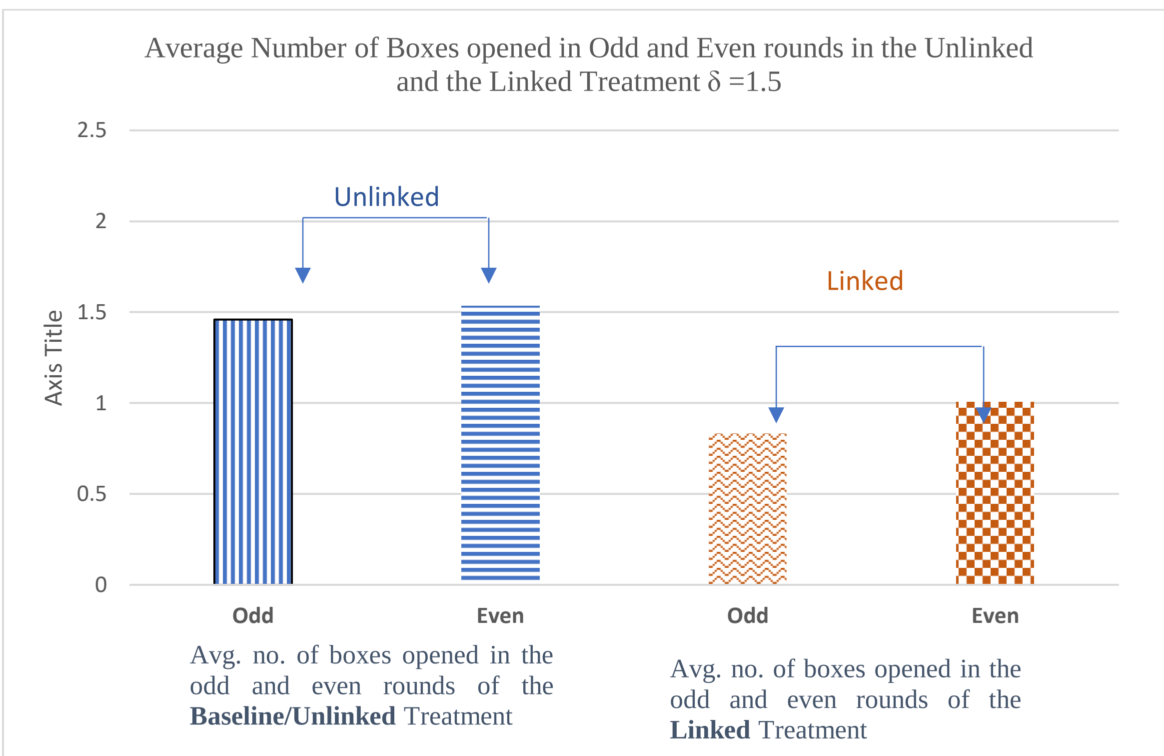


Figure 14: Average Number of Boxes opened in odd rounds of the linked treatment $\delta = 1.5$.

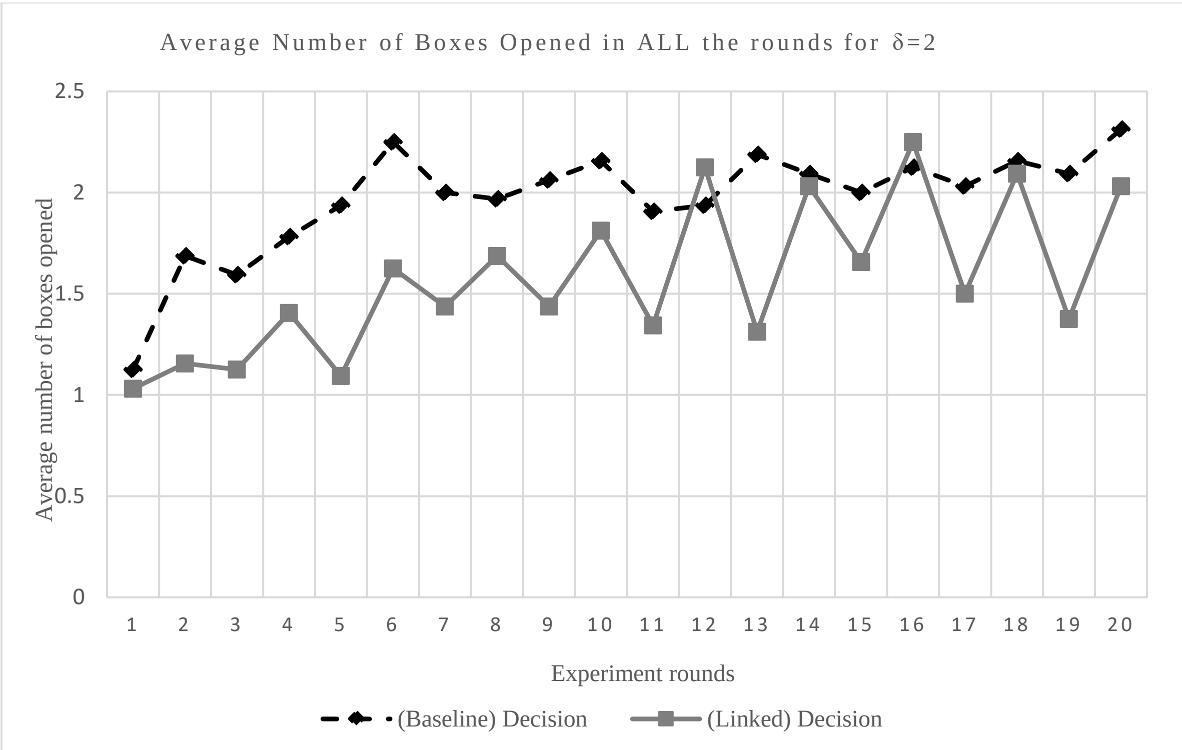


Figure 15: Average Number of Boxes opened in all rounds in the Baseline and the Linked Treatment.

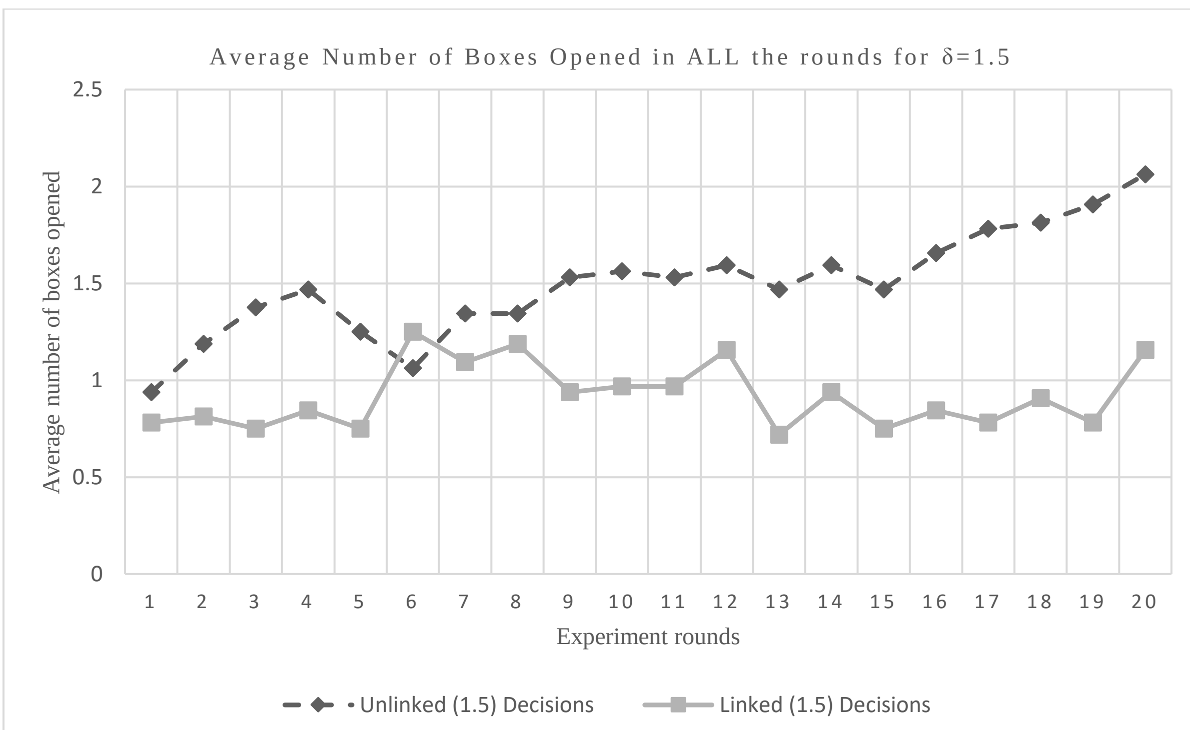


Figure 16: Average Number of Boxes opened in all rounds in the Baseline and the Linked Treatment.

4.3 Pro-Sociality – Dictator Game

I conducted a modified version of the dictator game to elicit the pro-sociality preferences of our players. The dictator game is considered a weak measure of pro-sociality. I use role uncertainty to be cost effective. With role uncertainty, all subjects initially make a decision in the role of the dictator. Afterward, actual player roles are assigned randomly, the determined allocators (as I call them in the game instructions) or the dictators are randomly matched with the recipients, and the players are paid according to the decision of the actual, assigned dictator (e.g., Charness and Grosskopf, 2001; Engelmann and Strobel, 2004; Iriberri and Rey-Biel, 2011). This allows us to get one observation per participant and the Dictator Game applicable is a "companion measure" of altruism or pro-sociality. Eckel and Grossman (1996a, 1998) use a double-anonymous dictator game to show women are twice more selfless than men. The more money that is allocated by the participant, the more pro-social they are. There is however also evidence to show, if controlling for societal culture and values women and men tend to have the same pro -social behavior such as dictator giving (Gong, B., Yan, H. & Yang, CL. (2015)). Women and men both seemed to allocate similarly. Out of the 116 subjects who decided to allocate $2.5 or less 55.2% were women and 44.83%were men. The proportion of women and men who decided to allocate

$0 was also similar, 24% of the women and 28% of the men. Around 26.76% of women decided to allocate $2.5 or higher as opposed to only 15.8% of the men. However, no statistically significant difference was found between the decisions of men and women. A Wilcoxon-Rank Sum test was used, and the corresponding p-value was equal to - 0.5078.

Dictator Allocation	0	0.5	1	1.5	2	2.5	3	5	Total
Female	17	1	15	2	17	12	4	3	71
Male	16	0	12	0	20	4	3	2	57
Total	33	1	27	2	37	16	7	5	128

Table 2: This table represents the allocation choice by each subject as the dictator role.

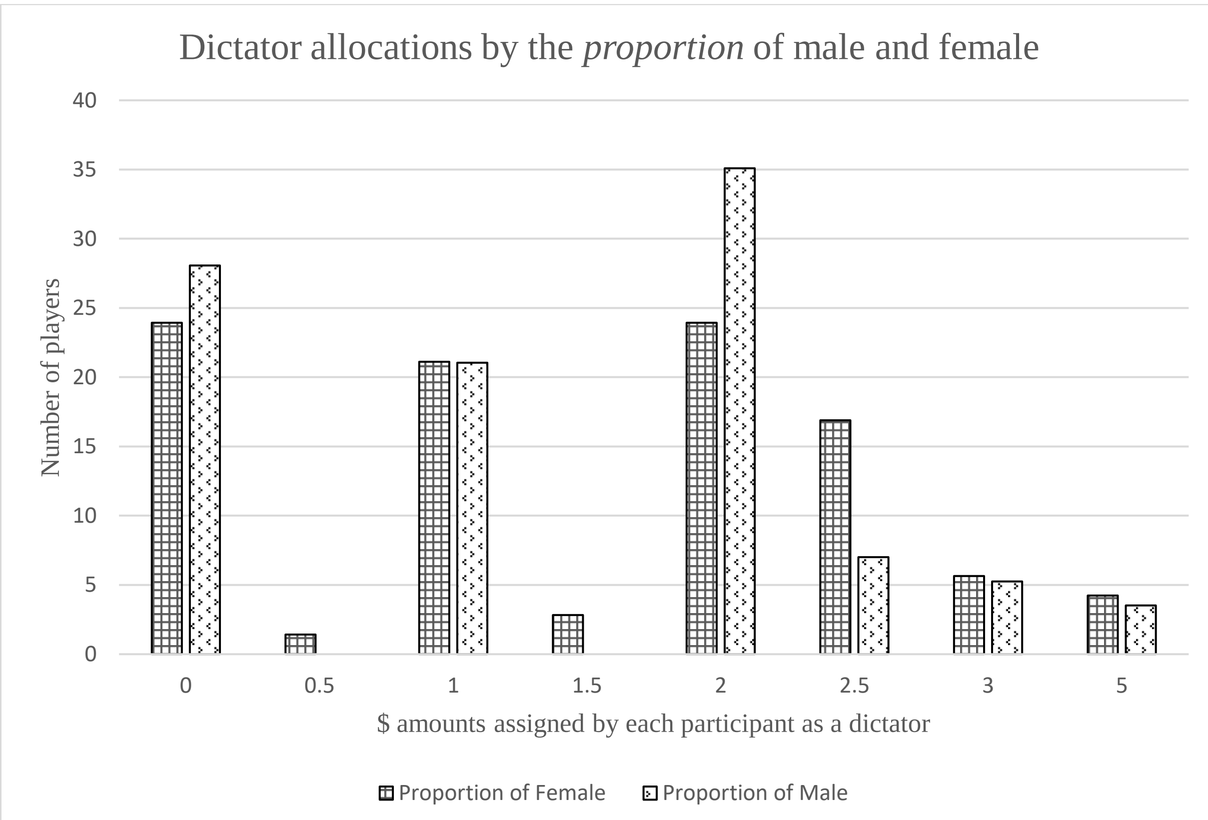


Figure 17: In a Dictator Game with role uncertainty, all participants make a decision as if they were the dictator. This means they know they can keep all the money or give some to the other player, but they don't know if they will actually be the dictator. After all decisions are made, the roles are randomly assigned. The determined allocators (or dictators) are then randomly matched with the recipients, and the players are paid according to the decision of the actual, assigned dictator. The more money that is allocated by the participant, the more pro-social they are. The figure above represents how much money each participant chose to allocate as a dictator. The figure also bifurcates the data by the proportion of the 2 genders (self-identified by the participants). We found no statistically significant difference between the decisions of men and women.

4.4 Risk Attitude Elicitation – Bomb Task

There has been some evidence in economic literature to show women tend to be more risk averse than men, as previous surveys of economics (Eckel & Grossman, 2008c) and psychology (Byrnes, Miller, and Schafer 1999) have reported this conclusion women are more risk averse than men in the vast majority of environments and tasks. Most notably, Charness & Gneezy (2011) analyzed fifteen different data sets from experiments around the world that were not designed to investigate gender differences in risk aversion. They were all conducted in different countries, with different styles of instructions and different payment structures, and unequivocally they all showed that men are more risk loving than women. However, there is also ample evidence to show that there aren't any gender differences in risk aversion, such as Holt & Laury (2002) menu and Crossetto & Filipin (2013) ink bomb measures.

I conducted a modified version of the original Bomb Risk Elicitation Task (BRET) by Crossetto & Filipin (2013). I do not observe a big difference between the decisions of men and women in their decisions to open boxes. This is in line with what Crossetto & Filipin (2023) observe that gender effects are dependent on context. They perform three widely used risk attitude elicitation tasks, BRET being one of them, to find a causally significant effect of the presence of a 'safe option'. They show that the absence of a safe option results in women being significantly more risk averse than men in some of the commonly used risk attitude elicitation tasks. Charness et al. (2018) have also shown that the complexity of the task affects differences observed in male and female risk attitude. Out of 44 subjects who opened six or more boxes, 56.82% were women, and 43.18% were men. However, I found no statistically significant difference between the decisions of men and women. A Wilcoxon-Rank Sum test was used, and the corresponding p-value was equal to - 0.4486.

No. of boxes selected	2	3	4	5	6	7	8	
Risk Aversion	0.8	0.67	Risk Neutral	0.29	0	Risk Averse -0.4	-1	Total
Female	3	5	17	21	16	4	5	71
Male	2	8	13	15	15	2	2	57
Total	Risk Loving -	13	30	36	31	6	7	128

Table 3: summarizes the risk attitudes of the subjects. It shows the number of boxes opened by subjects out of 12 and also categorizes the decisions by gender. Risk Loving <0, Risk Neutral = 0, Risk Averse > 0.

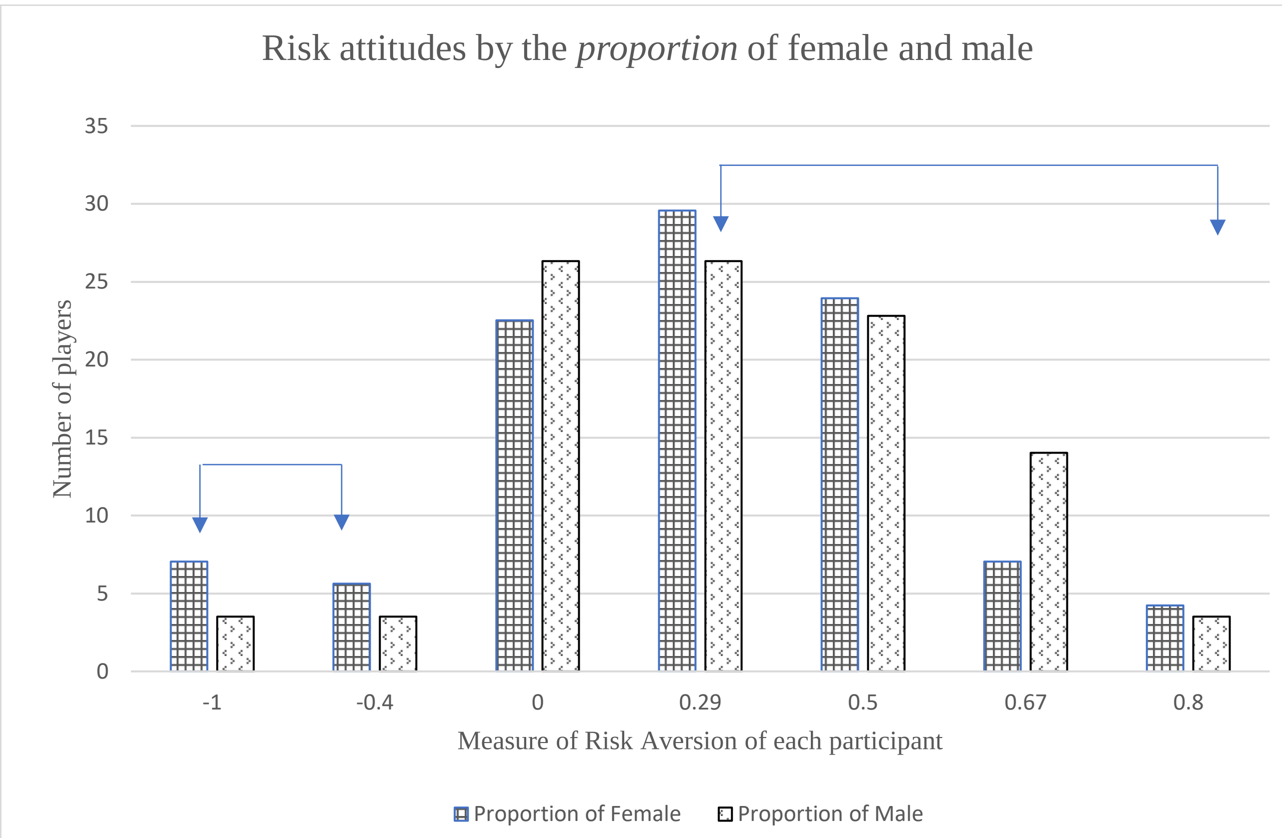


Figure 18: players' risk attitudes were assessed using a Bomb Task before playing the Corruption game on screen. They could choose between 0 to 12 boxes, with each box chosen giving a $1 payout, but one box contained an ink bomb resulting in no payout. Participants could select boxes in any order they liked. A risk-neutral person would choose six boxes, while a risk-averse individual would pick fewer, and a risk-loving person would select more than six. The BRET task effectively measures risk aversion without the influence of loss aversion since there are no negative earnings considered as losses. Risk Loving <0, Risk Neutral = 0, Risk Averse > 0. We found no statistically significant difference between the decisions of men and women.

5. CONCLUSION

I designed a novel experiment to study corruption as a coordination game in the lab, an important next step in understanding the widespread corruption phenomena in developing countries. In the Common Pool Corruption experiment with the 2x2 treatment setup I observe the two different equilibria of “No Steal” and “All Steal” as I change the damages, or the cost of corruption associated with stealing from the common pool. As the cost of stealing decreases, the pull towards either equilibrium becomes more pronounced in both the linked and the unlinked treatments. I also successfully show that there is a significant effect when corruption is studied as a 2-period game as opposed to studying it as a one-shot game. The next step in this common pool corruption model is varying the probability of audits and test it with different group sizes. I have ran pilot sessions in the laboratory which indicate that, even with a probability of audit in a smaller group size, can be very effective in deterring corruption. Also, evolving the common pool corruption model to introduce the auditor as another subject and test for vertical interdependence as in a principle-agent model. Common pool corruption captures a unique and pervasive form of petty corruption in the day-to-day life of people in developing countries. And understanding it and studying the lab provides a helpful insight into developing future policy measures to combat it.

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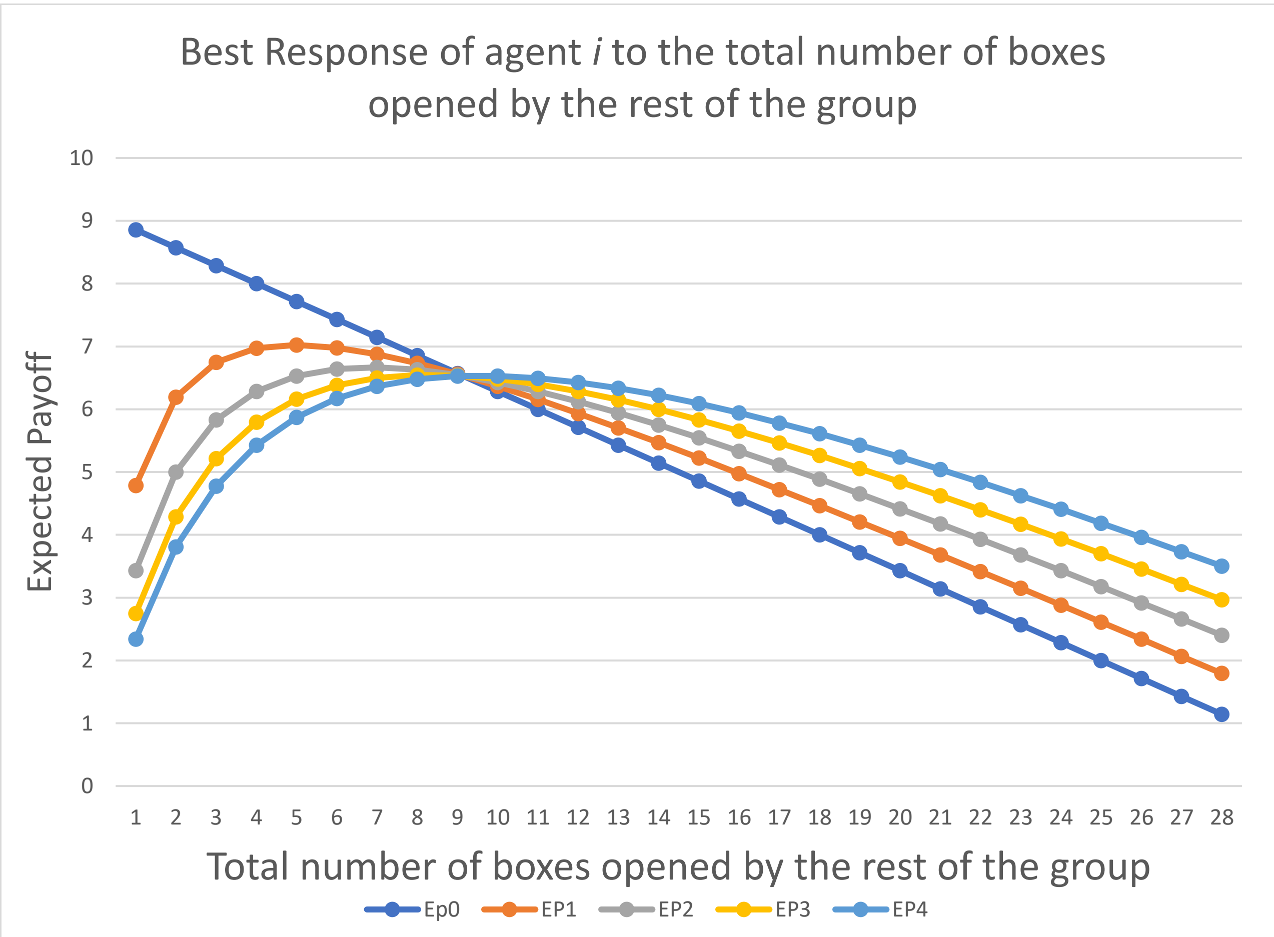
6. APPENDIX

Chapter 2 Appendix

Mixed Strategy Equilibrium



The above figure shows that picking between 0 and 4 boxes is always the best option. The choice flips from 0 to 4 in 9-10 boxes as opened by the rest of the group. **Each line represents the expected payoff for agent i if they picked 0 boxes (EP0), 1 box (EP1), etc.**

For agent x_i to be indifferent between 0 and 4 boxes their Expectation of the two expected payoffs should be equal

$$\mathbb{E}\left(Y\ \left[\frac{0\ +\phi}{Y+0}-\frac{\delta}{(N-1)}\right]\right)=\ \mathbb{E}\left(Y\left[\frac{4+\phi}{Y+4}-\frac{\delta}{(N-1)}\right]\right)$$

The above expression is from equation (7) above.

$$\mathbb{E}\left(Y\frac{\phi}{Y}\right) - \mathbb{E}\left(\frac{\delta}{N-1}\right) = \mathbb{E}\left(Y\left[\frac{4+\phi}{Y+4}\right]\right) - \mathbb{E}\left(\frac{\delta}{N-1}\right)$$

I have to show that each official is indifferent between 0 and 4 when all remaining players choose 4 with a probability p .

Let $k = 0, 4, 8,12, 16,20,24,28$ which is the decision of all the players not agent i

ϕ can be considered a sure payment. And on the right-hand side if the agent i chooses 4 the other officials choose k

$$\phi = \sum_k \mathbb{P}(Y = k)\, k \left[\frac{4+\phi}{4+k}\right] \qquad k = 0, 4, 8,12, 16,20,24,28$$

$$\frac{\phi}{4+\phi} = \sum_k \mathbb{P}(Y = k)\left[\frac{k}{4+k}\right]$$

Let $k' = \frac{k}{4}$

$$\frac{\phi}{4+\phi} = \sum_k \mathbb{P}(Y = k)\left[\frac{k'}{1+k'}\right]$$

Since there are a total of N agents and k' ways to choose them, I will have the following binomial:

$$\frac{\phi}{4+\phi} = \sum_{k'} \binom{N}{k'} p^{k'} (1-p)^{N-k'} \left[\frac{k'}{1+k'}\right]$$

$$q_{k'} = \binom{N}{k'} p^{k'} (1-p)^{N-k'}$$

For $p = 0.404$ I obtain $q = (q_0, \dots, q_7) = (0.127, 0.258, 0.291, 0.197,\ 0.080, 0.018, 0.002)$, which results in:

$$\frac{\phi}{4+\phi} = \sum_{k'=1}^{k'=7} \binom{N}{k'} p^{k'} (1-p)^{N-k'} \left[\frac{k'}{1+k'}\right]$$

Where $\phi = \frac{64}{7}$ □

However, as I have already discussed above the mixed strategy equilibrium will be unstable any deviation from this average by one player can lead to a situation where the best response for the other players changes, leading them to open more or fewer boxes to maximize their payoff. This makes the equilibrium unstable.

Linked rounds First order conditions.

I will now consider a 2-period model where rounds 1 and 2 are interdependent. The expected payoff for agent i in a pair of rounds will be, denoted by EP_i, which is given in equation (16). The boxes opened by agent i in the first period will be denoted by x_{1i}. Equation (16) represents the case where agent i chooses to open $x_{1i} \geq 0$ boxes and at least one box is opened by the rest of the group in the first and second period, $\sum_{j\neq i} x_{1j}, \sum_{j\neq i} x_{2j} > 0$. Since one player will always be detected whenever at least one person opens a box, the common pool will get divided among $N-1$ players in the first period. And the common pool will get divided between $N-2$ players in the second period, since the player detected in the first period does not participate in the second period. The product of the two probabilities in the second term of equation (16) determines the probability that the agent i is not caught either period.

Consider a continuous model to identify values of $N, \delta\ and\ \alpha$ for which there is a Nash equilibrium that is "interior" and not at a corner. The following is the case where $\sum_{j\neq i} x_{1j} > 0, \sum_{j\neq i} x_{2j} > 0 \quad for\ all\ j \neq i.$

Let $Y_1\ and\ Y_2$ be equal to everyone's decisions but agent i in period 1 and 2 respectively.

$$Y_1 = \sum_{j\neq i} x_{1j}\ , Y_2 = \sum_{j\neq i} x_{2j} \tag{15}$$

The expected payoff function will be given by for agent i is given by:

$$EP_i = \frac{Y_1}{Y_1 + x_{1i}}\left[x_{1i} + \frac{\alpha N - \delta x_{1i} - \delta Y_1}{N-1}\right] + \left(\frac{Y_1}{Y_1 + x_{1i}}\right)\left(\frac{Y_2}{Y_2 + x_{2i}}\right)\left[x_{2i} + \frac{\alpha(N-1) - \delta x_{2i} - \delta Y_2}{N-2}\right] \tag{16}$$

$$Let \frac{\alpha N}{N-1} = \phi_1\ and\ \frac{\alpha(N-1)}{N-2} = \phi_2 \tag{17}$$

$$EP_i = \frac{Y_1}{Y_1 + x_{1i}}\left[x_{1i} + \phi_1 - \frac{\delta(x_{1i} + Y_1)}{N-1}\right] + \left(\frac{Y_1}{Y_1 + x_{1i}}\right)\left(\frac{Y_2}{Y_2 + x_{2i}}\right)\left[x_{2i} + \phi_2 - \frac{\delta(x_{2i} + Y_2)}{N-2}\right] \tag{18}$$

Taking the denominator $Y + x_i$ inside the brackets:

$$EP_i = Y_1 \left[\frac{x_{1i} + \phi_1}{Y_1 + x_{1i}} - \frac{\delta(Y_1 + x_{1i})}{(Y_1 + x_{1i})(N-1)}\right] + \left(\frac{Y_1}{Y_1 + x_{1i}}\right) Y_2 \left[\frac{x_{2i} + \phi_2}{Y_2 + x_{2i}} - \frac{\delta(Y_2 + x_{2i})}{(Y_2 + x_{2i})(N-2)}\right] \quad (19)$$

$Y + x_i$ cancels out in the numerator and the denominator of the second term inside the bracket.

$$EP_i = Y_1 \left[\frac{x_{1i} + \phi_1}{Y_1 + x_{1i}} - \frac{\delta}{(N-1)}\right] + \left(\frac{Y_1}{Y_1 + x_{1i}}\right) Y_2 \left[\frac{x_{2i} + \phi_2}{Y_2 + x_{2i}} - \frac{\delta}{(N-2)}\right] \quad (20)$$

Taking partial derivative with respect to x_{1i} and x_{2i} and setting the derivatives equal to zero:

$$\frac{\partial(EP_i)}{\partial x_{1i}} = 0 \quad (21)$$

$$\frac{\partial(EP_i)}{\partial x_{2i}} = 0 \quad (22)$$

$$\frac{\partial(EP_i)}{\partial x_{1i}} = \frac{Y_1}{(Y_1 + x_{1i})^2}[(x_{1i} + \phi_1) - (Y_1 + x_{1i})] - \frac{Y_1}{(Y_1 + x_{1i})^2} Y_2 \left[\frac{x_{2i} + \phi_2}{Y_2 + x_{2i}} - \frac{\delta}{(N-2)}\right] = 0 \quad (23)$$

x_{1i} cancels in the first order condition with respect to x_{1i} :

$$\phi_1 - Y_1 - Y_2 \left[\frac{x_{2i} + \phi_2}{Y_2 + x_{2i}} - \frac{\delta}{(N-2)}\right] = 0 \quad (24)$$

$$\frac{\partial(EP_i)}{\partial x_{2i}} = Y_2 \left[\frac{(x_{2i} + \phi_2) - (Y_2 + x_{2i})}{(Y_2 + x_{2i})^2}\right] = 0 \quad (25)$$

x_{2i} cancels in the first order condition with respect to x_{2i} :

$$Y_2 \quad \left[\frac{\phi_2 - Y_2}{(Y_2 + x_{2i})^2}\right] = 0 \tag{26}$$

I can also analyze for symmetric equilibrium $Y_2 \ = \ (N-2)x_2^*$. For (26) to be zero the following will hold

$$Y_2 = \phi_2 \tag{27}$$

$$(N-2)x_2^* = \frac{\alpha(N-1)}{N-2} \tag{28}$$

The second period is similar to the one-shot game, where $Y_2 = \phi_2$ and assuming symmetric equilibrium gives us $x_2^* = \frac{\alpha(N-1)}{(N-2)^2}$ which in my experiment is equal to $x_2^* = \frac{56}{36}$. Taking the value of $x_2^* = \frac{56}{36}$ and putting it in equation (24) while also assuming symmetric equilibrium $Y_1 = (N-1)x_1^*$ and solving for x_1^* will give us the following:

$$\phi_1 - Y_1 \ = Y_2\left[\frac{x_{2i} + \phi_2}{Y_2 + x_{2i}} - \frac{\delta}{(N-2)}\right] \tag{29}$$

$$x_1^* = \alpha\left[\frac{N}{(N-1)^2} - \frac{N-2-\delta}{(N-2)^2}\right] \tag{30}$$

$$x_1^* \approx 0.417, x_2^* \ \approx 1.556 \tag{31}$$

Consider a continuous model to identify values of $N, \delta\ and\ \alpha$ for which there is a Nash equilibrium that is "interior" and not at a corner. The following is the case where no boxes are opened in the first period and everyone but agent i opens at least one box.

$$EP_i = \frac{\alpha N}{N} + \left(\frac{\sum_{j \neq i} x_{2j}}{\sum_{j=1}^{N} x_{2j}}\right)\left(x_{2i} + \frac{\alpha N - \delta \sum_{j=1}^{N} x_{2j}}{N-1}\right)$$

$$x_{1j} = 0 \text{ for all } j \in \{1, N\} \text{ and } \sum_{j \neq i} x_{2j} > 0 \text{ for all } j \neq i \qquad (5)$$

$$Let\ Y = \sum_{j \neq i} x_{2j}$$

$$EP_i = \frac{\alpha N}{N} + \left(\frac{Y}{Y + x_{2i}}\right)\left(x_{2i} + \frac{\alpha N - \delta(Y + x_{2i})}{N-1}\right)$$

$$Let \frac{\alpha N}{N-1} = \phi$$

$$EP_i = \frac{\alpha N}{N} + \left(\frac{Y}{Y + x_{2i}}\right)\left(x_{2i} + \phi - \frac{\delta(Y + x_{2i})}{N-1}\right)$$

Taking the denominator $Y + x_{2i}$ inside the brackets:

$$EP_i = \frac{\alpha N}{N} + Y \left[\frac{x_{2i} + \phi}{Y + x_{2i}} - \frac{\delta(Y + x_{2i})}{(Y + x_{2i})(N-1)}\right] \qquad (6)$$

$Y + x_{2i}$ cancels out in the numerator and the denominator of the second term inside the bracket.

$$EP_i = \frac{\alpha N}{N} + Y \left[\frac{x_{2i} + \phi}{Y + x_{2i}} - \frac{\delta}{(N-1)}\right] \qquad (7)$$

Taking partial derivative with respect to x_{2i}

$$\frac{\partial(EP_i)}{\partial x_{2i}} = \frac{\partial\left(\frac{\alpha N}{N} + Y \left[\frac{x_{2i}+\phi}{Y+x_{2i}} - \frac{\delta}{(N-1)}\right]\right)}{\partial x_{2i}} \tag{8}$$

Setting the derivative equal to zero:

$$\frac{\partial(EP_i)}{\partial x_{2i}} = 0 \tag{9}$$

$$Y \left[\frac{(x_{2i}+\phi)-(Y+x_{2i})}{(Y+x_{2i})^2}\right] = 0 \tag{10}$$

x_{2i} cancels in the first order condition.

$$Y \left[\frac{\phi - Y}{(Y+x_{2i})^2}\right] = 0 \tag{11}$$

I can also analyze for symmetric equilibrium $Y = (N-1)x^*$. For (11) to be zero the following will hold

$$Y = \phi \tag{12}$$

$$(N-1)x^* = \frac{\alpha N}{N-1} \tag{13}$$

Simplifyihold.he above gives a solution for x^* in a continuous model

$$x^* = \frac{\alpha N}{(N-1)^2} \tag{14}$$

In my experiment this will equal

$$x^* = \frac{64}{49}$$

Consider a continuous model to identify values of N, δ *and* α for which there is a Nash equilibrium that is "interior" and not at a corner. The following is the case where everyone but agent i opens at least one box in the first period and no one opens any boxes in the second period.

$$EP_i = \frac{\sum_{j\neq i} x_{1j}}{\sum_{j=1}^{N} x_{1j}} \left(x_{1i} + \frac{\alpha N - \delta \sum_{j=1}^{N} x_{1j}}{N-1}\right) + \left(\frac{\sum_{j\neq i} x_{1j}}{\sum_{j=1}^{N} x_{1j}}\right) \left(\frac{\alpha N}{N}\right)$$

$$With \sum_{j\neq i} x_{1j} > 0 \;\; for\, all\, j \neq i \quad and\; x_{2j} = 0 \; for\, all\, j = i.$$

$$Let\; Y = \sum_{j\neq i} x_{1j}$$

$$EP_i = \frac{Y}{Y + x_{1i}} \left(x_{1i} + \frac{\alpha N - \delta(Y + x_{1i})}{N-1}\right) + \left(\frac{Y}{Y + x_{1i}}\right) \left(\frac{\alpha N}{N}\right)$$

$$Let \frac{\alpha N}{N-1} = \phi$$

$$EP_i = \frac{Y}{Y + x_{1i}} \left(x_{1i} + \phi + \frac{\delta(Y + x_{1i})}{N-1}\right) + \left(\frac{Y}{Y + x_{1i}}\right) \left(\frac{\alpha N}{N}\right)$$

Taking the denominator $Y + x_{1i}$ inside the brackets:

$$EP_i = Y \left[\frac{x_{1i} + \phi}{Y + x_{1i}} - \frac{\delta(Y + x_{1i})}{(Y + x_{1i})(N-1)}\right] + \left(\frac{Y}{Y + x_{1i}}\right) \left(\frac{\alpha N}{N}\right) \tag{6}$$

$Y + x_{1i}$ cancels out in the numerator and the denominator of the second term inside the bracket.

$$EP_i = Y \left[\frac{x_{1i} + \phi}{Y + x_{1i}} - \frac{\delta}{(N-1)}\right] + \left(\frac{Y}{Y + x_{1i}}\right)\left(\frac{\alpha N}{N}\right) \tag{7}$$

Taking partial derivative with respect to x_{1i}

$$\frac{\partial(EP_i)}{\partial x_{1i}} = \frac{\partial\left(Y \left[\frac{x_{1i} + \phi}{Y + x_{1i}} - \frac{\delta}{(N-1)}\right] + \left(\frac{Y}{Y + x_{1i}}\right)\left(\frac{\alpha N}{N}\right)\right)}{\partial x_{1i}} \tag{8}$$

Setting the derivative equal to zero:

$$\frac{\partial(EP_i)}{\partial x_{1i}} = 0 \tag{9}$$

$$Y \left[\frac{(x_{1i} + \phi) - (Y + x_{1i})}{(Y + x_{1i})^2}\right] - \frac{Y\alpha}{(Y + x_{1i})^2} = 0 \tag{10}$$

x_{2i} cancels in the first order condition.

$$Y \left[\frac{\phi - Y - \alpha}{(Y + x_{1i})^2}\right] = 0 \tag{11}$$

I can also analyze for symmetric equilibrium Y = (N-1) x*. For (11) to be zero the following will hold

$$Y = \phi - \alpha \tag{12}$$

$$(N-1)x^* = \frac{\alpha N}{N-1} - \alpha \tag{13}$$

Simplifying the above gives a solution for x^* in a continuous model

$$x^* = \frac{\alpha}{(N-1)^2} \tag{14}$$

In my experiment this will equal

$$x^* = \frac{8}{49}$$

6.1 Summary of Experimental Data

	Count of Decision by Round for Unlinked Treatment $\delta = 2$[4]					
Round	**0**	**1**	**2**	**3**	**4**	Total number of boxes (8x4)
1	5	19	7	1	0	32
2	4	8	16	2	2	32
3	4	11	13	2	2	32
4	6	8	10	3	5	32
5	5	8	9	4	6	32
6	3	6	12	2	9	32
7	3	10	8	6	5	32
8	4	8	10	5	5	32
9	6	4	10	6	6	32
10	4	8	7	5	8	32
11	4	7	13	4	4	32
12	3	11	8	5	5	32
13	3	6	10	8	5	32
14	1	8	14	5	4	32
15	4	7	11	5	5	32
16	3	7	11	5	6	32
17	4	7	9	8	4	32
18	4	7	7	8	6	32
19	5	4	11	7	5	32
20	2	7	9	7	7	32
Grand Total	77	161	205	98	99	640

Table 1: summarizes how many subjects decided to open 0,1,2,3 or 4 boxes each round of the ***Unlinked,*** $\boldsymbol{\delta = 2}$ treatment. There was a total of 32 subjects over 20 rounds. Each session consisted of 8 subjects.

[4] Veconlab sessions under Common Pool Corruption: cpcz7, cpcz8, cpcz9, cpcz10. Treatment: **Unlinked,** $\boldsymbol{\delta = 2}$

	Count of Decision by Round for Linked Treatment $\delta = 2$[5]					
Round	**0**	**1**	**2**	**4**	**3**	Total number of boxes
1	13	12	3	3	1	32
2	12	10	6	3	1	32
3	12	11	4	2	3	32
4	9	10	7	3	3	32
5	11	13	4	2	2	32
6	9	7	7	4	5	32
7	9	11	6	5	1	32
8	12	3	7	7	3	32
9	9	12	4	5	2	32
10	7	8	8	7	2	32
11	12	7	7	4	2	32
12	7	4	8	9	4	32
13	11	9	7	4	1	32
14	8	3	10	9	2	32
15	9	8	4	4	7	32
16	6	3	8	8	7	32
17	9	10	5	4	4	32
18	6	5	9	8	4	32
19	10	8	9	3	2	32
20	7	5	7	7	6	32
Grand Total	188	159	130	101	62	640

Table 2*:* summarizes how many subjects decided to open 0,1,2,3 or 4 boxes each round of the ***Linked,*** $\boldsymbol{\delta = 2}$ treatment. Each round a total of 32 boxes could be opened. There was a total of 32 subjects over 20 rounds. Each session consisted of 8 subjects.

[5] Veconlab sessions under Common Pool Corruption: cpcz2, cpcz5, cpcz 11, cpcz12.
Treatment: **Linked,** $\boldsymbol{\delta = 2}$

	Count of Decision by Round for Unlinked Treatment $\delta = 1.5$[6]					
Round	0	2	1	3	4	Grand Total
1	15	7	8		2	32
2	12	10	7	1	2	32
3	9	6	11	3	3	32
4	9	11	7	2	3	32
5	12	9	6	4	1	32
6	13	10	7	1	1	32
7	12	9	5	4	2	32
8	11	6	8	5	2	32
9	10	10	5	4	3	32
10	9	10	6	4	3	32
11	12	10	3	2	5	32
12	11	9	4	3	5	32
13	11	9	5	4	3	32
14	12	10	2	3	5	32
15	11	9	5	4	3	32
16	11	5	4	9	3	32
17	11	6	3	6	6	32
18	10	9	2	6	5	32
19	9	10	2	5	6	32
20	10	6	1	7	8	32
Grand Total	220	171	101	77	71	640

Table 3*:* summarizes how many subjects decided to open 0,1,2,3 or 4 boxes each round of the ***Unlinked,*** $\boldsymbol{\delta = 1.5}$ treatment. Each round a total of 32 boxes could be opened. There was a total of 32 subjects over 20 rounds. Each session consisted of 8 subjects.

[6] Veconlab sessions under Common Pool Corruption: cpcz15, cpcz16, cpcz 17, cpcz18.
Treatment: **Unlinked,** $\boldsymbol{\delta = 1.5}$

	Count of Decision by Round for Linked Treatment $\delta = 1.5$[7]					
Round	0	1	2	3	4	Grand Total
1	17	7	6	2	0	32
2	15	10	6	0	1	32
3	17	7	7	1	0	32
4	13	14	3	1	1	32
5	18	8	3	2	1	32
6	13	9	3	3	4	32
7	17	5	3	4	3	32
8	11	11	5	3	2	32
9	17	5	6	3	1	32
10	14	11	3	2	2	32
11	18	6	2	3	3	32
12	12	11	4	2	3	32
13	21	4	4	1	2	32
14	13	12	4	2	1	32
15	20	5	3	3	1	32
16	15	11	2	4	0	32
17	20	4	5	1	2	32
18	16	7	5	4	0	32
19	20	3	6	2	1	32
20	15	6	5	3	3	32
Grand Total	322	156	85	46	31	640

Table 4*:* summarizes how many subjects decided to open 0,1,2,3 or 4 boxes each round of the ***Linked,*** $\boldsymbol{\delta = 1.5}$ treatment. Each round a total of 32 boxes could be opened. There was a total of 32 subjects over 20 rounds. Each session consisted of 8 subjects.

[7] Veconlab sessions under Common Pool Corruption: cpcz13, cpcz14, cpcz 19, cpcz20. Treatment: **Linked,** $\boldsymbol{\delta = 1.5}$

Following are various data visualization methods for my experiments data from a2x2 treatment design. They were all plotted in R. My experiment will use a 2x2 design as follows:

Cost of Corruption	**$\delta = 2$**	**$\delta = 1.5$**
Unlinked/Independent Rounds (Odd and Even Rounds)	Number of Rounds = 20 32 subjects = 4 groups	Number of Rounds = 20 32 subjects = 4 groups
Linked Rounds	Number of Rounds = 20 32 subjects = 4 groups	Number of Rounds = 20 32 subjects = 4 groups

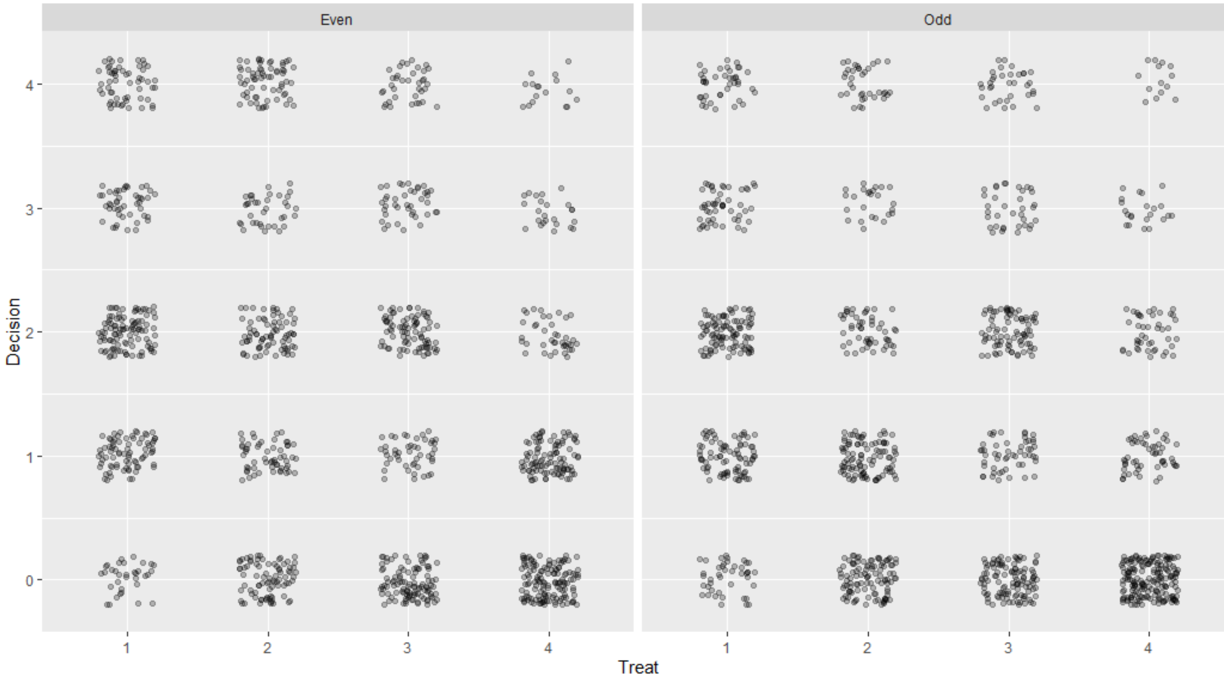


Figure 4 Various decisions ranging from 0 to 4 (discreet) among the 4 treatments in odd vs even rounds.

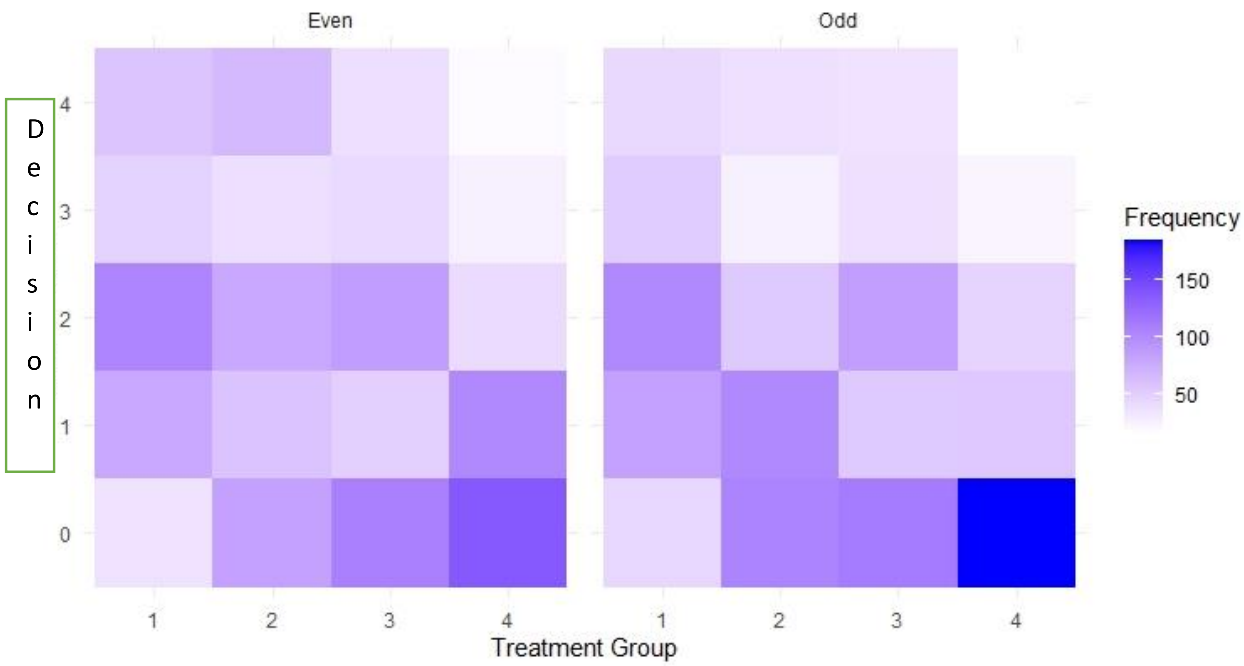


Figure 5 Heat map of Decisions.

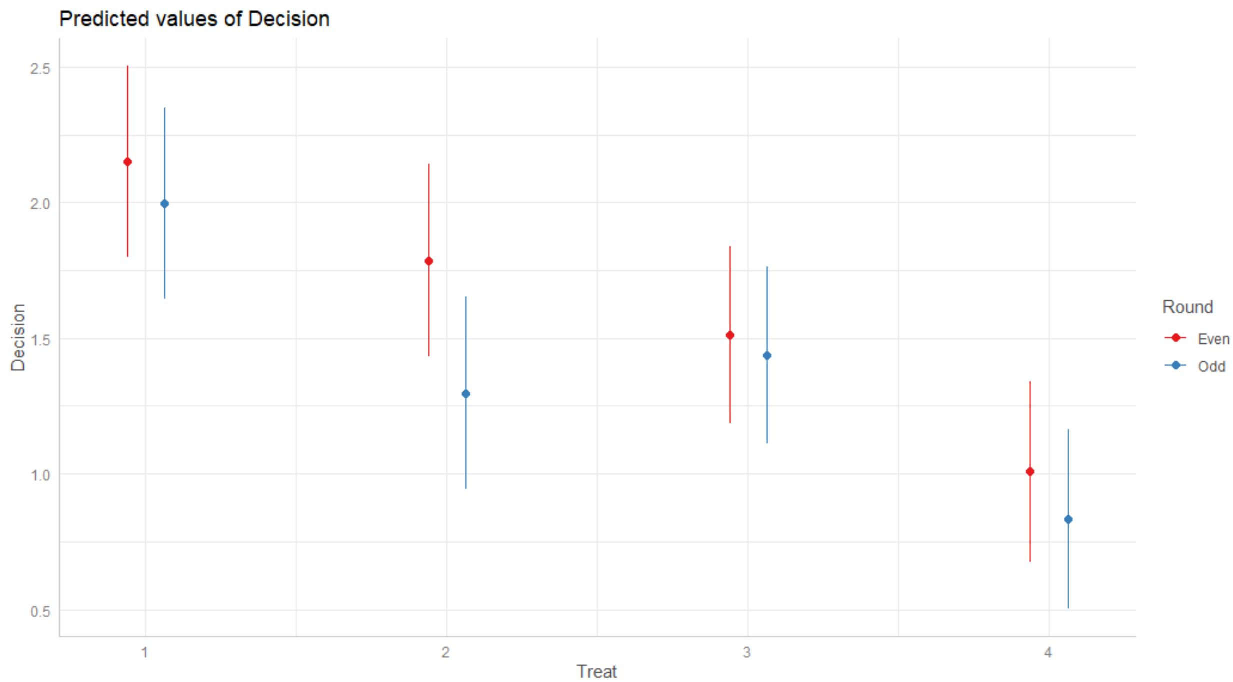
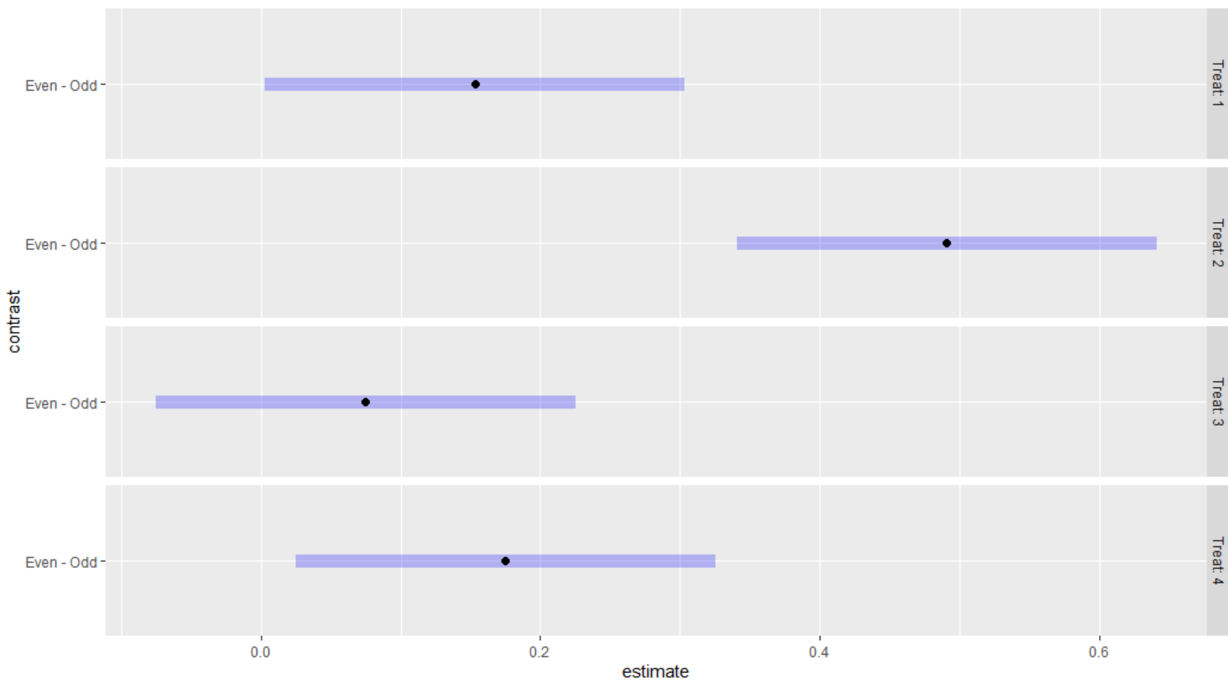
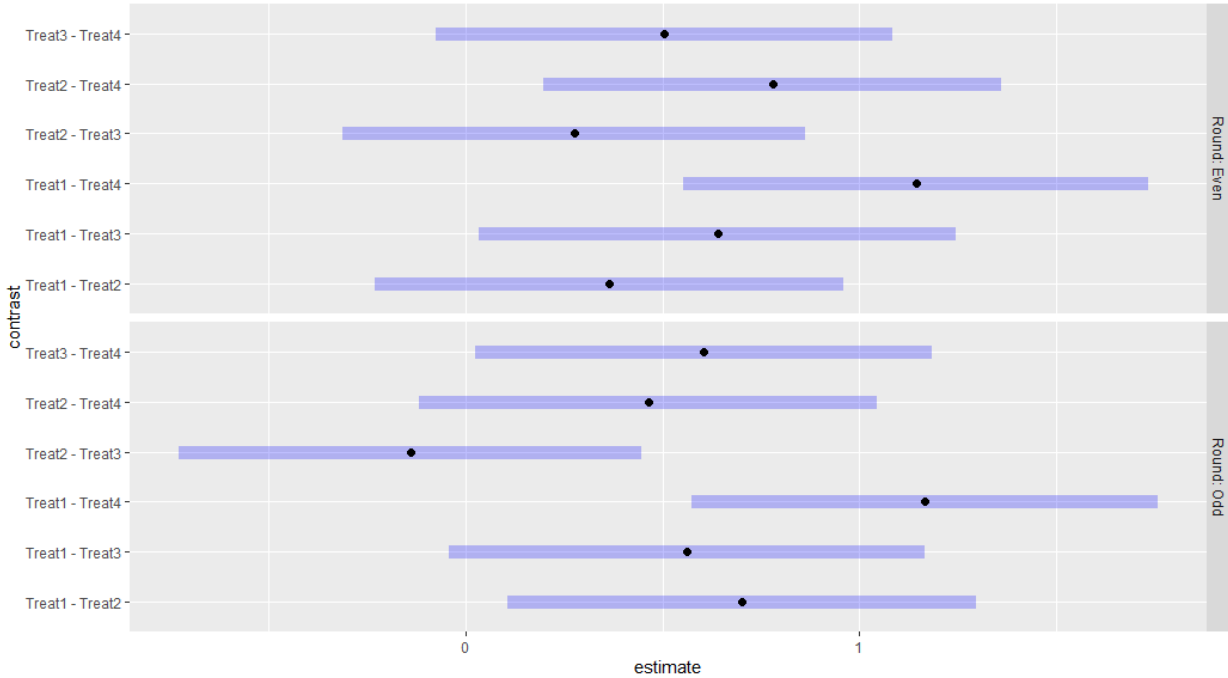


Figure 6 Confidence intervals between various decisions (0 -4) among odd and even rounds.


Even - Odd
Even - Odd
Even - Odd
Even - Odd
contrast
Treat: 1
Treat: 2
Treat: 3
Treat: 4
0.0
0.2
0.4
0.6
estimate


Treat3 - Treat4
Treat2 - Treat4
Treat2 - Treat3
Treat1 - Treat4
Treat1 - Treat3
Treat1 - Treat2
Round: Even
contrast
Treat3 - Treat4
Treat2 - Treat4
Treat2 - Treat3
Treat1 - Treat4
Treat1 - Treat3
Treat1 - Treat2
Round: Odd
0
1
estimate

6.2 Instructions

6.4.1 Unlinked Treatment or Independent Rounds

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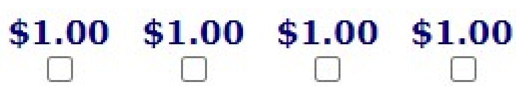
- Rounds and Matchings: The experiment will consist of a number of rounds. Note: You will be matched with the same 7 other people in all rounds.

- Interdependence: Your earnings in each round will be determined by a random event and by the decisions that you and the 7 other people make.

- Box Decisions: Each person in your group will see 4 boxes as shown below, and each box contains $1.00 that can be extracted by marking the box with your curser in this manner. You will not be able to see their box marks while choosing yours, and vice versa.



- Common Pool: In addition to any money that you extract from your boxes, there is a pool of $64.00 that will be divided equally between you and the 7 others, but each box marked by anyone in the group will reduce this common pool by $2.00.

- Random Audit: Finally, only one of the marked boxes will be selected at random to be audited, and the person who marked that box will earn nothing in that round from extractions or from a pool share. Each marked box is equally likely to be audited, so if a total of N boxes marked by those in the group, then each of those marked boxes has a 1/N chance of being the one that is audited.

- Subsequent Rounds: This process with be repeated with the same group of people, for a number of rounds.

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- **Sources of Money Earnings**: In each round, you may earn money by marking boxes and extracting the money from those boxes. You may also earn money from your share of the equal division of a common pool, the size of which is decreasing in the total number of boxes marked by members of your group of 8 people.

- **Audit Penalty**: Regardless of the source, your earnings for the current round will be reduced to zero if one of the boxes that you mark is the one identified in the audit at the end of the round.

- **Random Audit Process**: Each of the 8 people in your group has 4 boxes, so the total number of boxes marked by all group members will be between 0 and 32. Only one of the boxes that is actually marked will be discovered in the audit. If there are N boxes that are actually marked in a round, then it is as the random audit is based on a spin of a roulette wheel with N equally likely stops, with each stop pertaining to one of the marked boxes and bearing the label of the person who marked that box.

- Sequence and Restart: After earnings for each round are calculated and saved, the subsequent round will begin, again with 4 boxes per person and $1.00 available for possible extraction in each. Similarly, the common pool is reinitialized to be $64.00, from which extractions (if any) in the current round are used to a reduction of $2.00 from this initial pool, with the final common pool amount being divided equally among eligible group members (excluding a person identified in the random audit process if there were any extractions in this round. Therefore, there is no connection between the result of the audit in one round and the available earnings in a subsequent round. The precise number of rounds will not be announced in advance.

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Please use the mouse button to select the best answer.

- Question 1: If X the total number of boxes marked by the 8 people in your group (including any boxes you marked), and if you marked y of your 4 boxes, what is the probability that a box you marked will be the one flagged in a random audit?
    - a) y/32
    - b) y/X
- Question 2: If a box you marked was the one the random audit detected in an odd-numbered round (rounds 1, 3, 5 etc.), how many boxes will be available to you in the following even-numbered round (rounds 2, 4, 6 etc.)?
    - a) 0 (no boxes available)
    - b) 4 boxes
    -

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Please use the mouse button to select the best answer.

- Question 1: If X the total number of boxes marked by the 8 people in your group (including any boxes you marked), and if you marked y of your 4 boxes, what is the probability that a box you marked will be the one flagged in a random audit?
    - a) y/32
    - **b) y/X**

Your answer, **(b)** is **Correct**. The audit will only search for a marked box, so the denominator should be the number of marked boxes, not the total number of boxes.

- Question 2: If a box you marked was the one the random audit detected in an odd-numbered round (rounds 1, 3, 5 etc.), how many boxes will be available to you in the following even-numbered round (rounds 2, 4, 6 etc.)?
    - a) 0 (no boxes available)
    - **b) 4 boxes**

Your answer, **(b)** is **Correct**. No boxes are available in a even-numbered round following audit detection in a prior odd-numbered round.

Instructions Summary

- Please remember that you will be matched with the **same** 7 people in all rounds.
- Each person in your group will see 4 boxes, and each box contains **$1.00** that can be extracted by marking one or more boxes.

- In addition to any money that you extract from your boxes, there is a **common pool** of **$64.00** that will be divided equally between you and the 7 others, but each box marked by anyone in the group will reduce this pool by **$2.00**.
- Only one of the boxes marked by people in your group will be identified in a random audit, and the person who marked that box will earn nothing in the round. Each box marked by you or anyone else is equally likely to be the one identified in the audit.
- Your earnings in each round equal the sum of your extractions from your marked boxes, plus your share of the common pool (after pool reductions due to extractions), although round earnings are reduced to zero if you are detected in an audit in that round.
- There will be a number of rounds, and you are matched with the same people in all rounds. If you have a question now, please raise your hand.
- **Special Earnings Announcement:** Your cash earnings will be **10%** of your total earnings at the end of the experiment.

6.4.2 Linked Treatment with Odd-Even Rounds

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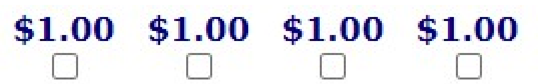
- Rounds and Matchings: The experiment will consist of a number of rounds. Note: You will be matched with the same 7 other people in all rounds.
- Interdependence: Your earnings in each round will be determined by a random event and by the decisions that you and the 7 other people make.

- Box Decisions: Each person in your group will see 4 boxes as shown below, and each box contains $1.00 that can be extracted by marking the box with your curser in this manner. You will not be able to see their box marks while choosing yours, and vice versa.



- Common Pool: In addition to any money that you extract from your boxes, there is a pool of $64.00 that will be divided equally between you and the 7 others, but each box marked by anyone in the group will reduce this common pool by $2.00.

- Random Audit: Finally, only one of the marked boxes will be selected at random to be audited, and the person who marked that box will earn nothing in that round from extractions or from a pool share. Each marked box is equally likely to be audited, so if a total of N boxes marked by those in the group, then each of those marked boxes has a 1/N chance of being the one that is audited.

- Second Round: The first round will be followed by a second, also with 4 boxes, but the money amounts in each box will depend on the audit outcome in the first round, as explained on the next page.

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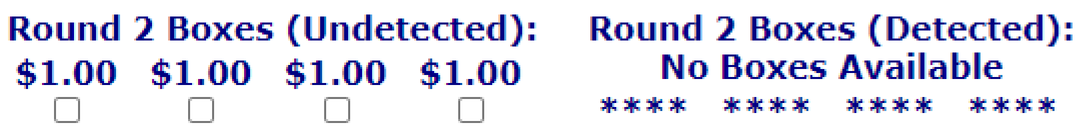
- Grouping in Round 2: You will be in the same group of 8 people that you interacted with in the first round.

- Box Decisions: As before, each person in your group will see 4 boxes as shown below. If you were not detected extracting money from your boxes in round 1, then each of your boxes now contains $1.00 that can be extracted by marking the box with your curser. You may mark 0 boxes, all 4 boxes, or any number in between. If you were detected extracting money in round 1, then you have no boxes available in the second round.



- Earnings Pool: In addition to any money that you extract from your boxes, there is a pool of money that will be divided equally between people in your group who were not detected extracting money in the first round. The second round pool size is determined by multiplying the number of eligible (previously undetected) group members by a per person constant $8.00. As before, this pool will be reduced if people extract money from their boxes in this round. The pool reduction will be $2.00 for each box marked by an eligible (previously undetected) recipient in this round.

- Random Audit: As before, only one of the boxes marked by eligible recipients be selected at random to be audited, and the person who marked that box will earn nothing in the round. Each marked box is equally likely to be audited, so if a total of N boxes marked by those in the group, then each of those marked boxes has a 1/N chance of being the one that is audited.

- Third Round: The second round will be followed by a third, also with 4 boxes, but the money amounts in each box in the third round revert back to the $1.00 amounts used first round, irrespective of any prior audit outcome.

- **Sources of Money Earnings**: In each round, you may earn money by marking boxes and extracting the money from those boxes. You may also earn money from your share of the equal division of a common pool, the size of which is decreasing in the total number of boxes marked by members of your group of 8 people.

- **Audit Penalty**: Regardless of the source, your earnings for the current round will be reduced to zero if one of the boxes that you mark is the one identified in the audit at the end of the round.

- **Random Audit Process**: Each of the 8 people in your group has 4 boxes, so the total number of boxes marked by all group members will be between 0 and 32. Only one of the boxes that is actually marked will be discovered in the audit. If there are N boxes that are actually marked in a round, then it is as the random audit is based on a spin of a roulette wheel with N equally likely stops, with each stop pertaining to one of the marked boxes and bearing the label of the person who marked that box.

- **Sequence and Restart**: After earnings for each round are calculated and saved, the subsequent round will begin, again with 4 boxes. Each odd-numbered round in the sequence will be like round 1, each even-numbered round will be like round 2, with with the amount $1.00 available for possible extraction in each. However, there is a connection between the audit outcome in the first round (of each two round sequence) and what is available in the second (even-numbered) round:

    i) a person flagged in the first round will have no available box earnings in the second round and

ii) will receive no share of the second-round common pool, which will be set to be the product of the number of eligible recipients and the per-person amount $8.00. This product is the pool used, subject to a reduction of $2.00 for each box marked by any group member, with the final common pool being divided equally among eligible group members.

The precise number of pairs of even and odd numbered rounds will not be announced in advance.

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Please use the mouse button to select the best answer.

- Question 1: If X the total number of boxes marked by the 8 people in your group (including any boxes you marked), and if you marked y of your 4 boxes, what is the probability that a box you marked will be the one flagged in a random audit?
  - a) y/32
  - b) y/X

- Question 2: If a box you marked was the one the random audit detected in an odd-numbered round (rounds 1, 3, 5 etc.), how many boxes will be available to you in the following even-numbered round (rounds 2, 4, 6 etc.)?
  - a) 0 (no boxes available)
  - b) 4 boxes

- ○

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Please use the mouse button to select the best answer.

- Question 1: If X the total number of boxes marked by the 8 people in your group (including any boxes you marked), and if you marked y of your 4 boxes, what is the probability that a box you marked will be the one flagged in a random audit?
  - a) y/32
  - **b) y/X**

Your answer, **(b)** is **Correct**. The audit will only search for a marked box, so the denominator should be the number of marked boxes, not the total number of boxes.

- Question 2: If a box you marked was the one the random audit detected in an odd-numbered round (rounds 1, 3, 5 etc.), how many boxes will be available to you in the following even-numbered round (rounds 2, 4, 6 etc.)?
  - a) 0 (no boxes available)
  - **b) 4 boxes**

Your answer, **(b)** is **Incorrect**. No boxes are available in a even-numbered round following audit detection in a prior odd-numbered round.

Page 6 of 6 : Instructions Summary

- Please remember that you will be matched with the **same** 7 people in all rounds.

- Each person in your group will see 4 boxes, and each box contains **$1.00** that can be extracted by marking one or more boxes.
- In addition to any money that you extract from your boxes, there is a **common pool** of **$64.00** that will be divided equally between you and the 7 others, but each box marked by anyone in the group will reduce this pool by **$2.00**.
- Only one of the boxes marked by people in your group will be identified in a random audit, and the person who marked that box will earn nothing in the round. Each box marked by you or anyone else is equally likely to be the one identified in the audit.
- The first round (and all odd-numbered rounds) will be followed by a second (even-numbered) round in which you have 4 boxes that each contain **$1.00**, unless the audit in the previous round identified you as a person who extracted money from the box that was audited. The common pool for the second (even-numbered) round will be the product of the pool amount per person, **$8.00**, and the number of eligible recipients, which means excluding a person whose marked box was flagged in the prior audit or in the audit for that round. In even-numbered rounds, each box marked by anyone reduces the common pool by **$2.00**.
- There will be a number of rounds, with pairs of odd and even-numbered rounds that are linked in this manner.
- Your earnings in each round equal the sum of your extractions from your marked boxes, plus your share of the common pool (after pool reductions due to extractions), although round earnings are reduced to zero if you are detected in an audit in that round.

- If one of your extractions is detected in a second-round audit, then you still get to keep money from extractions and a common pool share from the first round of that sequence.
- There will be a number of rounds, and you are matched with the same people in all rounds. If you have a question now, please raise your hand.
- Special Earnings Announcement: Your cash earnings will be 10% of your total earnings at the end of the experiment.

6.4.3 Additional Pro-Sociality Task (Pen-Paper Task)

Session Name:

Please write your ID

Instructions:

This task is about dividing money between yourself and another person to whom you will be randomly matched. You are endowed with $5; the recipient is endowed with $0. You can decide how much of your $5 endowment to transfer to the recipient. You can choose any amount between $0 and $5. The recipient receives the amount that you decide to transfer to him/her; you receive the amount that you decide not to transfer and thus to keep.

How much of your $5 endowment do you want to transfer to the recipient? $_________

After everyone in the room has made their decision, we will randomly match two people, one will be the allocator and the other will be the recipient. The recipient will receive the amount the randomly matched allocator has decided to transfer. These earnings will be added dollar for dollar to your total earnings at the end of the experiment.

6.4.4 Bomb Risk Elicitation Task

Each of the 12 boxes shown below contains $1.

One of the boxes contains a hidden ink bomb.

The location of the ink bomb has been pre-determined randomly in a manner that is equivalent to throwing a 12-sided die,

with each box being equally likely to be selected.

This random location has been done independently for each person.

You may now choose the boxes from which to extract $1,

but if you mark the box in which the ink bomb is located,

then you will find out after you submit your decisions that your earnings will be $0 for this task.

If you do not encounter the ink bomb, your earnings from the task will be a dollar for each box checked.

You may mark as many or as few boxes as you wish.

If you mark NO boxes at all, you will earn $0.

If you mark ALL 12 boxes, you will encounter the ink bomb and earn $0.

Earnings from this task will be withheld and will be announced after the final period of Common Pool task.

Earnings from the Ink Bomb task will be paid dollar for dollar and will NOT be scaled down.