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Essays on Intertemporal Choice under Uncertainty

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Abstract

Essays on Intertemporal Choice under Uncertainty

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The dissertation investigates intertemporal decision-making under uncertainty. In particular, I analyze how two traditionally under-explored sources of uncertainty affect trade-offs between the present and the future in making decisions: a) uncertainty of life, and b) strategic uncertainty in collective action dilemmas.

Chapter 1 deals with the temporal dynamics of value in strategic interactions, and Chapter 2 extends the analysis to incorporate interaction between a homogeneous vis-à-vis a heterogeneous triad. Participants affiliated with different social groups at the University of Washington, Seattle, participated in a series of one-shot Voluntary Contribution Mechanism (VCM) games; the games extended the incentive structure of the VCM to decompose it into the relative temporal change in the public and private accounts, in addition to varying the social composition of the participating groups. Results from the experiment indicate that temporal delay is a significant factor in explaining voluntary contribution, with the outcomes being sensitive to the time horizon. To gauge the mechanisms of voluntary contribution with delayed rewards, the hypothesis as to whether expectation of how others' value the future affect one's own contribution was also tested. The results indicate that conditioning on our future self, how others value the future enters our calculus of voluntary contribution, but conditioning on our present self it has no effect. In "real life" settings, that benefits from cooperative behavior materialize in the near or distant future is perhaps the general rule. The proper functioning of markets is built upon cooperation between buyer and seller, the benefits of which are often realized in the future (for example, e-commerce or group buying schemes). The provision of public goods, whether it be providing immunization to a village, restoring a natural park, or contributing towards global public goods such as carbon offset projects – each have a temporal element embedded into them. In climate change and environmental negotiations, different countries with differing stated valuations of the future interact to provide a global public good, i.e. a habitable climate. Summers and Zeckhauser (2008) note that at International Panel of Climate Change (IPCC) negotiations, how to discount the future is always a thorny issue. Other real-life applications such as the contours of racism and the role of cliques in organizational behavior can also be better understood by unpacking the interaction between social and temporal preferences in collective action. Future studies

confirming the robustness of the results, finding contradictory evidence, as well as testing hypothesis not found significant in the present study will be a fruitful line of inquiry. While there has been a plethora of studies on discounting behavior in individual decisions that have documented the phenomenon of present-bias (Kahneman, 1979; Frederick and Loewenstein, 2002), the results from the first two chapters contributes to the nascent literature in the field of discounting in strategic interactions that have been conducted to date by Deck and Jahedi (2013a, 2013b).

Chapter 3 analyzes data from the World Bank Living Standard Measurement Survey (LSMS) conducted in Nepal (2003/04 and in 1995/96), in addition to the data on conflict measures collected by INSEC, a non-profit group promoting human rights, to gauge the effect of the “Maoist” civil war on agricultural household decision-making. Results indicate that in addition to causing the destruction of physical capital, life and the deterioration of social norms, the civil war was associated with changes in future-oriented decision making and inhibited household investments in the future. The evidence suggests that the civil conflict in Nepal further exacerbated the existing poverty levels by inhibiting investment levels further pushing households deeper in the chasm of a “poverty trap.”

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Introduction

Time plays a critical role in decision-making. Intertemporal choices involve an assessment of the costs and benefits accrued over time. This dissertation explores intertemporal decisions. The nature of the environment in which a decision is made certainly influences the outcome. The contribution of this dissertation is to investigate how individuals make intertemporal decisions in the face of various uncertain environments. Specifically, I investigate how two under-explored sources of uncertainty influence intertemporal choices: a) uncertainty of life, b) uncertainty originating from strategic interactions.

Chapter 1 focuses on how the timing of the costs and benefits in the provision of public goods affects decision-making. Chapter 2 extends the analysis to incorporate a comparison of homogeneous and heterogeneous triads in decision-making, including an analysis of an interaction effect between group homogeneity and the timing of costs and benefits. The data for the analysis in Chapter 1 and Chapter 2 was collected from conducting a Voluntary Contribution Mechanism (VCM) game with undergraduates who are affiliated to different student organizations at the University of Washington, Seattle. I am very grateful for a NSF Doctoral Dissertation Improvement Grant (Award # SES-1155962) for making the research possible.

In Chapter 3, I investigate how uncertainty induced by the civil-war in Nepal affected agricultural investment. As agricultural investment involves an intertemporal assessment of present and future benefits – the backdrop of the civil war helps investigate whether uncertainty of life due to the civil-war affected forward-thinking investments in the domain of agriculture.

Chapter 1

Discounting the Future in a Social Dilemma

1.1 Introduction

This chapter deals with the temporal dynamics of value in strategic interactions. The paper investigates whether the timing of when benefit is received and the timing of when contribution is made affect cooperation in strategic interactions. Understanding the dynamics of cooperation, or ‘ethical behavior’, is critical as factors such as trust and the voluntary honoring of contracts is as important as legal enforcements for the proper functioning of markets and social systems (Granovetter, 1985; Elster, 1989; Ghosh and Ray, 1996). Not surprisingly, cooperative behavior has been extensively studied in the social sciences. The Prisoners’ dilemma is arguably the most familiar game among scholars who investigate cooperative behavior – the game provides a framework to analyze the tension between individual incentive to engage in opportunistic behavior to maximize personal gain and the decision to cooperate and maximize the common good. An extension of the Prisoners’ dilemma from a two-player game to more than two players captures the intrinsic problem of ‘free-riding’ inherent in the voluntary provision of public goods. Prisoners’ dilemma can be seen as a representation of the pay-off structure individuals face in social dilemmas (Lichbach, 1996).

Several important public goods choices are embedded in a temporal context and require an assessment of both present and future benefits and costs. The existing studies on the influence of the temporal dynamics in the provision of public goods have mostly focused on the driving mechanisms behind the ‘decay in contribution’ in repeated games (Ledyard, 1995 provides a review; for a more recent review, see Chaudhari, 2010). Time horizons are a critical factor that drives cooperation; Axelrod’s (1984) seminal work on the *Evolution of Cooperation* first introduced the metaphor of the ‘shadow of the future’, exploring the idea that the probability of future interaction affects the level of cooperation. Subsequently, empirical evidence has suggested that when interactions are repeated over time, a threat of future retaliation enforces cooperative behavior by significantly reducing opportunistic behavior (Dal Bo, 2005). However, thus far, the temporal dynamics of value have not been investigated in one-shot public good games. How does delay in the benefits received from provision of public goods influence cooperative behavior in a one-shot game? How does the timing of contribution affect behavior? What role does trust and beliefs about others’ contribution play in the assessment of future benefits?

While studies using the Contingent Valuation Method (CVM) have gauged the rate of time preference for the Willingness to Pay (WTP) for public goods when the benefits are delayed (Viscusi and Huber, 2006; Kovacs and Larson, 2008), to the best of this author's knowledge, discounting behavior for voluntary contribution towards public goods have not been investigated thus far. To date, experimental models on individual behavior in the provision of public goods in one-shot games have assumed, albeit implicitly, that the benefits received from public goods are experienced immediately and that individual contribution towards the game are also made now (for example, Fischbacher et.al., 2001; Ledyard, 1995). In this paper, I relax the assumption allowing benefits received from the public goods to be experienced in the future, as well as allowing contributions towards the public goods game to be made in the future.

In reality, several public goods decisions we make involve the assessment of costs and benefits that are spread over time. Broadly speaking, a group of students working together on a 'project', a group of farmers collecting money to improve irrigation facilities, villagers in a developing country deciding the investment level in their local schools, are all faced with a public goods game with rewards that are not realized immediately. Several other pertinent examples of cooperation where the benefits of the action are delayed are frequently encountered in environmental contexts. The increasing popularity of carbon offsets can be seen as an example of providing a public good (Kotchen, 2009) – individuals and institutions concerned about the emission of carbon dioxide into the atmosphere, which contributes towards climate change, can make contributions to help reduce emission. In order to secure future benefits, the costs of abatement, in such cases, are borne in the present. Along a similar line, fostering institutions that build trust and enhance cooperation are critical to adaptation strategies to reduce the severity and cost of climate change impacts. Insurance as a public good has been suggested as one of the ways in which the spatially disproportionate idiosyncratic losses can be smoothed through risk sharing of climate change impacts among a larger pool (Kunreuther 1997, 2004). The assessment of future benefit in such a context is also contingent upon the action of others.

At present, little is known about cooperative behavior in social dilemmas in light of existing behavioral literature that posits that individuals exhibit myopic behavior or a 'present-bias' (Thaler, 1981; Frederick et.al, 2002 provide a review on time discounting). Present-bias or hyperbolic discounting behavior – whereby valuation of future benefit relative to the present falls

rapidly for short delays in time, and more slowly for longer time intervals -- has been attributed to impulsivity (Ainslie 1975; Loewenstein and Prelec, 1992) and difference in the perception of near and future term benefits (Trope and Liberman, 2003). While a plethora of literature exists examining the functional form of discount rate for the future in individual decisions, other than Deck and Jahedi (2013a, 2013b) there is little research on discounting behavior in strategic interactions. In contrast to Deck and Jehedi (2013a, 2013b), who examine discounting behavior in a competitive environment, this paper investigates how future benefits are valued relative to present benefits in a cooperative environment.

Public goods are generally categorized into two categories: ‘discrete’ public goods provide a fixed level of benefit after a threshold of provision-point is reached, whereas ‘continuous’ public goods provide a benefit equal to a fixed proportion of group contribution. (Asch et.al, 1991; Abele et.al., 2010). For the purpose of the paper, I focus on ‘continuous’ public goods since they capture the essential feature of several important environmental decisions which allow for the provision of incremental benefits for delayed rewards.

This paper investigates individuals discounting behavior as the benefits from contribution are removed further in time. Furthermore, in light of recent studies (Noor, 2011; Noor and Ren, 2011) that suggest that individuals exhibit their *normative preferences* when the consequences of their decisions are removed temporally, and exhibit their *temptation preferences* when consequences of their decisions are immediate, the paper also investigates whether individuals’ exhibit time-consistent preferences in the provision of public goods? In other words, does the timing of contribution affect individual behavior?

The study aims to make a contribution towards two strands of literature: i) on discounting behavior, and ii) on decision-making in strategic interactions. As noted earlier, while discounting behavior in individual decisions has been extensively studied, the paper makes a contribution to the nascent field of discounting in strategic interactions. In the literature on strategic interactions, the subjective view of time and temporal perceptions of actors has generally been ignored (Keegan and Kabanoff, 2008). The paper aims to contribute towards this gap in the literature by exploring how the temporal perception of actors influences voluntary contribution when the

timing for contribution and the rewards from contribution are delayed in a one-shot public goods game.

The rest of the paper is organized as follows: section 1.2 discusses the relevant literature on discounting behavior and cooperation in social dilemmas; section 1.3 outlines the research questions; section 1.4 describes the research methodology, specifies the empirical specification, provides a discussion of the proposed experimental procedure, provides results obtained from the descriptive statistics and from empirical tests of hypothesis, and presents the discussion of the results; finally section 1.5 discusses the contributions and the limitations of the study.

1.2 Literature Review

There exists a vast literature on both the role of time in decision-making and the mechanisms driving cooperation in public goods games. In order to facilitate a better understanding of the research questions posed by the paper, this section has been broken down into several parts. Part A discusses the relevant literature on the role of time in decision-making – to elucidate the distinction between the different strands of literature, the section is further broken down as A.1, which summarizes literature on individual decision-making when the timing of contribution is in the future, as A.2, which considers literature when the benefits realized are in the future, and as A.3, which provides an inter-disciplinary review of literature on the mechanisms driving decision-making when time is a factor. Section B.1 provides a review of the somewhat limited literature that uses the Contingent Valuation Methodology to study discounting behavior in the provision of Public Goods and section B.2 provides a critical review of studies that examine the mechanisms of cooperation in the provision of public goods.

A.1 Temporal Social Preferences: Are People Temptation-stricken Moralists?

How do individuals' preferences change when the benefits accrued to others are spread over time? Noor and Ren (2011) provide preliminary evidence suggesting that individuals are more generous when the consequences of the decision (i.e. to allocate resources between oneself and a charity) are removed temporally. The authors examine temporal social preferences in a dictator game where the participant must divide \$10 between themselves and the American Red Cross; they manipulate the timing of payments—immediate versus after a month—and find that on average dictators give more when payments are delayed, i.e. from a (temporal) distance. They argue that individuals temporally removed from the consequences of their action exhibit their normative preference, whereas they exhibit their temptation preference when they have to make a decision whose benefits materialize immediately. This distinction between normative and temptation preferences as discussed by Noor and Ren (2011) is similar to the claim in *Construal Level Theory* (discussed in more detail below) that at a psychological distance individuals tend to focus on the high level attributes of decisions, but when the choice is immediate they are more likely to be influenced by the tangible specifics of the decision. I build on the terminology developed by Noor and Ren to examine *normative preferences* and *temptation preferences* exhibited by individuals in contributing towards a public good.

Normative preferences, which are revealed when the agents are distanced from the consequences of their choices, captures the agents' view of what they 'should' do, whereas temptation preferences arise when the agents' desires conflict with their 'normative preferences' (Noor, 2011). Do agents think that they 'should' contribute towards public goods but succumb to the temptation preferences and lessen the amount of their contribution or choose to not contribute at all thus exhibiting dynamically-inconsistent choice behavior?

A.2 Discount Rate for Individual Decisions

Traditional analysis of intertemporal behavior in economics have relied almost exclusively on the Discounted Utility model proposed by Samuelson (1937), which assumes that individual discount rates are constant and are considered as given within the context of the model. In a seminal essay, "A Note on the Measurement of Utility," Samuelson (1937) condensed all factors

that determine human behavior in intertemporal choices into a single parameter – the discount rate. The Discounted Utility (DU) model assumes that individual's intertemporal preferences can be characterized by a single discount rate and that the subjective value of a good drops by a fixed percentage for every unit of time that the consumption of the good is delayed. This suggests a discounting curve that is exponential in nature. The Exponential Discounting Utility (EDU) model posits that for a *dated reward* (x, t) with a reward of $\$x$ received after a delay of time t , the agents' preferences, which capture the trade-off they make between time and money, can be represented as:

$$U(x, t) = \delta^t u(x)$$

where $u(x)$ is a strictly increasing utility function and δ^t is an exponential discounting function with $\delta \in (0,1)$.

In the Exponential Discounting Utility model, which is standard in the economics framework, temporal discounting takes on the exponential form:

$$V = Ae^{-bD} \quad (1)$$

where V = subjective value of future reward, A = amount, D = delay of receipt; b = parameter that governs the rate of discounting.

Exponential discounting of this form represents a *time-consistent* model of discounting.

However, the descriptive validity of this model has been challenged by studies which have shown that individuals demonstrate *time-inconsistent* behavior whereby in a choice involving a larger and a smaller reward where the smaller reward is available sooner than the larger one, individuals initially may choose the larger reward when both outcomes are in the distant future, but as the receipt time approaches, they reverse their preferences and choose the smaller over the larger reward (Frederick, et.al, 2002 provide a discussion). Preference reversals violate the stationarity assumption (Koopmans, Diamond, and Williamson, 1964)—the assumption that if X is preferred to Y at one point of time, X will be preferred over Y at all points of time -- which is one of the key assumptions of the DU model. The exponential discounting model described in Equation (1) does not, by itself, predict preference reversals – to explain time-inconsistent behavior with the exponential model requires the additional assumption that the discount rate for

the larger amount is lower than the discount rate for the smaller amount (Green and Myerson, 2004). This exponential model of temporal discounting is consistent with the idea that waiting for a delayed reward involves risk (Kagel, Green, and Caraco, 1986); if waiting for smaller delayed rewards is *riskier* than waiting for larger rewards, this may explain preference reversals (Green and Myerson, 2004).

While Samuelson himself had reservations regarding the descriptive validity of the DU model, the assumptions of his model remained largely unchallenged in economic circles for several decades. The emergence of behavioral economics, which sought to improve the descriptive power of economic models, accelerated the accumulation of empirical evidence investigating the actual underpinnings of decisions made when costs and benefits are spread over time. A strong and growing experimental literature has challenged the assumptions on which the DU model is based. The most robust anomalies documented against the DU model are *Decreasing Impatience*, the *Magnitude Effect*, and *Loss Aversion* (Frederick, Loewenstein, and O'Donoghue, 2002, provide a review). *Decreasing Impatience* posits that individuals exhibit more patience in money-time trade-offs when the trade-offs between rewards are more distant. The hyperbolic discounting model takes this anomaly into account, adopting a discount function $D(t) = 1/(1+t)$ (Ainslie, 2001). Hyperbolic discounting behavior has been attributed to impulsivity (Ainslie 1975; Loewenstein, 1996) and difference in the perception of near and future term benefits (Trope and Liberman, 2003). Several alternative discounting functions have been explored to determine which best describes individual behavior to explain preference reversals. Both the generalized hyperbolic discounting and quasi-hyperbolic discounting models (Laibson, 1997; Loewenstein and Prelec, 1992, Mazur, 1987) capture decreasing impatience. The hyperbolic discounting function as proposed by Mazur (1987) takes on the form:

$$V = \frac{A}{1 + kD} \quad (2)$$

where V = subjective value of future reward; A = amount; D = delay; and k is a parameter governing rate of decrease in value.

The hyperbolic discounting model posits that individuals have a declining rate of time preference (Thaler, 1981), and takes the form of Equation 2 if one assumes that value is directly

proportional to rate of reward (Rachlin, 2008). This implies that choices of delayed rewards are choices between different rates of reward (Green and Myerson, 2004). While there is strong empirical evidence of hyperbolic discounting behavior, a few studies (e.g., Andreoni and Sprenger, 2009) find no evidence of present-bias as suggested by hyperbolic discounting.

The *Magnitude Effect* posits that individuals exhibit greater patience towards larger rewards (Lowenstein and Prelec, 1992; Thaler, 1981; Noor, 2011); discount rates are lower for larger-magnitude outcome. For example, an individual may prefer \$10 now to \$20 in a year, but also prefer \$2000 in a year to \$1000 now. Both choices offer a 100% return for waiting a year, but the choices can be explained given that I exhibit a lower discount rate for the larger reward.

Loss Aversion. While neo-classical economics treats individual preferences as given and exogenous, emerging evidence suggests that preferences are context-specific or reference dependent. Behavioral economics and judgment and decision research demonstrate that preferences are endogenous to the environment, with individual behavior determined by reference-points based on recent outcome expectations (Koszegi and Rabin, 2006; Tversky and Simonson, 1993). Prospect theory (Kahneman and Tversky, 1979) posits that individuals treat losses from some reference-point as more consequential than gains; they exhibit risk-averse behavior when evaluating gains, whereas they exhibit risk-taking behavior when mitigating losses.

A.3 How do Individuals Discount the Future: Decision-Process in making Intertemporal Choices

A vibrant line of research conceptualizes intertemporal choice as a conflict between mutually incompatible “systems.” Laibson (1997) proposes a beta-delta account of discounting where the beta system is concerned with immediate rewards whereas the delta component is concerned with delayed rewards – the competition between these incompatible components is posited to be at play while making intertemporal choices. Laibson’s account is similar to other theories of competition between dual-processes, such as between “passion” and “reason” (Ainslie, 1975), between rational, cognitive processes and irrational, emotional processes referred to as hot and cool systems (Metcalf and Mischel, 1999) and between the far-sighted self and the myopic self,

referred to as “planner” and “doer” (Thaler and Shefrin, 1981). Loewenstein (1996), along a similar line, provides a ‘hot-cold’ model that incorporates visceral influences (for example: hunger, sexual drive, pain) in decision-making. The ‘cold’ state that considers welfare in the long run conflicts with the ‘hot’ self that causes heat-of-the-moment behaviors. These models illustrate the conflict between short-term and long-term consequences of choices—humans tend to over-emphasize short-term benefits, thus acting against their long-term interests.

The fundamental question posed by the conflict between the two selves as described above is why individuals don’t wait for larger rewards, albeit delayed, when that is in their best interest. One suggestion is that the perceived risk of waiting for delayed rewards may shape human behavior temporally. The implicit risk hypothesis (Benzion et al., 1996) posits that since delayed rewards are uncertain, individuals are justified in adjusting their subjective value of the delayed rewards to take into account their perceived probability of actually receiving the pay-off (Prelec and Loewenstein, 1991; Dasgupta and Maskin, 2005; Rachlin et al., 2008). This view is prominent especially in behavioral ecology where uncertainty is highly prevalent in the form of the risk of losing food to competitors (Houston, Kacelnik and McNamara, 1982). Furthermore, the fact that temporal and probability discounting take the same hyperbolic form when outcomes are plotted against delay and odds-against respectively point to the possibility that they reflect a single discounting process (Green and Myerson, 1996; Rachlin, 2002). Rachlin et al. (2008) argue that delay discounting and probability discounting reflect the same psychological process, while Prelec and Loewenstein (1991) also note strong similarities between the two processes.

However, the single process view of temporal and probability discounting has been challenged by empirical evidence that individuals respond to the two types of discounting in different ways, as shown by their responses to temporal and probability discounting during very high inflation (Ostaszewski et al., 1998) and across different cultures (Du et al, 2002). Ostaszewski et.al. (1998) studied temporal and probability discounting in Poland during a period of very high inflation – having given the participants choice between old Polish zlotys that was depreciated relative to the U.S. dollar, new Polish zlotys that was a more stable currency, and U.S. dollars, in a series of three experiments, the authors offered different probabilistic and delayed amounts that were equivalent in terms of exchange rate. They found that the rates of discounting for the probabilistic rewards were the same for the old Polish zlotys and the U.S. dollar, whereas delay

discounting was much steeper when amounts were expressed in terms of the old Polish zlotys. Furthermore, when the choice was between new Polish zlotys and U.S. dollars, there was no difference in discounting in either the probabilistic or the delayed rewards. Another challenge to the single-process view comes from cross-cultural studies examining discounting of delayed and probabilistic rewards. Comparing American, Chinese and Japanese graduate students in probability and delay discounting tasks Du et.al. (2002) found that “Americans and Chinese discounted delayed rewards more steeply than the Japanese. In addition, the Americans discounted probabilistic rewards the most, whereas the Chinese discounted probabilistic rewards the least.” The fact that the Japanese discounted probability rewards more steeply than Chinese, while for delay discounting the results were the other way around challenge a single-process view of discounting, although the authors also noted significant commonalities in the delay and probability discounting processes across all three groups.

Recent fMRI studies isolate the activation of different brain regions and show differential activation for risky and delay tasks (Luhmann, 2009; Weber and Huettel, 2008). Luhmann (2009) found temporal processing to be associated with the brain region responsible for the process of prospection—imagining the events of one’s future. Luhmann argues that probability discounting may differ from temporal discounting because in the latter individuals don’t just evaluate the reward, but also the experience of waiting.

That the brain region responsible for prospection was implicated in temporal discounting tasks gives credence to the ‘future self-continuity hypothesis’—the idea that individual differences in perceived continuity between one’s current and future selves would lead to more patient choices. Parfit (1971, 1982, 1984) argues that the self as we know it is a succession of overlapping entities and hence lacks a ‘continuous whole’ to which future utilities can be ascribed.¹ Frederick (1999) provided an empirical test of Parfit’s normative claim that it may be rational to discount the future based on one’s connectedness to one’s future selves and found *no* correlation between individual discount rates and the “connectedness” of an individual across time. To measure psychological connectedness, he asked respondents how similar they were at various times in the past and how similar they expect to be at various times in the future considering their

¹ The idea of an individual “continually becoming a new person” can be found in philosophical discourse as far back as Plato (Symposium). Whiting (1986) also provides philosophical discussion on the continuity of the self.

“personality, temperament, likes and dislikes, beliefs, values, ambitions, goals, ideals, etc.” and to measure implicit discount rates he asked respondents to make a series of choices between \$100 tomorrow and one of seven amounts delivered one year from now. However, Bartels and Rips (2010) subsequently revisited the Parfitian notion and found a positive relationship between perceived psychological connectedness and patience. Higher “future self-continuity” also predicts higher lifetime accumulation of financial assets (Hal Ersner-Hershfield et al, 2009).

Construal Level Theory

A line of research in psychology explores the effect of how individuals perceive/imagine the future in their intertemporal choices. Construal level theory (Trope and Liberman, 2003; Liberman and Trope, 2000) posits that traversing psychological distance entails mental construal, and the farther an object is removed from direct experience the higher the level of construal. According to Construal Level Theory (CLT), the cognitive representation (construal) of outcomes has a bearing on the perceived utility derived from the option. Individual choices either have a high level attribute—relating to the goal underlying the option—or a low-level construal—relating to more concrete tasks needed for the goal to be realized. For example, if I had the choice of learning how to play the piano, at a high-level construal, the *idea* of being able to play the piano might be appealing to me from a temporal distance (or any psychological distance), however as the temporal distance diminishes, the nuts-and-bolts of learning the notes, scales and chords—that is, perception at a low level of construal—might make the option less attractive to me. Similarly, the idea of wanting to live in a “green” society might seem appealing to me from a psychological distance, but from a psychologically proximate distance, eliminating a vacation on a plane or paying for carbon taxes might not seem so appealing. The intuitive idea behind CLT is that from a distance we see the forest whereas as we get closer we see the trees. However, a less intuitive contribution of CLT is that it involves traversing psychological distance—in time, in space, in social distance, and in hypotheticality—and these different distance dimensions are cognitively related to each other, similarly influence and are influenced by level of mental construal, and similarly affect prediction, preference and action (Trope and Liberman, 2010). Trope and Liberman argue that psychological distance captures a fundamental aspect of meaning common to all distance. How do individuals perceive cooperation when the benefits are immediate and when they are distant in time? How do they perceive cooperation

when the other agents are at various psychological distances socially? Are the effects of time and social distance additive? Construal level theory provides a framework to analyze these questions based on the level of abstraction.

B.1 Discount Rate for Public Goods using Contingent Valuation Methodology

Similar to individual decisions about private goods, the costs and benefits associated with providing public goods are also often spread over time. Costs are often incurred immediately whereas the benefits of the public good may materialize in the future. The individual rate of time preference—how individuals make trade-offs between present and future consumption—is therefore an important determinant of individuals' provision of public goods. Viscusi and Huber (2006) examine discounting for public goods using environmental quality as a case study and—consistent with hyperbolic discounting—find that the rate of time preference is very high for immediate improvements and drops off substantially thereafter. Using a nationally representative sample of 2,914 respondents, the authors examine the revealed rates of time preference based on responses where subjects' indicate the most preferred choice among different policy alternatives that are varied based on amount of time delay (0,2,4 and 6 years), water quality improvement, and the costs associated with the policy; the authors estimate a quasi-hyperbolic discounting parameter ranging from 0.48 to 0.61. Kovacs and Larson (2007) use a contingent valuation method (CVM) question to address the preservation of additional open space adjacent to a large regional park and find discount rates of around 30% when the time frame of the payment schedule is varied across surveys. Extending these studies, the research proposed entails experimentally investigating how individuals discount the future in the provision of public goods.

B.2 Mechanisms of Cooperation in the Provision of Public Goods

Pure public goods are goods that—once collectively provided—are non-rival, i.e. the consumption of which by one individual does not reduce the availability of the good for the consumption by another individual, and non-excludable, i.e. they become available to the entire community (Samuelson, 1954). The Prisoner's dilemma game can be seen as a representation of the pay-off structure individuals face in social dilemmas like the provision of public goods

(Lichbach, 1996). In a two player version of the Prisoner's dilemma, players have the option to cooperate or defect—if both players cooperate both receive moderately high rewards, if both defect both receive moderately low rewards, if one cooperates and one defects the defector receives a very high reward, while the cooperator receives a very low reward (for example Poundstone, 1992; Rapoport et al., 1965). A standard two-player Prisoner's dilemma illustrates the incentive-structure faced by an individual under uncertainty about the behavior of the other player, in which the overall welfare of each individual is maximized when both players cooperate. Assuming that individuals are self-interested, the dominant strategy of the individual in the game is to defect—in other words, defecting is the best strategy for each individual regardless of what the other does. The Prisoner's dilemma captures the essential features present in public goods games whereby everyone in the cooperating group will outperform everyone in the non-cooperating group but selfish individuals in the latter do better than cooperators (Poundstone, 1992).

However, everyday life provides numerous examples of people voluntarily contributing to the provision of public goods, contrary to game-theoretic predictions of zero contribution. Also contrary to game-theoretic predictions, a study using a one-shot public goods game (Marwell and Ames, 1981) showed that people on average invested 40% to 60% of their endowment in the public good. Isaac et al. (1985) subsequently extended this to repeated games and found that while they could replicate the findings of Marwell and Ames in the first round, in subsequent rounds they observed a decay in contribution, with contributions going down to an average of 9% of subjects' endowment. Isaac et al. (1985) attributed to the decay in contribution to learning: individuals may not initially realize that contributing to the public goods is a dominated strategy and contributions decline as they learn that over time. Andreoni (1988) successfully designed an experiment to test the learning hypothesis whereby subjects were told that they would play 10 rounds of a repeated public goods game, and afterwards they would play again with the same players. As expected, in the first game contributions decayed as the rounds progressed; however, interestingly, he found that the initial pattern of contribution was restored in the second game when playing with the same persons. The findings were obviously contrary to the 'learning hypothesis' as individuals' seemed to 'unlearn' what they learned in the first game

in the second game. Cookson (2000) subsequently replicated the findings showing that contributions decayed but persistently returned to the initial level after each re-start.

Subsequent research, particularly in behavioral economics, has focused on individuals' preferences for contribution to public goods and their beliefs about the contribution of others. Andreoni (1990) studying individuals' decision to give to charities finds that people experience an increase in their utility from the act of giving—called the 'warm-glow' (contributing independent of others' contributions, or giving for the sake of giving)—in addition to the utility generated by the increase in the total supply of public goods. Palfrey and Prisbrey (1996, 1997) assigned subjects different marginal rates of substitution (MRS) between a public good and a private good; changing the MRS from round to round the authors were able to separate the effects of altruism, warm-glow, and confusion. The authors found little support for altruism, but found that warm-glow had a significant effect. Goeree, Holt and Laury (2002) found more evidence for altruism than for warm-glow; they found that contributions are increasing in 'external' return to someone else, which can't be explained simply through warm-glow.

However these models (Goeree et al., 2002; Palfrey and Prisbrey, 1996, 1997) do not take into account how individuals consider others' contributions to public goods. A separate strand of literature has argued that people are conditional co-operators, that is, people's voluntary contributions depend on their beliefs about the contribution of others, and people will reduce their contributions if they observe others free-riding (Gächter, 2007, provides an overview). Fischbacher et al. (2001) find that conditional cooperators don't quite match the average contribution of others, but contribute slightly less than the average contribution because of self-serving bias. While most studies examine reciprocal behavior based on past moves of group members, Fischbacher et al. look at how participants take into account their own prior beliefs about the behavior of others. Fischbacher and Gächter (2008, 2009) disentangle beliefs and preferences and argue that people are imperfect conditional cooperators—they conclude that "beliefs decline because contributions decline, and not vice versa." Using simulations based on elicited beliefs, actual contributions and belief updates, the authors argue that a self-serving bias leads to contribution decay as each individual tries to contribute less than the others. Andreoni (1995) provides a systematic attempt to distinguish the two leading hypotheses for cooperation, other-regarding preferences (kindness, altruism, warm-glow) and the learning/confusion

hypothesis, and finds that “on average about 75 percent of subjects are cooperative, and about half of these are confused about incentives, while about half understand free-riding but choose to cooperate out of some form of kindness.” He concludes that subjects’ preference for cooperation should be an important area of inquiry for experimental studies of public goods. The present research considers the role of different temporal horizons in the provision of public goods in collective action dilemmas.

1.3 Research Question

As discussed earlier, in light of behavioral research that examines decision-making over time, the paper aims to examine decision-making in a one-shot Voluntary Contribution Mechanism (VCM) Game. Specifically, the present paper addresses the following research questions:

Research Question 1: Does the timing of when the benefit from collective investment decision is realized affect average contribution in a one-shot VCM Game with delayed rewards? How does average contribution change with delays of different temporal horizons?

Research Question 2: Does the expectation of how others’ value the future influence average voluntary contribution in a one-shot VCM Game with delayed rewards?

Research Question 3: How does the timing of contribution affect voluntary contribution in a one-shot VCM Game? Do agents exhibit time-consistent preferences in the provision of public goods? In other words, if an agent plans to contribute \$X in the future to the provision of public goods received at a later time, do they contribute $< \$X$ as the time to contribute approaches?

1.4 Research Methodology

An experiment was conducted in order to answer the research questions posed above. The first part of this section, 1.4.A, describes the general structure of a Voluntary Contribution Mechanism (VCM) game; the second part, 1.4.B, describes the experimental procedure followed in the study; Section 1.4.C summarizes the descriptive statistics; and, section 1.4.D provides results from hypothesis tests and discussion of the results.

1.4.A Incentive Structure of Voluntary Contribution Mechanism (VCM) Game

Before considering the details of the experiment, a note on the incentive structure of the Voluntary Contribution Mechanism Game (VCM) game is discussed briefly. The VCM game can be illustrated as follows: Consider a society that consists of three *agents* indexed by i, j and k . The agents engage in an *action* that determines the pay-off they receive. Each agent chooses the level of investment into a public account given their initial endowment E . The agents must decide whether, and how much, of the endowment to ‘invest’ in a public good account, and how much to ‘keep’ in a private account. The agents simultaneously decide their allocations into the public account; their contribution of an amount C_i (where $0 \leq C_i \leq E$) to the public account is multiplied by a constant factor Ω -- the Marginal Per Capita Return (MPCR) -- and divided equally among the participants. In the case of the proposed study, the participant contributions are doubled before being divided equally among them.

Assuming linear payoffs, the return for individual i , R_i , is given by the following formula:

$$R_i = \beta(E_i - C_i) + \Omega \sum C_{i,j,k}.$$

Given that three individuals participate in the game and the contribution they make is doubled, Ω , or the MPCR, is equal to 0.67, and measures the rate of return from aggregate contributions to the public good account. The coefficient of $E_i - C_i$ in equation 1, β , measures the private return from own consumption of amount not invested in the public account, or kept in their private account. In the above equation, hypothetically speaking, β can take the value of 1 if individuals are allowed to contribute nothing to the public account, and a value of 0 if individuals contribute all their endowment into the public account (i.e. $E=C$). When $\beta > \Omega$ rational self-interested individuals have a dominant strategy to contribute nothing (in our model, $\Omega = 0.67$, is less than

$\beta=1$). However, when $\beta < n \Omega$ (in our model, $1 < (2/3)*3$), group rationality dictates that individuals contribute all of their endowment to the public good account. The relative incentive to free-ride is given by β/Ω (Private Good Return/Public Good Return) which is 1.5 in our model. Based on prior literature, besides Ω , or MPCR, other factors such as communication (Issac and Walker, 1988a) and group size (Issac and Walker, 1988b; Walker and Williams, 1994) have been posited to influence ‘free-riding’ behavior, and consequently, voluntary contribution at the group level in a one-shot Public Goods Game.

The standard Voluntary Contribution Mechanism (VCM) game is the most frequently studied version of a public goods problem. The dependent variable of interest is the voluntary contribution individuals make to a public good.

Assume that individual i makes a voluntary contribution in the VCM game when interacting with individuals’ j and k . The benefits accrued from contribution to the VCM game is accrued at different time periods for oneself and others participating in the group.

1.4.B Experimental Procedure

The subjects recruited for the study belonged to three different social organizations at the University of Washington – namely, South Asian Student Association (SASA), Latino Student Union (LSU), and the Chinese Student Association (CSA). Recruiting students affiliated with social groups that differed in identifiable ways was necessary as one of the hypotheses to be tested involved the effect of social composition on voluntary contribution over time (discussed in the next chapter). Letters of Cooperation were obtained from the presidents of the student organizations in order to recruit participants from their respective organizations.

The recruitment process for the study involved two stages. In the first stage, each of the presidents from the three student organizations were asked to forward an invitation to participate in the study to their members via the organization’s email listserv². The invitation to participate

² In the first stage, the cooperation of the leadership of four student social organizations was enlisted. Following completion of human subjects approval, each of the student association presidents were asked to forward an invitation to participate in the study to their members via the organization’s email listserv. During the months-long human subjects review process for the project a leadership transition had taken place in the fourth student

in the study explicitly mentioned that the goal of the study was to “investigate the roles of time and group identification in decision-making.” Students were told that they would be compensated \$5 for agreeing to participate in the study, in addition to having the opportunity to earn more from participating in the VCM game. The students were asked to indicate that they met the criterion for participating in the study which were as follows: i) should be older than 18, ii) should be able to follow simple written and oral instructions in English, iii) should be willing to share their Husky Card³ number and Husky Card picture, and iv) should be a current student at the University of Washington. The Registrar’s Office at the University of Washington cooperatively facilitated access to the student’s Husky Card picture – picture taken for identification as a University of Washington student – with the informed consent of the participants.

Once students provided their informed consent to participate in the study, \$5 was deposited into their Husky Card accounts. In the second stage of the study, participants from the three student organizations were randomly matched (more detail on the assignment process discussed below) in groups of three such that each group consisted of students who either belonged to the same student organization (homogeneous group) or such that each of the three students belonged to a different student organizations (heterogeneous group). They were also given the following information:

“You will be asked to make allocations in six different scenarios. At the end of the game, we will randomly pick one of the six scenarios, which will be used to determine your actual earning that is deposited to your Husky Card Account. You will be notified of your earnings after all three members complete their allocations. Your earnings will be deposited to your Husky Card Account immediately after the experiment, or in the future, as described in the scenario”.

Being asked to make a series of choices, one of which was used to determine their actual earning from the game, gives the experiment a repeated measures design. A repeated measures design

association, and the new leaders in that association failed to send out the invitation, which left the three organizations named above.

³ Husky Card is an identification card with a picture and student number that is provided to each university student.

has an advantage in that it economizes on subjects and provides a more efficient estimator of relevant parameters⁴ (Davis, 2002).

With cooperation from the UW Housing and Food Services division it was also possible to deposit the earnings of the participants to their Husky Card account directly. The ability to do so serves a critical research design need as one of the challenges of investigating discounting behavior is to ensure that the delayed benefits over time are equivalent to immediate benefits in terms of a) transaction cost, and b) perceived confidence in actually receiving the payment. In order to equalize the payments in all other respects except the amount, previous studies have relied on methods such as a deferred cheque (Anderhub, et.al, 2001), a signed certificate by a faculty member redeemable for a cashiers' check or university cheque on the appropriate day of payment (Coller and Williams, 1999), delivery of cheque into the campus mailbox on the appropriate day for students participating in the experiment (Anderson and Sprenger, 2009), and home delivery by trusted agent on the day of the benefit (Tanaka et.al., 2010).

Each university student has a Husky Card, which is automatically linked to a reloadable debit account that can be used for on-campus dining, vending machines, parking, and printing services. Parents and friends can use the Guest Deposit Feature to make deposits to a cardholders' Husky Card Account, and the transferred amount is reflected on the students' balance immediately. This feature allowed us to transfer the given amount of money to the students on the appropriate day while ensuring that the transaction cost for the student is zero in both cases. In order to equalize the perceived confidence of actually receiving the payment, the immediate benefits were also transferred on to the Student Husky Card after the experiment but on the same day. The Husky Card is frequently used by students, and we don't have any reason to believe that students would treat the delay in benefits from receiving cash any different than benefits accruing in the form of balance in their card account.

In the second stage of the study, after being matched with two other participants, each triad in the study were given detailed instructions on the choice they would need to make, in accordance to the VCM game, in different scenarios where the timing of benefit and the timing of contribution

⁴ It is worth noting that the term repeated measures design is often used loosely to connote designs where the same measure is captured repeatedly over time, as well as, like in the present study, where the same subjects are repeatedly exposed to different treatments.

were varied in different ways. In each round students were given \$15 that they could either keep in their private account or invest in a public account (Please refer to Appendix A for the complete instructions as seen by the participants).

1.4.C Descriptive Statistics

A total of 255 potential participants clicked on the link that was sent through the respective listserves of the three student organizations to participate in the study. The final count of respondents who agreed to participate in the study was 106.⁵ This indicates that 149 (or, 58.4%) of the respondents who clicked on the invitation chose not to participate in the study. The software used to administer the study, Qualtrics, has an attractive feature that allows the researcher to analyze the respondents as well as non-respondents of the study. The statistics obtained from Qualtrics reveals that a total of 100 potential participants (or, 39.2%) opted-out of the study in the page where they are asked to indicate that they agree to the conditions of participation. In most likelihood, this drop in participants from the study was driven largely by the unusual condition that required participants to be willing to share their Husky Card picture. As the drop is relatively non-trivial, this perhaps indicates a selection process into the study whereby people uncomfortable/unwilling to share their pictures with others chose not to participate.

Due to the differential membership size of the student organizations, of the 106 respondents who agreed to participate in the study in the first stage, 44 were affiliated with the Chinese Student Association (CSA), 42 were affiliated with the South Asian Student Association (SASA), and 20 were associated with the Latino Student Union (LSU). Each of the 106 respondents had \$5 deposited to their Husky Card Account within 24 hours of agreeing to participate.

The 105 respondents with pictures who agreed to participate in the study were assigned to the Treatment group -- a heterogeneous group where each participant is from a different student organization -- or to the Control Group -- a homogeneous group where each participant is from

⁵ 106 respondents agreed to participate, but as one respondent didn't have a Husky Card Picture, the total number of respondents was effectively 105.

the same student organization. As the number of responses from the smallest student organization, Latino Student Union, was very limited, logistically it was not possible to randomly assign the participants evenly across the Treatment and Comparison group. As per the research design, it is imperative that in the heterogeneous treatment one student from each of the student groups is assigned – using approximately half of the respondents from the Latino Student Union (LSU) would have likely resulted in a much smaller Treatment (heterogeneous) group compared to the Control (homogeneous) groups. The participants were therefore randomly assigned unevenly across the two groups using the R Statistical software package. 14 participants from each of the three groups were assigned to the Treatment condition, and the rest to the control group. The 105 respondents make up 35 triads, or groups of three. A total of 14 heterogeneous triads (Treatment Group) and 21 homogenous triads (Control Group) were generated from the respondents in the first stage. In matching the triads, participants were again randomly assigned to triads of mixed gender composition to account for the role of gender in decision-making⁶.

The 105 respondents who agreed to participate in the first stage were sent a link containing the second part of the study, which contained detailed instructions and asked the participants to make a series of allocation choices. In each triad the participant is asked to make a series of allocation decisions based on the scenario and the pictures of the other two participants with whom they are matched. The participants are asked to keep their allocation decisions private.

A total of 69 respondents completed the second part of the study. Each of the 69 respondents who made their allocation choices completed the six different scenarios in the study thereby generating a total of 414 observations. The six scenarios that the participants encountered in the second part of the study varied in the timing of benefit and the timing of contribution for oneself as well as for the other two participants in the VCM game – henceforth, this is also referred to as the “temporal treatments”. As noted earlier, the participants are told to make their allocation decisions carefully, as one of the scenarios from the triad would be used to calculate their effective pay-off. The first allocation decision faced by the participants was when the timing of contribution and the timing of benefit for oneself and the other two are immediately after the

⁶ With the exception of one triad that was all female.

experiment. This helps establish that baseline results with the results being comparable to other one-shot games. The other five scenarios are randomly varied so as not to generate any carry-over effects. Figure 1 below provides a schematic illustration of the order in which the different “temporal treatment” were administered to the participants.

#1	#2	#3	#4	#5	#6
<i>Temporal Treatment1</i>	<i>Temporal Treatment2</i>	<i>Temporal Treatment3</i>	<i>Temporal Treatment 4</i>	<i>Temporal Treatment 5</i>	<i>Temporal Treatment 6</i>
<i>Contribution</i>	<i>Contribution</i>	<i>Contribution</i>	<i>Contribution</i>	<i>Contribution</i>	<i>Contribution</i>
<i>NOW</i>	<i>NOW</i>	<i>NOW</i>	<i>15 DAYS LATER</i>	<i>NOW</i>	<i>NOW</i>
<i>Benefit for Self:</i>	<i>Benefit for Self:</i>	<i>Benefit for Self :</i>	<i>Benefit for Self:</i>	<i>Benefit for Self :</i>	<i>Benefit for Self:</i>
<i>NOW</i>	<i>NOW</i>	<i>15 DAYS LATER</i>	<i>15 DAYS LATER</i>	<i>5 DAYS LATER</i>	<i>15 DAYS LATER</i>
<i>Benefit for Others:</i>	<i>Benefit for Others:</i>	<i>Benefit for Others:</i>	<i>Benefit for Others:</i>	<i>Benefit for Others:</i>	<i>Benefit for others:</i>
<i>NOW</i>	<i>15 DAYS LATER</i>	<i>NOW</i>	<i>15 DAYS LATER</i>	<i>5 DAYS LATER</i>	<i>15 DAYS LATER</i>

Figure 1: Schematic Representation of the order in which “temporal treatments” were chosen to be administered based on random assignment.

The descriptive statistics -- mean, standard error, median, % contributing zero, number of observations – for each of the six scenarios are summarized in the table below.

	Mean	Standard Error	Median	% Non-contributors	Observations
Treatment 1 (Contribution = Now; Benefit for Self = Now; Benefit for Others = Now)	8.12	0.59	10	14.49	69
Treatment 5 (Contribution = Now; Benefit for Self = 5 days; Benefit for Others = 5 days)	8.08	0.62	10	18.84	69
Treatment 6 (Contribution = Now; Benefit for Self = 15 days; Benefit for Others = 15 days)	7.22	0.67	7	24.64	69
Treatment 4 (Contribution = 15 days; Benefit for Self = 15 days; Benefit for Others = 15)	8.4	0.65	8	18.84	69
Treatment 2 (Contribution = Now; Benefit for Self = Now; Benefit for Others = 15 days)	7.29	0.62	7	20.29	69
Treatment 3 (Contribution = Now; Benefit for Self = 15 days; Benefit for Others = Now)	8.2	0.66	7	18.84	69

Table 1: Descriptive Statistics of the “Temporal Treatments”

Table 1 above summarizes the summary statistics of each of the six “temporal treatments.” The descriptive statistics show that the mean contribution in each of the six scenarios is well above zero – this is contrary to the prediction of the Nash equilibrium, which suggests that individuals should contribute nothing. Prior studies suggest that in a one-shot public goods game, average contribution is between 40 to 60 % of the initial [endowment (Chaudhari 2010, Andreoni, 1988).

The contribution of \$8.12 out of the initial endowment of \$15 dollars (or, 54.13%) in Treatment 1 (baseline results) suggests that the level of voluntary contribution from the participants is within the range of findings from previous studies. Contrary to most one-shot games conducted previously, in this study design participants are able to see the picture of the other participants with whom they are playing. The mean contribution level suggests that variation in this element does not, on average, elicit a significantly different contribution. Treatment 5 and Treatment 6 capture the change in voluntary contribution when the benefit from contribution to the public account materializes after 5 days and 15 days respectively (for oneself and others). We expect contribution levels to diminish when benefits from contribution materialize only in the future -- the mean, median and the % of non-contributors in the above table shows that a 5 day delay does not elicit any notable change. In fact, the average contribution in Treatment 5 – when the benefits from contribution towards the public account is accrued after 5 days – when compared to the baseline results, in which case both contribution and benefits are materialized now, are

equal when reported to the first decimal point; the medians of the two temporal treatments are also the same. This suggests, preliminarily, that a “front end delay” – a comparatively short time horizon delay compared to benefits materializing now – might not be as important a consideration in strategic interactions as while making individual decisions. The summary statistics of Treatment 6 – in comparison to the baseline results – is notably different, with mean contribution decreasing and percentage of non-contributors increasing.

Treatment 4 captures the change in voluntary contribution when the timing of contribution as well as the benefit from contribution is in the future (after 15 days). Following Noor (2011), this captures the normative preference of contribution which is exhibited when individuals are distanced from the consequences of their action. While, as per expectations prior to the study, the descriptive statistics above shows that the mean normative contribution (Treatment 4) is greater than the baseline results (Treatment 1), contrary to expectations, the median contribution and the proportion of contributors seems to have decreased.

It is often useful to compare the descriptive statistics stratified by the covariate. The table below provides the mean contribution further broken down by the covariates.

	MeanContribution		MeanContribution			MeanContribution	
	byTreatment		by Group			by Gender	
	Homogeneous	Heterogeneous	SASA	CSA	LSU	Male	Female
Treatment1	8.39	7.76	8.15	7.89	8.8	9.98	7
# Observations	40	29	26	33	10	26	43
Treatment 2	7.78	6.86	7.85	7.24	6.7	7.88	7.09
# Observations	40	29	26	33	10	26	43
Treatment 3	8.3	8.07	8.92	7.33	9.2	9.88	7.19
# Observations	40	29	26	33	10	26	43
Treatment 4	8.62	8.09	7.75	8.58	9.5	10.48	7.14
# Observations	40	29	26	33	10	26	43
Treatment 5	8.36	7.69	7.85	8.23	8.2	9.58	7.17
# Observations	40	29	26	33	10	26	43
Treatment 6	7.3	7.1	6.69	7.58	7.4	9.38	5.9
# Observations	40	29	26	33	10	26	43

Table 2: Mean contribution summarized by covariates across the “temporal treatments”

Table 2 above facilitates a closer look at the pattern of mean contribution summarized by covariates. Across all the six “temporal treatments” voluntary contribution in the homogenous triad – when all three participants belong to the same social group – is greater than in the heterogeneous triad. The direction of the sign is in the expected direction. The analysis of mean contribution when stratified by the social group to which the participants were affiliated show that, across all six temporal scenarios, there isn’t any noteworthy variation.

While the primary goal of the study is to investigate the role of social and time preference in collective action, with gender being treated as a potentially confounding covariate, the relative magnitude of the difference in mean contribution between male and female participants across all six temporal scenarios, as shown above, indicates the need to further investigate the role of gender in the decision-making process.

The discussion of voluntary contribution, stratified by the covariates, is helpful in establishing the stylized facts of the data. A graphical illustration of voluntary contribution broken down by

the covariates can also be accessed in the Appendix below. However, while instructive, it is important to note that the above summary includes data stratified by one covariate at a time, and due to the nature of possible interactions between the covariates, the information obtained could be potentially misleading.

To investigate the research questions outlined above, empirical tests of the hypothesis were conducted. A discussion of the hypothesis tests follows below.

1.4. D. Hypothesis Testing

Merrett (2012) provides a critical review of different empirical estimation strategies used thus far to analyze public goods game data and categorizes those into two broad categories: 1) that treat voluntary contribution as a continuous variable, and 2) that treat voluntary contribution as a discrete variable. Some of the challenges associated with modeling data from the VCM games includes taking into account their discrete and censored nature. Merrett (2012) notes that most studies analyzing VCM games don't move beyond examining the descriptive statistics.

For the present analysis, I conduct several tests to gauge the research questions posed above. Before conducting the hypothesis tests, for clarity, the empirical specification used to capture the effect of time on voluntary contribution is presented below.

Empirical Specification: Temporal Treatment

To test the effect of time on strategic interactions vis-à-vis the contribution participants make in a VCM game, let us consider an individual i who makes a voluntary contribution, C , in the temporal treatment t . The empirical specification used to capture the role of time in the VCM games can be written as:

$$C_{it} = \beta_i (\text{Social Treat}) + \delta_{it} (\text{Temporal Treat}) + \chi_i (\text{Social Group}) + \varphi_i (\text{Gender}) + \varepsilon_{it}$$

In the above equation, C_{it} denotes voluntary contribution by individual i at time period t , β_i is a dummy coefficient capturing whether individuals were assigned to the homogeneous or heterogeneous triad (Treatment =1; Control =0), δ_{it} captures the parameter for the change in

voluntary contribution induced by the temporal change in the scenario of the contribution, χ_i is a dummy coefficient capturing the control variable for the social group from which the participants were recruited (SASA, CSA, and LSU – reference category: CSA), and ϕ_i is a dummy coefficient that captures the control variable for gender (male =1 and female =0). The above empirical specification captures the coefficients of a linear model; this assumption is made for simplicity, as it is feasible that the time variable takes on an exponential or hyperbolic function with delay.

For the present analysis, I employ two different empirical estimation strategies: a) parametric tests, and b) non-parametric tests

1.4.D.1 Parametric Tests

Ordinary Least Square (OLS) regression is a standard method employed to estimate the coefficients of a linear model. When the assumptions of the OLS model holds – for example, error term has a constant variance (homoscedasticity), the independent variables are uncorrelated with the error term – the model is said to be BLUE (Best Linear Unbiased Estimator).

However, OLS estimates can be inconsistent when the data is censored in nature. The Tobit model takes both left and right censoring in the dependent variable into account to estimate the coefficients of the linear relationship. In the present, as the data is left censored at zero and right censored at fifteen, Tobit is a good candidate for the analysis.

When the dependent variable takes more than two categories, and the dependent variable is ordinal in nature, ordered logistic regression can be employed. Ordinal Regression Model, also known as cumulative link models (Christensen, 2013), belong to a family of regression model employed for ordinal responses such as consumer rating, school grade etc. In this study, participants are asked to decide how much of their initial endowment of \$15 they would like to contribute to a public account – the dependent variable, therefore, can be treated as an ordinal variable taking 16 values (0 to 15).

If we consider a cumulative link model with an ordinal response variable Y_i that can fall in j categories, then Y_i follows a multinomial distribution with parameter π , where π_{ij} denotes the probability that the i th observation falls in the j th category (Christensen, 2013).

One of the important assumptions that underlie ordinal regression models are that the coefficients that describe the relationship between the different categories of the response variable are the same (i.e. the relationship between the covariates and the response variable for participants who contribute, say \$5, is the same as the relationship when the contribution is \$10). This is also known as the proportional odds assumption (Bruin, 2006).

Table 3 below summarizes the results obtained using the different estimation methods described above. The responses from the different temporal scenarios are modeled below together with the error being clustered at the individual level.

Table 3: The effect of “temporal treatment” on voluntary contribution

VARIABLES	OLS	Tobit	Ordered Logit
Temporal Treatment 2	-0.732 [0.605]	-1.188 [1.034]	-0.259 [0.204]
Temporal Treatment 3	0.080 [0.404]	0.330 [0.666]	0.003 [0.150]
Temporal Treatment 4	0.275 [0.455]	0.532 [0.817]	0.081 [0.164]
Temporal Treatment 5	-0.043 [0.404]	-0.330 [0.659]	-0.019 [0.149]
Temporal Treatment 6	-0.906** [0.436]	-1.475** [0.746]	-0.347** [0.157]
Social Treatment (Homogeneous=0; Heterogeneous=1)	-0.166 [1.173]	0.086 [2.102]	-0.073 [0.444]
Gender (Male=1; Female =0)	2.701** [1.112]	5.088** [2.155]	0.910** [0.424]
Student Group Affiliation LSU	1.180 [1.556]	1.704 [2.704]	0.359 [0.529]
Student Group Affiliation SASA	0.188 [1.110]	0.162 [1.984]	-0.022 [0.410]
Constant	6.933*** [1.000]	6.360*** [1.739]	-1.233*** [0.432]
Observations	414	414	414

Robust standard error in parenthesis

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

1.4.D.2 Non-Parametric Regression

To gauge the robustness of the results obtained, non-parametric tests that allow the researcher to tests various hypothesis without having to rely on distributional assumptions were also conducted. Recent years has seen a rise in the attention devoted to non-parametric statistics such as kernel based smoothing splines and neural networks (Bohling, 2005). Rank-based methods, or methods based on rank-transformation of the original data, are another family of non-parametric tests. One of the limitations of the rank-based methods, traditionally, was that the analysis was limited to a one-way decomposition of the response variable – for example, the Kruskal-Wallis test is the non-parametric equivalent of a one-way ANOVA (Shah and Madden, 2003). However, recent advances in the field have given practitioners several multivariate non-parametric tests from which to choose.

For the purpose of the present study, I rely on a rank-based multivariate non-parametric test developed by Brunner and colleagues (1999, 2001). Such rank-based methods have been shown to work for various types of data structures (ordinal, categorical, etc.), for highly skewed distributions, in cases where sample size may be small, and for repeated-measure designs (Brunner et.al., 2001)⁷. The tests result in a Wald-Type Statistic (WTS) and an ANOVA-Type

⁷ In the methodology developed by Brunner and colleagues (2001), the ranks are not used directly to obtain a test-statistic, but further computational procedures are employed upon the statistic to estimate the relative treatment effect. The relative treatment effect is defined in reference to the distribution of variables measured in the experiment. To test the null hypothesis that the empirical distribution of the two treatments are the same, each treatment – say, denoted by χ_{it} to represent the t th repeated measure of treatment i -- is converted to have a normalized distribution $F_i(x)$, which is then compared to the weighted mean distribution, say $H(x)$.

Following Brunner et.al (2001), the relative effect for the i th treatment is given by:

$$p_i = \int H dF_i$$

The relative treatment effect, p_i , which describes the stochastic tendency of F_i with respect to H , can be interpreted as whether observations in the i th treatment tend to be larger than an independent random variable which has H as its distribution (Shah and Madden, 2003). Relative

Statistic (ATS) which are comparable to their parametric counterparts (please see Appendix for results).

Using the empirical specification and the different methods described above, the hypothesis tests that follow from the research questions are conducted. The results and their interpretation are provided below.

Hypothesis 1: Voluntary Contribution decreases as the timing of when the benefits are received are removed further in time.

Two time horizons (5 days and 15 days) are considered to analyze how the delay in the benefits received from contribution to the public account affect voluntary contribution. The results from the comparison of each time delay to the baseline treatment (when all benefits are received the same day) are presented below.

First, let us consider the case when the delay in the benefit received from contribution to the public account was 5 days. To do so, we compare the baseline results (Treatment 1) with the scenario when benefits received from the public account for oneself and the others was after 5 days (Treatment 5).

The results from the parametric tests summarized above indicate that there is no significant effect of the time delay (5 days) on voluntary contribution. In results of the non-parametric tests also indicate that 5 day delay has no significant effect.

Now, again, we test the same hypothesis, but for when the delay in benefits received from contribution to the public account is 15 days.

treatment effect larger than 0.5 implies that observations in the i th treatment tend to be larger in comparison to the independent random variable with distribution H ; and vice, versa, when relative treatment effect is less than 0.5.

The results above indicate that when the delay in the benefits received from contribution to the public account is in 15 days, time delay is a significant factor in determining voluntary contribution.

The OLS estimate for the coefficient of the temporal treatment when delay is 15 days indicates that compared to the baseline results, individuals contribute \$0.91 less, holding all else constant, when benefits from the public account are accrued after 15 days. The coefficients from the tobit model indicate that individuals contribute \$1.48 less when benefits are accrued after 15 days compared to the baseline results. The tobit model accounts for the left censoring of the dependent variable at zero and the right censoring at fifteen; the linear effect is modeled on the uncensored latent variable.

The coefficient for the ordered logistic regression indicate that compared to the baseline results, when benefits from public goods are received after 15 days, the ordered log-odds of contribution decreases by 0.38. Taking the exponent of the coefficient gives us the odds-ratio for the coefficient. The odds ratio captures the cumulative odds of belonging to a certain category or higher or to one of the lower categories. The odds ratio of an individual's contribution in Treatment 6 is 0.68 times lower than in Treatment 1 given a voluntary contribution level and hold all other factors constant.

Consistent with the above results, the estimated Relative Treatment Effect coefficient from the multivariate non-parametric test also indicate that a randomly chosen observation from the combined dataset results in a smaller value than a randomly chosen observation from NOW with an estimated probability of 53%, and a smaller value than a randomly chosen observation from 15 days with an estimated probability of 47%.

Result 1: The results indicate that the temporal delay in benefits received from contribution to public account (time=15 days) has a significant effect on the level of voluntary contribution. As hypothesized, voluntary contribution decreases with the temporal delay. However, the “front-end” – or shorter – delay (time =5 days) has no significant effect. The OLS estimate for the coefficient of the temporal treatment when delay is 15 days indicates that compared to the baseline results, individuals contribute \$0.91 less, holding all else constant, when benefits from the public account are accrued after 15 days, whereas the coefficient from the tobit model indicates that individuals contribute \$1.48 less.

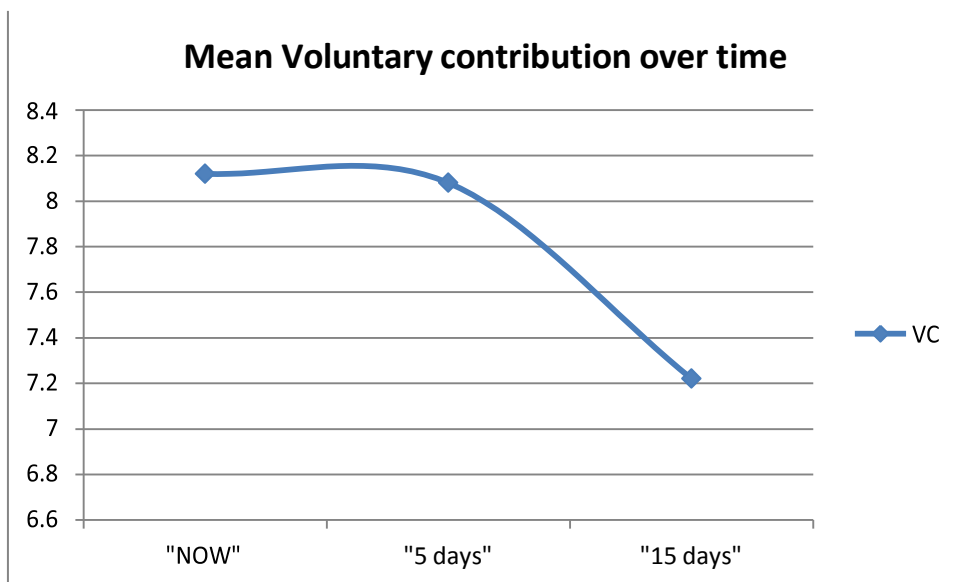


Figure 2: Mean Contribution over time

Hypothesis 2: The expectation of others’ valuation of the future will affect one’s voluntary contribution in the VCM game.

How does expectation of others’ valuation of the future affect one’s own voluntary contribution?

Say, three individual indexed as i , j , and k are participating in the VCM game. The change in allocation due to the temporal delay in benefits received from contribution to the public account not only captures i ’s discounting of her valuation of benefit from investment in the public account, but also i ’s expectation of the discounting behavior exhibited by individual j and

individual k . It is worth noting that the two factors are not independent of each other, and there is a likelihood of a strong interaction effect between the two. In order to gauge whether individual i 's expectation of discounting behavior by individuals j and k affect average voluntary contribution in an independent manner, we build on existing work by Deck and Jahedi (2011) on discounting behavior in strategic interactions. By varying the timing of benefit from investment in the public goods account for the others two individuals in the group relative to oneself, the following two comparisons help investigate whether the expectation of how others' value the future affects one's own voluntary contribution.

First let us consider Treatment 1 and Treatment 2. While in Treatment 1 ("baseline results") all benefits are received NOW, in Treatment 2 all benefits for oneself is received NOW, but for the other two participants benefits received from their contribution to the public account is only received after 15 days. The time coefficient in this model captures the change in allocation induced due to the temporal treatment.

Compared to Treatment 1, the average contribution in Treatment 2 tells us whether, conditional on benefit for self from public goods consumption being now, does timing of others' benefit from the public goods account affect one's contribution?

The results from Table 3 above suggest that the temporal treatment that captures the effect of the expectation of how others value their future benefits from contribution to the public account is not a statistically significant factor. The non-parametric test results also corroborate the non-significant findings.

To further investigate whether expectation of how others value their future benefits from contribution to the public account let us consider Treatment 3 and Treatment 6. As detailed above, in Treatment 6 the benefits received from contribution to the public good account materializes in 15 days for oneself as well as the other two participants in the group; in Treatment 3, the benefit others receive from the public account is NOW, whereas for oneself the benefit from the public account is in 15 days.

The comparison of the two “temporal treatments” helps pose the following question: conditional on benefit for oneself from public good consumption being in the future, does the timing of others benefit from the public good account affects one’s contribution?

All the temporal treatments described in the study can be investigated in comparison to the results generated from the baseline results, with the exception of the comparison between Treatment 3 and Treatment 6. To compare the two scenarios, a t-test was conducted on the coefficients of the variable for Treatment 3 and Treatment 6 generated from the regression in Table 3 above – the results of the t-test are presented in Table 4 below. The results indicate that the temporal treatment that captures the effect of the expectation of how others value their future benefits from contribution to the public account is a significant factor in explaining voluntary contribution. The p-value t-test for the coefficients generated from the OLS model was 0.07; for the coefficients generated from the tobit model it was 0.05; and for the coefficients generated from the ordinal logistic regression the p-value was 0.08.

Null: coefficient (Treatment 3) = coefficient (Treatment 6)

	OLS	Tobit	Ordered Logit
F-value	3.32	3.69	3.15
p-value	0.07	0.05	0.08

Table 4: T-test for coefficients comparing Temporal Treatment 3 and Temporal Treatment 6

Similarly, the p-value from the non-parametric test also indicated that the two scenarios are significantly different (p-value=0.07). The estimated Relative Treatment Effect coefficient for the time variable in Treatment 3 is 0.52, whereas the RTE for the time variable in Treatment 6 is 0.47, which implies that a random observation for Treatment 3 tend to be larger in comparison.

The comparison of the RTE is, indeed, consistent with the expected hypothesis. Conditional of benefits from the public account being after 15 days for oneself, participants tended to contribute more when benefit from the public account for others materialized NOW instead of after 15 days. While this may seem counter-intuitive on one level, from an economic perspective, it makes sense to expect that others will contribute more to the public account when the benefits

for them materializes NOW. To elaborate further, conditional on the benefits from the contribution to the public account for oneself being after 15 days, if the change in timing of when the benefits are received by the other two participants elicits a significantly different response for the participant in question, it is only logical to conclude that the phenomenon is, indeed, influenced by the expectation that others are sensitive to the timing of their benefit. Specifically, one expects that others will contribute more when they receive their benefits in the present than in the future.

Result 2: The results indicate the expectation of how others' value the future influences the level of voluntary contribution. Conditional on the benefit from the public account for oneself being NOW, the change in timing of benefit from the public account for the other two participants from NOW to after 15 days did not elicit a significantly different response. On the other hand, conditional on the benefits from the contribution to the public account for oneself being after 15 days, the change in timing of when the benefits are received by the other two participants elicited a significantly different response, i.e. participants contributed more when, conditional on the timing of their own benefit, others received their benefit sooner rather than after 15 days.

Hypothesis 3: Voluntary contribution increases as the timing of when contribution is made is distanced into the future.

Does timing of contribution affect voluntary contribution? The temporal treatments considered here are Treatment 1 ("baseline results") -- when the timing of contribution and timing of benefits received are all NOW -- and Treatment 4 -- when the timing of when contribution towards the public account is made as well as timing of when benefits are realized is after 15 days. The coefficient for the time variable captures the change in contribution influenced by being temporally distanced from consequences of actions when making immediate contributions (Noor and Ren, 2011). Following Noor and Ren (2009) and Noor (2011), subjects' normative preferences, which captures their behavior when the timing of contribution is temporally removed, reflects any ethical considerations participants might have in making their allocations.

Based on the premise that subjects' exhibit their temptation preference when they have to contribute in the present, the hypothesis test help gauge whether participants exhibit time-consistent preferences in making contribution towards public goods.

The results above indicate that being distanced to the consequences of one's action, in the form of contributing towards and receiving benefits from the public good account after 15 days vis-à-vis contributing towards and receiving benefits from the public account NOW – has no effect on voluntary contribution.

Result 3: The results above indicate that being distanced to the consequences of one's action, in the form of contributing towards and receiving benefits from the public good account after 15 days vis-à-vis contributing towards and receiving benefits from the public account NOW – has no effect on voluntary contribution.

In addition to the results generated from the hypothesis test above, it is also interesting to note that gender is a significant factor in explaining voluntary contribution employing different estimation strategies, including the non-parametric tests. The results indicate that males, on average, contribute more than females. Past studies examining the role of gender in the provision of public goods have found mixed results – Rapport and Chammah (1965) find that men are more cooperative than woman, whereas Mason, Phillips and Redington (1991) do not find any difference between men and women. Examining behavior in repeated-games when group size was fixed at four, Nowell and Tinkler (1994) find that all-women groups contribute more than all-male or mixed-gender groups. Croson and Gneezy (2009), meanwhile, investigate how different preferences between males and females could drive the results in various games; in particular, the authors posit that difference in risk-aversion between males and females (i.e. females tend to be more risk-averse) to be an important determinant of allocation decisions. The findings of the present study are also consistent with the argument that men are more likely to take social risks than women. Future studies to focus on the role of gender in allocations choices over time.

It is worth noting that one of the critical assumptions of the analysis is that there are no carry-over effects between the different temporal scenarios. As noted earlier, participants in the study were told to make their decisions carefully as any one of the scenarios would be randomly picked to determine their effective pay-off. Furthermore, with the exception of Treatment 1, the standard VCM game with no temporal component, which was introduced first to establish the baseline contribution level, all the other Treatments were chosen to be introduced in a random order.

With the exception of one hypothesis test to gauge the role of expectation of others' valuation of the future (when Treatment 1 and Treatment 2 were compared), no other hypothesis test involved comparison of scenarios that immediately preceded or succeeded each other. The less stringent assumption of conditional independence among Treatments given the previous Treatment holds for all these hypothesis tests.

1.5 Contribution and Limitation

The above results yield some interesting findings. While there has been a plethora of studies on discounting behavior in individual decisions that have documented the phenomenon of present-bias (Kahneman, 1979; Frederick and Loewenstein, 2002), the limited research on discounting in strategic interactions that have been conducted to date by Deck and Jahedi (2013a, 2013b) have found conflicting evidence. Examining discounting behavior in competitive strategic interactions such as contest games, in one study Deck and Jahedi (2013a) find no evidence that delay in valuation of benefits influences decision-making. In another study, using the same methodology, the same authors find that present-bias does affect decision-making in strategic contests like in individual decisions. The most significant difference between the two studies was that in the first study (where no effect was found) the time delay in benefits was one-week, whereas in the second study (where a significant effect was found) the time delay was two weeks.

While the context of the present study is different, with a cooperative strategic interaction in the form of Voluntary Contribution Mechanism Game conducted instead, the results obtained from the present study also yield results consistent to that of Deck and Jahedi (2013a, 2013b). As

summarized in Result 1 above, when the delay in benefits from contribution to the public account was 5 days later, no significant effect was found on voluntary contribution; but for 15 days, the time delay was a significant factor in explaining voluntary contribution. The inference drawn from this study is similar to that of Deck and Jahedi – that the lack of (and presence of) an effect at different time horizons could perhaps indicate that for short time delays, the strategic element of the decision-making process masks the temporal element. In other words, the temporal element might require a slightly longer time horizon to become salient.

Another important finding of the study, as summarized in Result 2 above, is that the expectation of how others' value the future influences the decision-making process when contributing towards public goods. As previously stated, the results show that conditional on the benefit from the public account for oneself being NOW, the change in timing of benefit from the public account for the other two participants from NOW to after 15 days did not elicit a significantly different response; however, conditional on the benefits from the contribution to the public account for oneself being after 15 days, the change in timing of when the benefits are received by the other two participants elicited a significantly different response. It is interesting to note that while in one comparison the results are not significant, in the other case they are. A closer look at the two comparisons shows that conditional on the benefit from one's own contribution to the public account being in the future, the change in timing of benefit for the other participants influences voluntary contribution, but conditional on the benefit from one's own contribution being NOW it doesn't. The result implies that conditioning on our future self, how others value the future enters our calculus of cooperation, but conditioning on our present self it has no effect.

As with most experimental studies, external validity is often a concern (Harrison and List, 2004), and extrapolations of the results obtained to other "real-world" actors and institutions always needs to be made with caution. Some of the standard issues arising in the external validity of VCM games are the generalizability of the participants used in the study (students at UW who belonged to different social organizations) to participants from other demographics, and the generalizability of the incentive to cooperate for the given amount to other cooperative situations (Andreoni, 2009). In addition, the novel temporal treatment introduced in the present study -- whereby the timing of contribution and benefits received from the private and public account of

the VCM game are varied -- could also perhaps reflect behavior specific to the game. However, extending the incentive structure of the VCM to decompose it into the relative temporal change in the public and private accounts does not seem problematic from the perspective of external validity. On the contrary, by introducing the temporal treatment into the model, the study extends the generalizability of previous studies.

In addition, the study also found that across the different temporal scenarios, gender – introduced as a potentially confounding co-variate in the model – was consistently significant with males contributing more than females on average. Future research should investigate the role of gender in strategic interaction with temporal delays.

As noted earlier, while the public goods game and individual discounting have both been extensively studied to date, there is no existing research, to the author's knowledge, on discounting behavior in a public goods game. In “real life” settings, the benefits from cooperative behavior materializing in the near or distant future are perhaps the general rule rather than exception. The proper functioning of markets is built upon cooperation between buyer and seller, the benefits of which often realize in the future (for example, e-commerce or group buying schemes). The provision of public goods, whether it be providing immunization to a village, restoring a natural park, or contributing towards global public goods such as carbon offset projects – each have a temporal element embedded into them.

Whether temporal delay plays a significant role in influencing voluntary contribution, and whether how others value the future affect voluntary contribution, are therefore important empirical questions with significant policy implications. The present study aims to provide some preliminary evidence to shed light on the phenomenon. The results, however, only contribute towards the nascent field of discounting in strategic interactions. Future research should focus on variations among the different decision-making domains (Hardisty and Weber, 2009) in strategic settings. In light of the findings from Deck and Jahedi (2013a, 2013b) and the present study, future studies on the role of time in strategic interactions should pay particular attention to various time horizons. Further studies confirming the robustness of the results or finding contrary evidence would also be fruitful.

Appendix A1: Histogram of Voluntary Contribution from for the “Temporal Treatments”

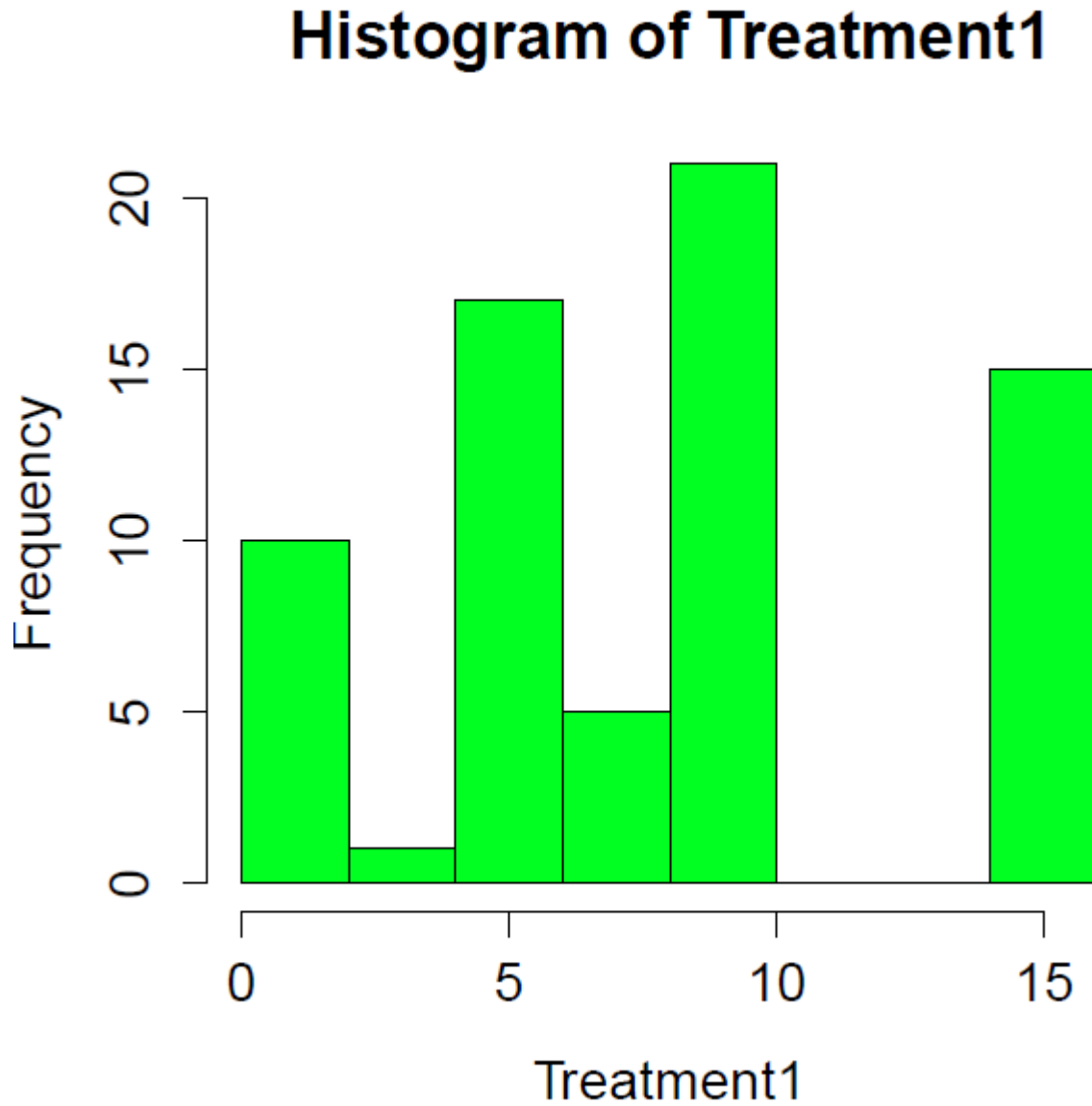


Figure 3: Histogram of Voluntary Contribution in Treatment 1

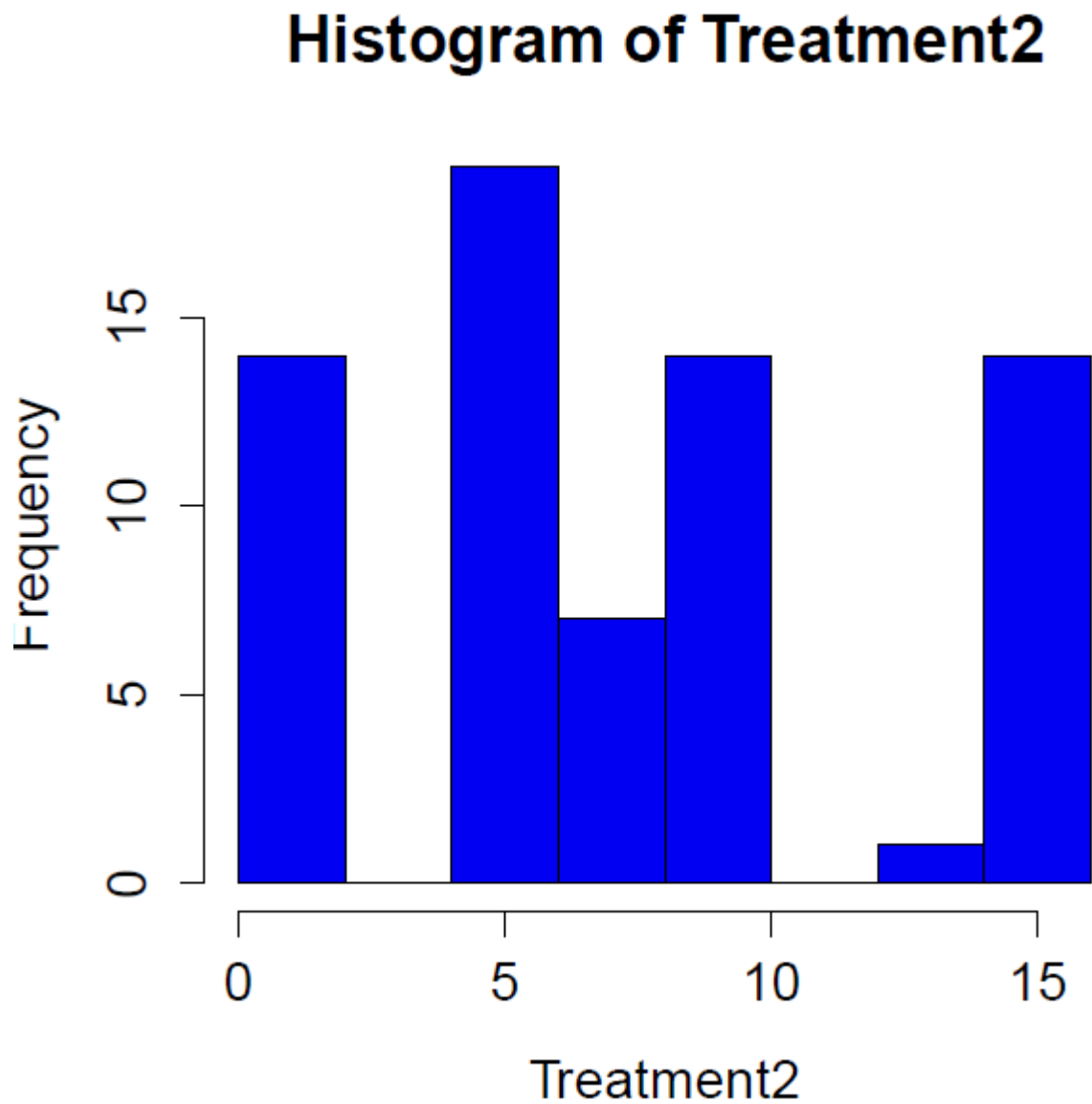


Figure 4: Histogram of Voluntary Contribution in Treatment 2

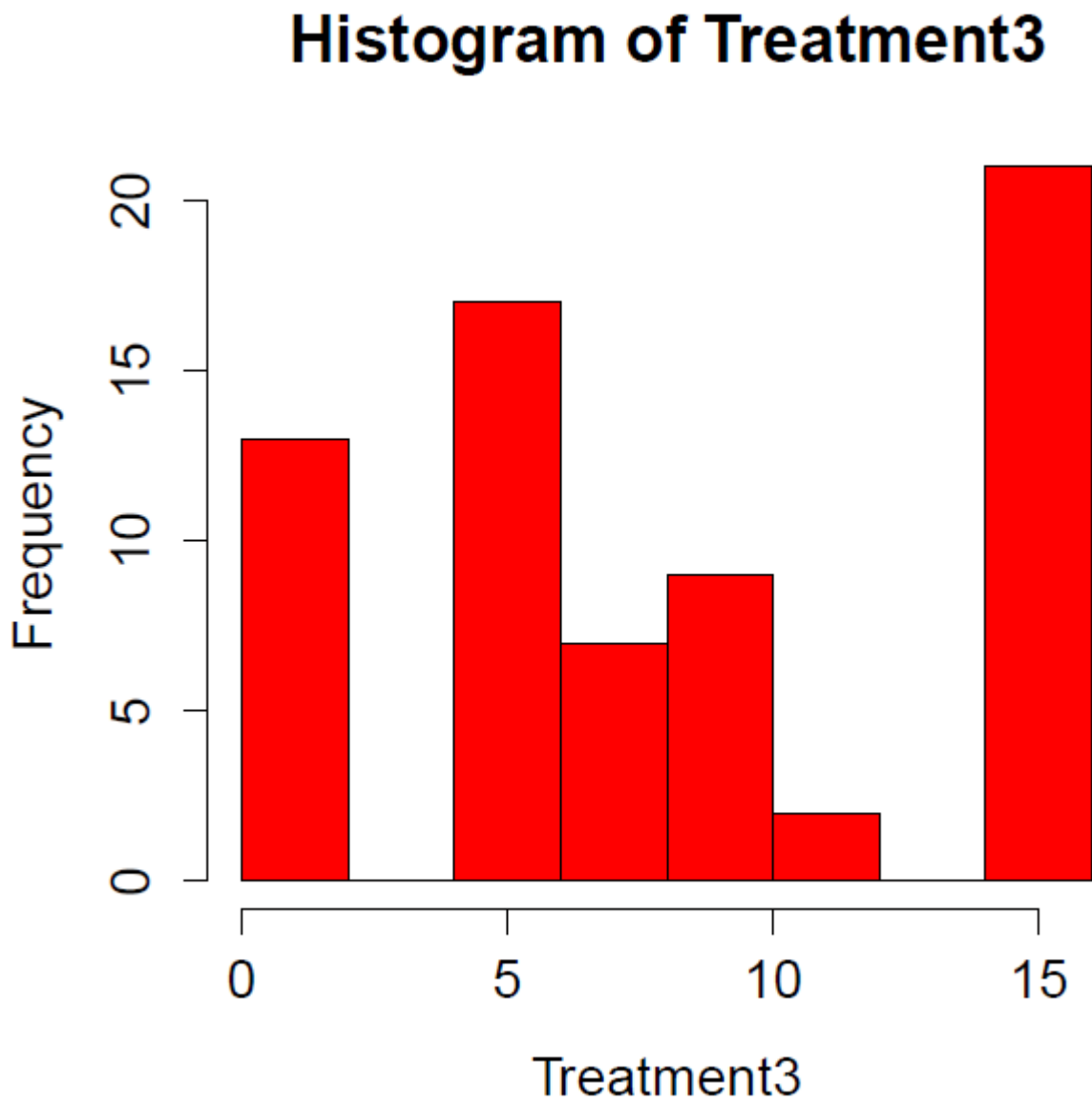


Figure 5: Histogram of Voluntary Contribution in Treatment 3

Histogram of Treatment4

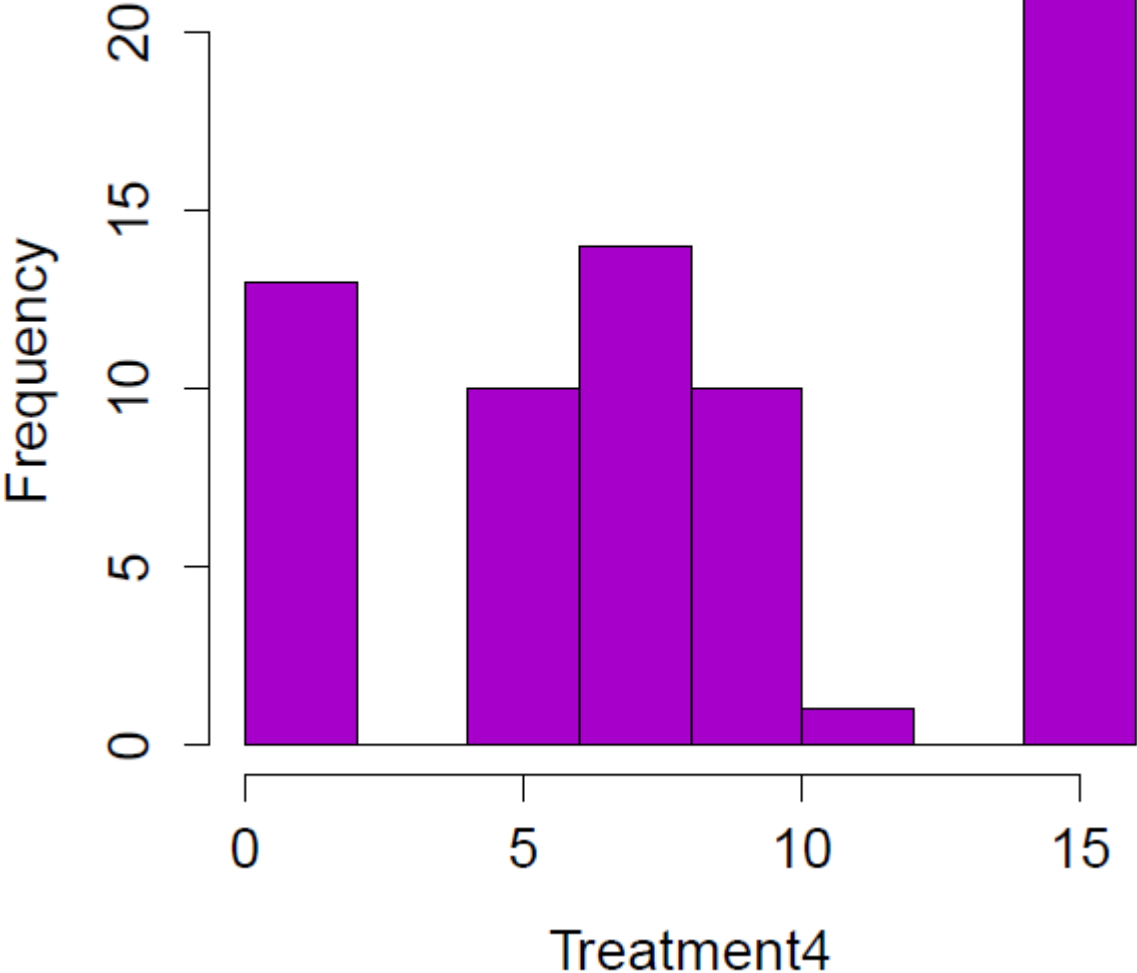


Figure 6: Histogram of Voluntary Contribution in Treatment 4

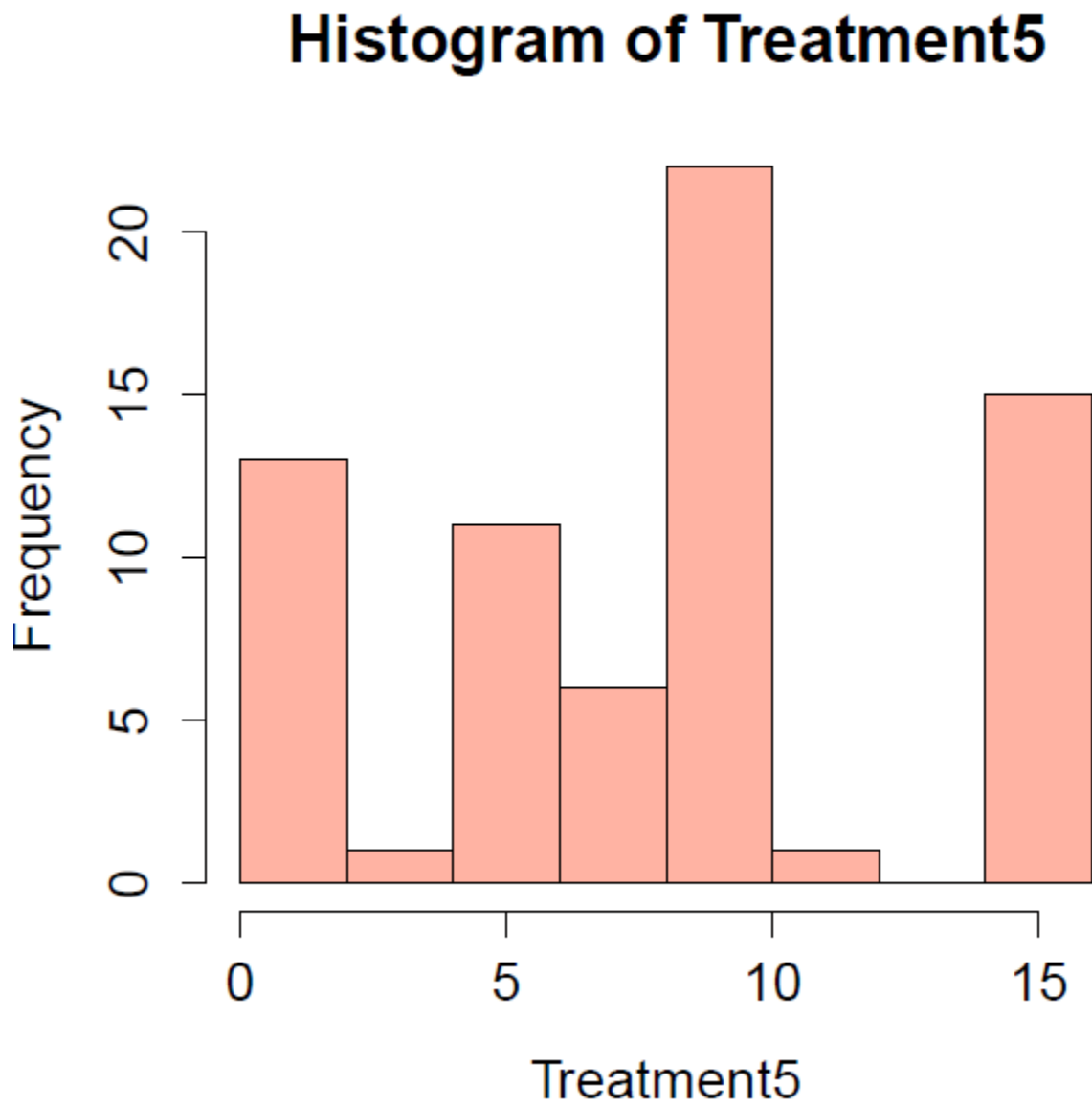


Figure 7: Histogram of Voluntary Contribution in Treatment 5

Histogram of Treatment6

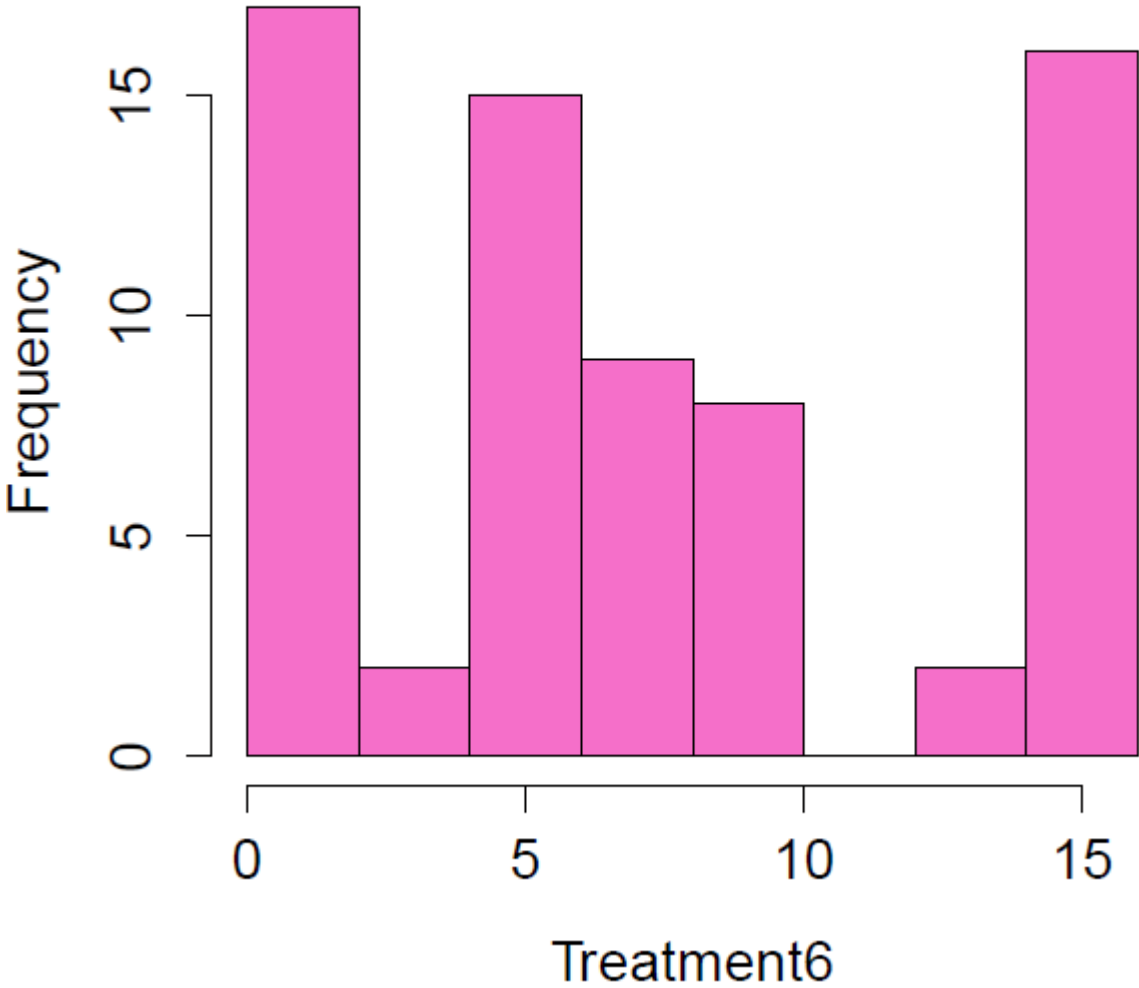


Figure 8: Histogram of Voluntary Contribution in Treatment 6

Appendix A2: ANOVA-Type Statistic and Wald-Type Statistic

Table 5: ANOVA-Type Statistic (ATS) and Wald-Type Statistic (WTS) for comparison between Treatment 1 and Treatment 5

	Model 1		Model 2		Model 3		Model 4	
Wald-Type Statistic (WTS)								
	Statistic	p-value	Statistic	p-value	Statistic	p-value	Statistic	p-value
Time	0.004	0.95	0.006	0.93	0.18	0.91	0.16	0.69
Treatment			0.45	0.5	0.31	0.58	0.09	0.75
Time*Treatment			0.02	0.89	0.003	0.95	0.13	0.72
Group					0.18	0.91		
Treatment*Group					2.33	0.31		
Group*Time					2.1	0.35		
Gender							5.81	0.01***
Gender*Treatment							1.72	0.19
Gender*Time							0.72	0.4
Treatment*Group*Time					1.55	0.46		
Treatment*Gender*Time							0.87	0.35
ANOVA-Type Statistic (ATS)								
	Statistic	p-value						
Time	0.004	0.95	0.006	0.93	0.04	0.95	0.16	0.69
Treatment			0.45	0.5	0.31	0.58	0.095	0.76
Time*Treatment			0.02	0.89	0.015	0.9	0.13	0.72
Group					0.08	0.84		
Treatment*Group					0.32	0.63		
Group*Time					0.5	0.56		
Gender							5.91	0.02**
Gender*Treatment							1.72	0.19
Gender*Time							0.72	0.4
Treatment*Group*Time					0.45	0.59		
Treatment*Gender*Time							0.86	0.35
	*p-value<0.1; **p-value<0.05; ***p-value<0.01							

Table 6: ANOVA-Type Statistic (ATS) and Wald-Type Statistic (WTS) for comparison between Treatment 1 and Treatment 6

	Model 1		Model 2		Model 3		Model 4	
Wald-Type Statistic (WTS)								
	Statistic	p-value	Statistic	p-value	Statistic	p-value	Statistic	p-value
Time	4.98	0.03**	4.28	0.04**	4.77	0.03**	3.58	0.059*
Treatment			0.2	0.66	0.2	0.66	1.90E-01	0.66
Time*Treatment			0.36	0.55	0.003	0.25	5.37E-05	0.72
Group					0.18	0.66		
Treatment*Group					5.91	0.05**		
Group*Time					2.1	0.12		
Gender							6.89	0.001***
Gender*Treatment							6.34E-01	0.43
Gender*Time							1.57E-02	0.9
Treatment*Group*Time					5.82	0.05**		
Treatment*Gender*Time							2.71	0.1*
ANOVA-Type Statistic (ATS)								
	Statistic	p-value						
Time	4.98	0.03**	4.28	0.04**	4.77	0.03**	3.57	0.058*
Treatment			0.2	0.66	0.19	0.66	1.92	0.66
Time*Treatment			0.36	0.55	0.25	0.62	5.37E-05	0.99
Group					0.13	0.77		
Treatment*Group					0.73	0.42		
Group*Time					1.5	0.22		
Gender							6.89	0.008***
Gender*Treatment							6.34E-01	0.42
Gender*Time							1.57E-02	0.9
Treatment*Group*Time					2.08	0.13		
Treatment*Gender*Time							2.71	0.1*
	*p-value<0.1; **p-value<0.05; ***p-value<0.01							

Wald-Type Statistic (WTS)

	Statistic	p-value	Statistic	p-value	Statistic	p-value	Statistic	p-value
Time	3.29	0.07*	3	0.08*	2.78	0.095*	2.2	0.1*
Treatment			3.38E-02	0.85	0.61	0.43	0.25	0.62
Time*Treatment			1.03E-05	0.98	0.43	0.51	0.18	0.67
Group					0.58	0.75		
Treatment*Group					5.64	0.059*		
Group*Time					6.47	0.04**		
Gender							5.28	0.02***
Gender*Treatment							0.18	0.67
Gender*Time							0.15	0.7
Treatment*Group*Time					3.11	0.21		
Treatment*Gender*Time							0.69	0.5

ANOVA-Type Statistic (ATS)

	Statistic	p-value	Statistic	p-value	Statistic	p-value	Statistic	p-value
Time	3.29	0.07*	3	0.08*	2.76	0.095*	2.2	0.1*
Treatment			3.39E-02	0.85	0.61	0.43	0.25	0.62
Time*Treatment			1.03E-05	0.98	0.43	0.51	0.02	0.89
Group					0.08	0.84		
Treatment*Group					1.51	0.22		
Group*Time					1.22	0.25		
Gender							5.38	0.02**
Gender*Treatment							0.18	0.68
Gender*Time							0.15	0.7
Treatment*Group*Time					0.82	0.4		
Treatment*Gender*Time							0.7	0.5

*p-value<0.1; **p-value<0.05; ***p-value<0.01

Table 7: ANOVA-Type Statistic (ATS) and Wald-Type Statistic (WTS) for comparison between Treatment 3 and Treatment 6

Chapter 2

Discounting the Future in Strategic Interactions in a Heterogeneous Population

2.1 Introduction

This chapter deals with the temporal dynamics of value in strategic interactions in a heterogeneous population. How to discount the future has been a lively and critical debate among scholars of climate change (Stern and Treasury, 2007; Nordhaus 2007). Reducing greenhouse gas emissions is critical to keeping the earth habitable for this generation and generations to come (Intergovernmental Panel on Climate Change, 2007). Uncoordinated emissions could lead to a “tragedy of the commons” (Hardin, 1968). In Hardin’s example, each individual acts independently to maximize her utility since the private benefit to the individual is greater than the social cost to the individual, and this results in overgrazing and degradation of the pasture, against the long-term interest of each herder. In a public goods dilemma, similar to a common-pool resource dilemma, the incentive of every self-interested individual in a group acting independently is to ‘free-ride’ on the contribution of others and contribute the least possible (Isaac et.al, 1985), leading to the suboptimal provision of public goods. Effectively coordinating a global policy of greenhouse gas emissions reductions benefits all countries. However, all countries have an incentive to free ride on the emissions reductions of other countries as long as emissions reductions are costly. Furthermore, not all countries discount the future the same way for emissions reduction investments (Becker et.al, 2010). Developing countries with high growth rates have alternative investment opportunities that compete with reductions in greenhouse gas emissions; under-developed countries may perceive investments in poverty reduction as more critical than reducing greenhouse gas emissions (Hepburn et.al, 2008). This illustrates a social dilemma, whereby in a group interaction an agent’s incentive is structured in such a way that their pay-off for “defecting” is higher than their pay-off for “cooperating” regardless of what other group members do, whereas each individual defection leads to a lower *overall* pay-off for group members than if they all cooperated (Dawes, 1980). The private benefit of reducing greenhouse gas is borne by the individual country, whereas the benefits are shared by all countries and individuals; this creates a ‘dilemma’ for the individual country to ‘free-ride’ on the emission reduction of other countries, leading to the suboptimal emission of greenhouse gases (Hasson et.al 2009). While whether results generated from individuals’ lend themselves to interpretations as to how countries behave is contestable, following Hasson et.al., I argue that the results can form the basis for qualitative interpretations

regarding the factors that play a role in determining patience in collective investment decision for each country and further shed light on factors that underlie decision-making on mitigation and adaptation strategies, such as vulnerability, trust and expectation of cooperation.

A robust finding in the literature on diversity based on ethnicity and other dimensions of social identity is that increased diversity results in a decline in the provision of public goods (Easterly and Levine, 1997; Alesina et.al, 2003). With government budgets becoming increasingly stretched to provide public goods, and societies across the world becoming more heterogeneous, understanding the mechanisms of non-cooperation in such scenarios has become critical.

Existing research on the mechanism of non-cooperation in the provision of public goods in diverse populations posits that heterogeneous populations make sustaining norms of cooperation tougher by making the punishment of defectors more costly. Miguel et.al. (2005) and Hubrayamunya et al. (2009) provide evidence in support of this mechanism. However, more recent research (Oliviera et al., 2011) finds that the negative correlation between diversity and contribution to public goods disappears when there are controls for beliefs and preferences (risk, time, preference for cooperation). The proposed paper builds on this, exploring how individuals' preferences affect cooperation *ex-ante* when varying the social identity of the agent vis-à-vis that of other agents participating in the provision of the public good. The paper will elucidate whether agents' time preferences, or patience, are endogenous to the social identity of the other agents participating in the provision of a public good. Identifying the mechanisms of discounting behavior for the provision of public goods in a heterogeneous population will contribute towards a better understanding of the negative relationship found in the literature between public goods provision and social heterogeneity – the paper contributes towards the discussion by investigating whether *temporal delay in the provision of public goods acts as a source of non-cooperation* in their provision in a heterogeneous population?

The goal of the proposed paper is to examine if, and how, the time preference of an agent varies with the social identity of other agents participating in providing the public good. The motivating example is countries interacting to address climate change, that is – to provide a habitable environment, which is a public good.

Most laboratory studies involving the study of public goods provision are based on the *Homo Economicus* conception of individuals, which assumes individuals to be purely self-interested in that they derive utility from their own consumption only. This assumption has been challenged by emerging evidence that individuals derive utility not only from their own consumption, but also receive positive or negative utility from the consumption and welfare of others. For example, models of social preferences based on altruism posit that individuals are willing to make sacrifices to increase the welfare of low-payoff recipients (Charness and Rabin, 2002) and models of social preferences based on inequality aversion suggests that some people care about equitable outcomes while others are purely self-interested and the outcome in the provision of public goods results from interactions between them (Fehr and Schmidt, 1999). Additionally, many laboratory studies have assumed that the costs and benefits associated with the provision of public goods are accrued immediately. Contrary to this assumption, some decisions we make regarding the provision of public goods involve immediate costs and delayed benefits, for instance, provision of a habitable environment through protection against climate change. How individuals make trade-offs between current benefit and future benefit, hence, is implicitly embedded in such collective action dilemmas. Relaxing both assumptions, the proposed study investigates the role of temporal and social preferences jointly in the provision of public goods.

Social capital – defined broadly as factors such as “trust, norms and networks that can improve the efficiency of society” (Putnam, 1993) – has been posited to an important factor in the provision of public goods (Beall, 1997). Recent studies have shown trust and expectation about others’ contribution to be positively associated with contribution to public goods (Gächter et.al, 2004; Thoni et.al. 2009). Contributing to public goods without knowing how much other individuals’ are going to contribute can be viewed as a decision made in the context of a social risk originating from the action of other individuals (Kocher et.al., 2011). How does such a social risk interact with the temporal risk associated with receiving delayed benefits? Does trust facilitate more patience? While existing literature has documented that patience leads to higher levels of cooperation (Stevens and Hauser, 2004; Streich and Levy, 2007) – one of the question this paper asks is whether a higher level of trust/expectation of cooperation leads to higher degree of patience in the provision of public goods when the benefits are delayed.

In contrast to neo-classical economics that treats preferences as given and exogenous, recent research in behavioral economics has argued that preferences are endogenous to the environment, with individual behavior determined by the reference-point based on recent expectation about outcomes (Koszegi and Rabin, 2006; Tversky and Simonson, 1993). In the paper, I allow preferences to be endogenous to gauge how one's discount rate for public goods, or the rate of substitution between current consumption and future consumption of public goods, is a function of, among other factors, the decision(s) of other individuals in a region or group that one interacts with. Does a higher level of trust and expectation of cooperation from others cause individuals' to be more patient in social dilemmas with delayed rewards?

The rest of the chapter is organized as follows: Section 2 provides a review of the relevant literature; Section 3 outlines the research question; Section 4 describes the tests conducted to test the relevant hypothesis; and Section 5 discusses the contribution and the limitations of the research.

2.2 Literature Review

In order to augment the earlier discussion of the pertinent research on the role of time in decision-making and relevant research on the mechanisms driving contribution to public goods, a discussion of the existing research on the role of group identity in contribution towards public goods is presented below.

Group Identity and Contribution to Public Goods

Group identity has been posited to be an important determinant of contributions to public goods. However, the *Homo Economicus* view has typically shied away from integrating notions of social identity or group membership into models of individual choice. Akerlof and Kranton (2000, 2010) were the first and most prominent to integrate identity, norms and social categories into economics; they argue that because different *norms* of behavior are associated with different *social categories*, identity will affect individual decision-making. Eckel and Grossman (2005) varied group identity experimentally from none to weak to strong and found that strong group

identity led to significantly increased cooperation in public goods games. Subjects participated in repeated-play public goods game, framed as a team production problem where each subject had 100 time units (TUs) that they could allocate between leisure activities or to teamwork, which determined the size of bonus for the group. Overt means of identifying subjects with a team generated greater cooperation, and working on unrelated team production tasks prior to the experiment significantly increased subjects' cooperative tendencies (Eckel and Grossman, 2005). Experimental studies have also looked at how pre-existing identities such as social group membership (Solow and Kirkwood, 2002) and gender (Brown-Kruse and Hummels, 1993; Cadsby and Maynes, 1998; Croson et al., 2003) affect behavior in public good games and that cooperation goes up in the presence of a common identity. Similarly, also following an experimental approach, Charness, Rigotti, and Rustichini (2007) show that "group membership affects preferences over outcomes, and saliency of the group affects the perception of the environment." When group identification is high, studies show that group cooperation is enhanced as individuals view group welfare as being linked to individual welfare (Turner et al., 1987; Gaertner and Dovidio, 2008).

The *Social Identity Theory* developed by Tajfel et.al (1971, 1979), which treats social identity as an individual's concept of self derived from her membership to different groups, plays a prominent role in providing a psychological basis for inter-group discrimination. Brewer and Kramer (1986) designed a 2*2*2 factorial design (Public goods vs. Commons Dilemma * Individualistic vs. Collective Social Identity* Small vs. Large Group size) to empirically test behavioral responses to Public Goods dilemma versus Commons dilemma when group size and social identity were varied; social identity was varied by manipulating the "common fate" that made salient either collective-level social identity or individual level identity. When the choice problem was framed as public goods dilemma, the authors found that in a small group making the collective identity salient led to increased willingness to sacrifice personal gain for collective welfare, whereas in large groups increasing salience of the collective identity led to respondents keeping as much for themselves against their long-term benefits (Brewer and Kramer, 1986). Studying social fragmentation and public goods contributions in a laboratory setting, Chakravarty and Fonseca (2010) find that the initial introduction of an out-group member to a group initially results in a jump in contributions from the majority group, while decreasing the

relative size of the majority group results in decreasing contributions to the public good (as the social distance between the majority and minority group increases). As the experiment progresses through several rounds, average contributions decline. In a related line of research, Chen and Li (2009) present experimental evidence measuring the effect of induced group identity (based on the minimal group paradigm, Tajfel et al, 1971) on social preferences and find that when matched with an in-group member participants show a 47% increase in charity concerns, 93% decrease in envy, and are more likely to choose social welfare maximizing actions.

2.3 Research Questions

Research Question 1: Does social heterogeneity decrease average voluntary contribution in a one-shot VCM Game?

Research Question 2: Does average voluntary contribution change differentially in a socially homogeneous and a socially heterogeneous group when benefits from collective action decision are realized in the future? In other words, is patience in collective action dilemmas with delayed rewards endogenous to the social identity of the agents in the game?

Research Question 3: How does the timing of contribution affect average voluntary contribution in a one-shot VCM Game in a socially homogeneous and a socially heterogeneous group? Is decision-making when the timing of contribution is in the future systematically different than when the timing of contribution is now?

2.4 Research Methodology

This chapter builds on the methodology described in Chapter 2, further incorporating the influence of social identity of other individuals on discounting behavior in strategic interactions (please refer to Chapter 2 for a discussion of the various ‘temporal treatments’). The social identity of the players are made salient and individuals’ are matched with others (1) in the same group, an in-group match, (2) in another group or other groups, an out-group match.

To elicit the effect of social identity, two strategies are possible: (i) artificially inducing identity based on the minimal group paradigm (Tajfel et al., 1971), (ii) using the existing group identities. The minimal group paradigm (Tajfel et.al, 1971) consists of artificially inducing identity among the participants, and argues that individuals *categorize* themselves as belonging to particular groups and exhibit discriminatory bias against out-group members. As individuals are a combination of multiple identities—race, country of origin, ethnicity, alumni of a particular school, gender—the minimal group paradigm creates a crisp way to extract social identity driven-behavior without being confounded by an individual’s multiple identities in reality. The primary drawback of using an artificially induced group is that individual temporal preferences are unlikely to be malleable given manipulation in the laboratory and as such could pose problems in our research design. For this reason, pre-existing identity presents a more robust approach. This study employs student group affiliations, as discussed earlier. An advantage of using this approach is the higher internal validity and reliability of behavioral choices based on group identity. This is especially likely to be the case when evaluating temporal social preferences, as individual temporal preferences are fairly stable and artificial manipulation in the laboratory unlikely to yield robust results. Please refer to Chapter 2 for a discussion of the experimental procedure used to assign subjects affiliated with different student organizations to a Treatment (heterogeneous triad) and a Control (homogeneous triad) group.

Before discussing the hypothesis tests, it is useful to outline the empirical estimation strategy used to capture the main effect being assigned to a homogeneous triad or a heterogeneous triad – henceforth, also referred to as the social treatment.

Social Treatment: Empirical Specification

Here we consider whether social treatment – assignment of participants into a homogeneous or a heterogeneous triad – has an effect on voluntary contribution in the VCM game. Specifically, there are two hypotheses that are considered: i) the effect of social treatment in the baseline condition (i.e. when contribution and benefits are all in the present), ii) the effect of social treatment when the contribution towards the public account is made in the future.

The following empirical specification captures the effect of social heterogeneity on voluntary contribution:

$$C_i = \beta_i (\text{Social Treat}) + \chi_i (\text{Social Group}) + \varphi_i (\text{Gender}) + \varepsilon_i$$

Where C_i denotes voluntary contribution by participant i , β_i captures the effect of social heterogeneity on voluntary contribution, χ_i captures the coefficient for the control variable on social group to which participants belong, and φ_i captures the parameter for the control variable on the gender of the participant.

Hypothesis 4: Voluntary contribution will be higher in the homogeneous triad where all three participants belong to the same social group.

The results obtained from the parametric tests summarized above indicate that social heterogeneity had no effect on voluntary contribution. The result of the non-parametric Kruskal-Wallis test also indicates that social treatment has no effect on voluntary contribution in a VCM game.

It is worth noting that due to the non-temporal nature of the hypothesis test, the number of observations used for the analysis is limited to the number of participants in the study. The non-significant findings therefore could be due to the small sample size. In order to assess the number of participants required for the study to detect a significant effect, i.e. reject the null hypothesis, given the effect size, a power analysis is conducted. As discussed by Cortina and Nouri (2000), to conduct a power analysis, one needs to specify three of the four relevant parameters: i) an alpha value which captures the probability of a false positive or Type I error – this value is

usually set to 0.05, ii) a beta value that captures that probability of a false negative or a Type II error – the coefficient 1- beta captures the power of the experiment or the probability of finding a true positive, iii) the sample size of the study, and iv) effect size of the study⁸, which measures the magnitude of the difference between variables holding variability constant.

The difference in mean contribution between the homogeneous triad (\$8.4) and the heterogeneous triad (\$7.8) divided by the pooled standard deviation⁹ gives an effect size of 0.12. Compared to the rule of thumb estimates provided by Cohen (1969) -- 0.2 is considered a small effect size, 0.5 a medium effect size and 0.8 a large effect size – 0.12 is a very small effect size. Using the alpha-value of 0.05, the beta value of 0.2 that is customary in most power analyses, and given the effect size calculated above, the G-Power Statistical Software (Faul et.al. 2007, 2009) indicates that a sample size of 1720 would be required to detect a significant effect.

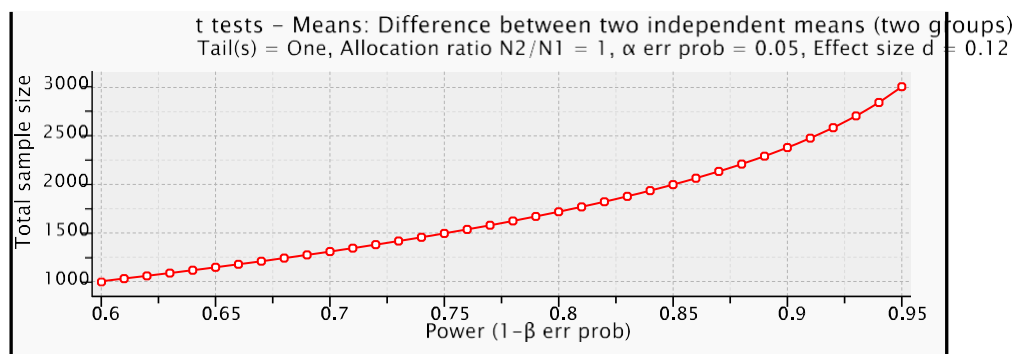


Figure 9: Power curve for Hypothesis 4

Result 4: Social treatment – whether participants in the triad belong to the same student organization or to different student organizations – does not affect voluntary contribution.

Hypothesis 5: Voluntary contribution will be higher in the homogeneous triad than the heterogeneous triad, even when individuals are distanced from the consequences of their action, i.e timing of contribution towards public good and benefits received from public good are both after 15 days.

⁸ Cortina and Nouri (2000) provide the formula for calculating the pooled standard deviation used to standardize the difference in means to capture the effect size.

⁹ $S_{pooled} = 4.93$

The results from the parametric tests above and from a non-parametric Kruskal-Wallis test indicate the social heterogeneity does not affect voluntary contribution when the timing of contribution and the timing of when benefits are received are after 15 days. A negative relationship between social treatment and voluntary contribution would have indicated that bias in social preferences are deeply rooted in individuals – as noted above, the limited sample size used for the analysis could have been an important consideration.

As noted above, the difference in mean contribution between the homogeneous triad (\$8.6) and the heterogeneous triad (\$8.1) divided by the pooled standard error¹⁰ gives an effect size of 0.09. The effect size of 0.09 is very small – according to the rule of thumb provided by Cohen (1969) 0.2 is considered a small effect, 0.5 a medium effect and 0.8 a large effect

Using the alpha-value of 0.05, and the beta value of 0.2 that is customary in most power analyses, given the effect size calculated above, the G-Power Statistical Software (Faul et.al. 2007, 2009) indicates that a sample size of 3056 would be required to detect a significant effect.

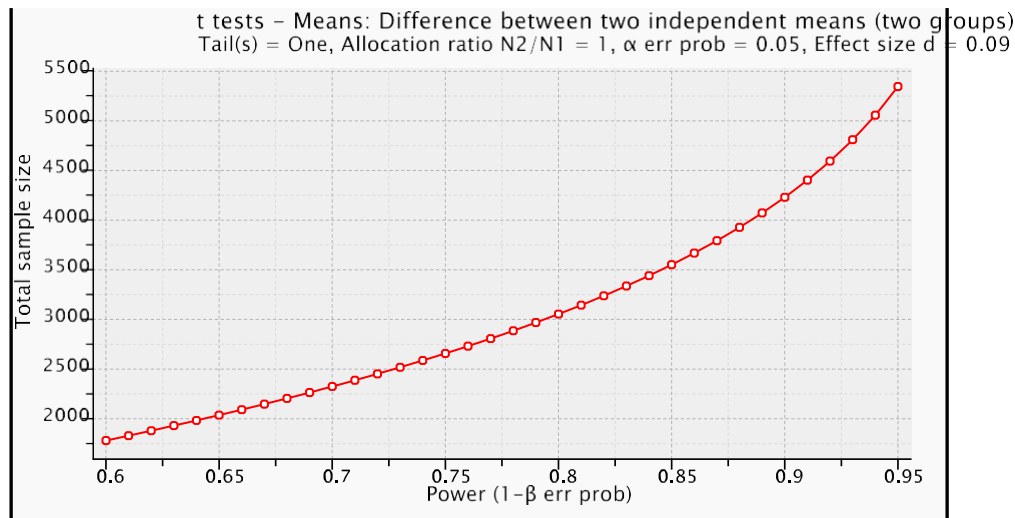


Figure 10: Power curve for Hypothesis 5

Result 5: Social treatment has no effect on voluntary contribution when individuals are distanced from the consequences of their action.

$$^{10} S_{\text{pooled}} = 5.45$$

Hypothesis 6: There exists an interaction effect between the social and the temporal treatment. Voluntary contribution will decline at a faster rate in the heterogeneous triad than the homogeneous triad when benefits from contribution to the public account are after 15 days.

In other words, this tests the null hypothesis that the average voluntary contribution across the different social compositions changes at the same rate when benefits from contribution to the public account are accrued in the future. Rejecting the null hypothesis would imply that rate of change of voluntary contribution is not the same across different social treatment when benefits from public goods are in the future.

Before considering the results from the non-parametric rank-transformation methodology developed by Brunner and colleagues (please refer to Chapter 2 for a discussion), the empirical specification of the interaction effect between the social and temporal treatment is outlined below.

Empirical Specification for the interaction effect between Temporal Treatment 6 and social treatment

$$C_{it} = \beta_i (\text{Social Treatment}) + \delta_{it} (\text{Temporal Treatment}) + \lambda_{it} (\text{Social Treatment} * \text{Temporal Treatment}) + \chi_i (\text{Social Group}) + \varphi_i (\text{Gender}) + \varepsilon_{it}$$

In the above equation, C_{it} denotes voluntary contribution by individual i at time period t , β_i captures whether individuals were assigned to the homogeneous or heterogeneous triad, δ_{it} captures the parameter for the change in voluntary contribution induced by the temporal change in the scenario of the contribution, λ_{it} captures the interaction effect between the temporal and the social treatment, χ_i captures the control variable for the social group from which the participants were recruited (SASA, CSA, and LSU), and φ_i captures the control variable for gender (male or female participant).

VARIABLES	OLS	Tobit	Ordered Logit
Temporal Treatment 2	-0.612 [0.724]	-0.928 [1.251]	-0.216 [0.249]
Temporal Treatment 3	-0.087 [0.577]	0.035 [0.934]	-0.077 [0.225]
Temporal Treatment 4	0.238 [0.702]	0.735 [1.238]	0.068 [0.262]
Temporal Treatment 5	-0.025 [0.477]	-0.163 [0.705]	-0.012 [0.176]
Temporal Treatment 6	-1.087* [0.546]	-1.599* [0.910]	-0.420** [0.204]
Social Treatment (Homogeneous=0; Heterogeneous=1)	-0.265 [1.255]	0.172 [2.168]	-0.115 [0.469]
Treatment2 * Social Treatment	-0.284 [1.273]	-0.614 [2.122]	-0.097 [0.423]
Treatment 3 * Social Treatment	0.398 [0.796]	0.701 [1.316]	0.180 [0.293]
Treatment 4 * Social Treatment	0.090 [0.862]	-0.474 [1.593]	0.030 [0.319]
Treatment 5 * Social Treatment	-0.044 [0.855]	-0.399 [1.407]	-0.016 [0.309]
Treatment 6* Social Treatment	0.432 [0.904]	0.294 [1.523]	0.170 [0.324]
Gender (Male=1; Female=0)	2.701** [1.119]	5.092** [2.157]	0.912** [0.425]
Student group affiliation LSU	1.180 [1.565]	1.705 [2.705]	0.357 [0.531]
Student group affiliation SASA	0.188 [1.117]	0.160 [1.984]	-0.025 [0.411]
Constant	6.975*** [1.037]	6.323*** [1.770]	-1.253*** [0.445]
Observations	414	414	414

Robust standard errors in brackets

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

Table 8: The effect of social and temporal treatment on voluntary contribution

The results above indicate that the coefficient for the variable capturing the interaction effect between social treatment and temporal treatment is not significant.

The change in voluntary contribution from Treatment 1 (baseline results) to Treatment 6 (benefits for self and others after 15 days) – $(\$8.4 - \$7.3) - (\$7.76 - \$7.1) = \$0.4$ – standardized by the pooled standard deviation yields an interaction effect size of 0.08. Compared to Cohen's (1969) standard values, this represents a small interaction effect size. Taking into account the correlation between the two repeated measures of 0.68, the standard alpha value of 0.05, and the beta value of 0.2, the G-Power Statistical Software shows that a total of 200 subjects would be required to yield a statistically significant result with a power of 0.8.

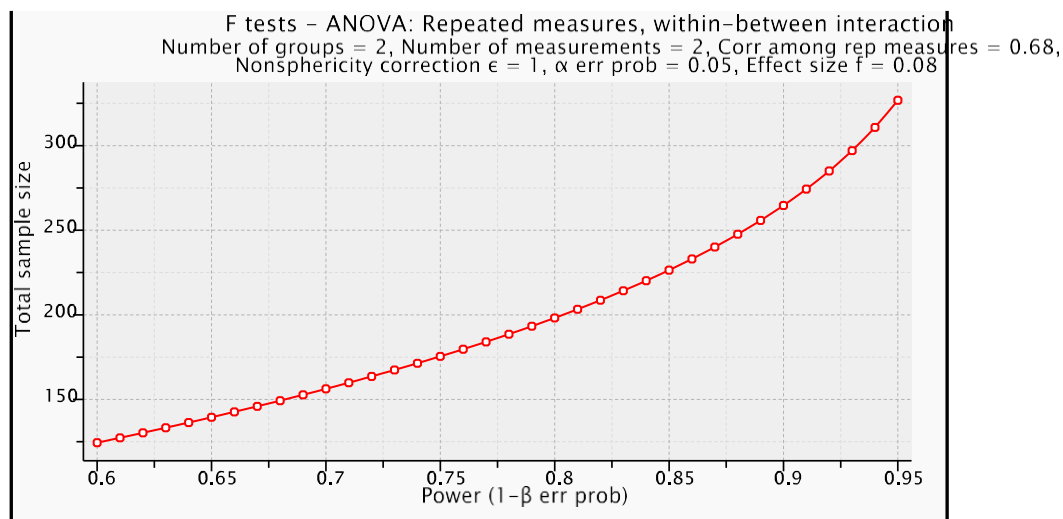


Figure 11: Power curve for Hypothesis 6

The results of the non-parametric test also find a lack of any interaction effect. However, in the non-parametric test, interestingly, the coefficient for the three-way interaction between Treatment*Group*Time is significant in the model. A three-way interaction implies the presence of a two-way interaction that varies across the level of the third variable. To facilitate an

understanding of the mechanism governing the three-way interaction, the table below presents the mean contribution stratified by the three covariates.

	Mean Contribution		Mean Contribution			Mean Contribution					
	by Treatment		by Group			by Treatment, Group					
	Homogeneous	Heterogeneous	SASA	CSA	LSU	SASA	CSA	LSU	SASA	CSA	LSU
Treatment1	8.39	7.76	8.15	7.89	8.8	9.46	7.54	10	6.36	8.7	8.5
Treatment6	7.3	7.1	6.69	7.58	7.4	8.46	6.35	9.5	4.27	10.4	6.88

Table 9: Mean contribution for Treatment 1 and Treatment 6 stratified by co-variables

The mean value of the dependent variable, it should be noted, may not necessarily capture the change across the different combination of variables; however, a closer look at the table above reveals that participants from different social groups responded in a different manner to the temporal treatment when stratified by the social treatment. In the table above, we see that the direction of change in magnitude is as expected for all the combination of variables (i.e. lower contribution when benefits are delayed and in the heterogeneous triad) except for participants from the Chinese Student Association. Participants affiliated with CSA, contrary to expectation, contributed more in the heterogeneous triad than the homogeneous triad, and quite surprisingly, contributed more when the benefits were delayed in the heterogeneous triad. Given the nature of the rank-sum transformation method developed by Brenner and colleagues, which concerns the change in relative rank across different treatments, it could be posited that the three-way interaction involves an interaction between Social and Temporal Treatment, when stratified by social group to which the participants belong.

Result 6: There is no interaction effect between the social treatment and the temporal treatment. However, while employing the multivariate non-parametric test, the coefficient for the three-way interaction between social treatment, temporal treatment, and social group is significant. This suggests that social treatment and temporal treatment could have an interaction effect, when considered at the level of each social group.

2.5 Contributions and Limitations

While some interesting findings emerged from the study on the role of temporal delays on voluntary contribution, the investigation into the role of social treatment and the interaction between temporal and social treatment did not reveal any interesting patterns. The only significant interaction of note in the hypothesis tests was the effect of the three-way interaction between the group to which student were affiliated, the social treatment, and the temporal treatment. This indicates that at the level of different social organizations, there could be an interaction effect between temporal treatment and social treatment.

One possible explanation for the lack of any statistically significant findings for social treatment could be that social categorization was explicitly stated as one of the goals of the research at the outset. Previous studies investigating the role of social categorization on decision-making have relied on deception so as not to cue the participants of the researcher's actual motives (Hubarimanya et.al., 2007). Ensuring that the participants are not conscious of what aspect of the decision-making process the researcher is investigating might be crucial to future research. However, it will remain a challenge to find novel research designs that both exploit an ingrained group affiliation in participants, while withholding the actual motive of the research.

In addition to the external validity concerns discussed in chapter 2, the social treatment is also susceptible to the lack of generalizability. However, as the social treatment involved assignment of participants affiliated to different social groups to either a homogenous triad or a heterogeneous triad, it could be argued that the results obtained from the triadic interactions are likely scalable beyond the model. As the model does not indicate any significant results, the external validity concerns are hypothetical.

The lack of any statistically significant results could merely be an artifact of the small sample size. To rule out the possibility, future research should continue to investigate the interactions between social distance and temporal discounting in strategic environments. The findings of such a line of inquiry could inform many policy and real-life decisions. In climate change and environmental negotiations, as discussed earlier, different countries with differing stated valuations of the future interact to provide a global public good, i.e. a habitable climate. Summers and Zeckhauser (2008) note that at International Panel of Climate Change (IPCC)

negotiations, establishing the baseline year from which to discount the future is a thorny issue. While external validity of the results obtained from individuals belonging to different social organizations (as in the present study) to countries interacting is perhaps tenuous, it does help provide some preliminary evidence to this very critical issue. Other real-life phenomenon such as the contours of racism and the role of cliques in organizational behavior can also be better understood by unpacking the interaction between social and temporal preferences in collective action. Given the research potential of the line of inquiry, other studies with larger sample of participants should be conducted to find evidence supporting or contradicting the hypothesis.

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APPENDIX B1: Questionnaire administered to participants

You are now taking part in an experiment on decision-making financed by the National Science Foundation. Thank you for participating.

You will be paid for participating, and the amount of money you earn depends on the decisions that you and the other participants make. You are randomly matched with two other individuals, who may or may not belong to the student organization with which you are affiliated. The individuals with whom you are playing will remain the same throughout the game.

You will be asked to make allocations in six different scenarios. At the end of the game, we will randomly pick one of the six scenarios, which will be used to determine your actual earning that is deposited to your Husky Card Account. You will be notified of your earnings after all three members complete their allocations. Your earnings will be deposited to your Husky Card Account immediately after the experiment, or in the future, as described in the scenario.

In order to keep your decisions private, please do not reveal your choices to any other participant.

(page break)

The exact process of the experiment is described below.

The decision situation

You will be a member of a group consisting of 3 people. Each group member has to decide on the allocation of \$15 in different scenarios. For each of the six scenarios that follow, you have been given \$15, your endowment, that you can choose to either keep in your private account or invest in a public account. You can put the \$15 into your private account or you can invest them fully or partially into the public account.

Your income from private account: If you put \$5 in your private account, your income from this account will be \$5. No one except you earns something from your private account.

Your income from public account: Each dollar that you and the other players of the group place in the public account will be doubled and then divided equally among the three of you. For example, if the group account holds a total of \$30 - the amount will be doubled ($2 \times \$30 = \60) and divided equally among the three of you ($\$60/3 = \20); in this example, each individual earns \$20 from the public account.

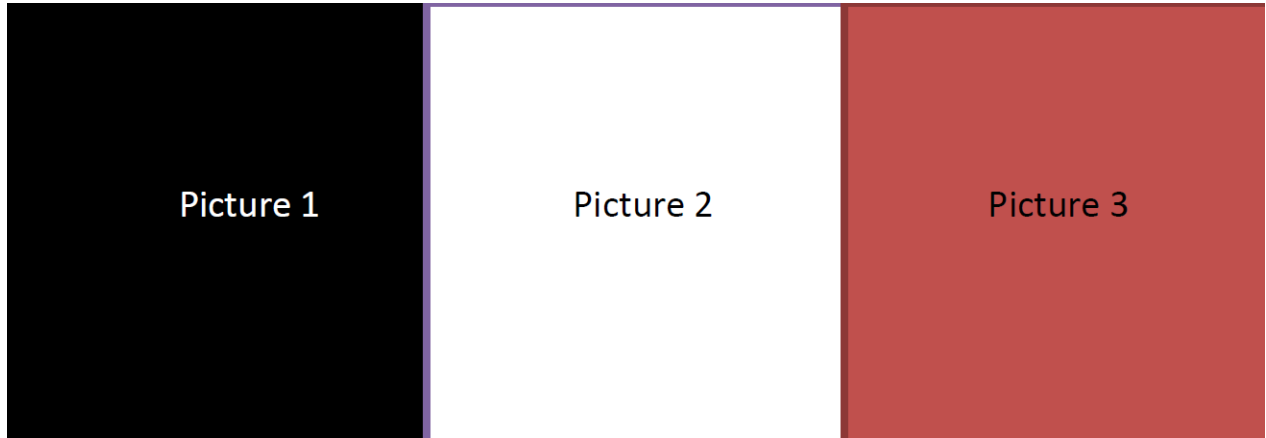
Your Total Income: Your total income is the sum of your income from your private account and that from the public account.

The Experiment

In each of the six scenarios that follow, the timing of when you and the other participants receive your/their earning from the private account and from the public account varies. For example, you might receive your earning from your contribution to the public account immediately after the experiment, whereas the other two participants receive theirs after 15 days.

Choose carefully! Your allocation from one of the six scenarios that follow will be your actual earning!

(page break)



Scenario 1: Please indicate how you would like to make your allocation in this scenario. Please note that the total amount from both accounts must add up to your endowment (\$15).

Immediately after the experiment, your earnings from your contribution to your private and the public account will be deposited to your Husky Card Account.

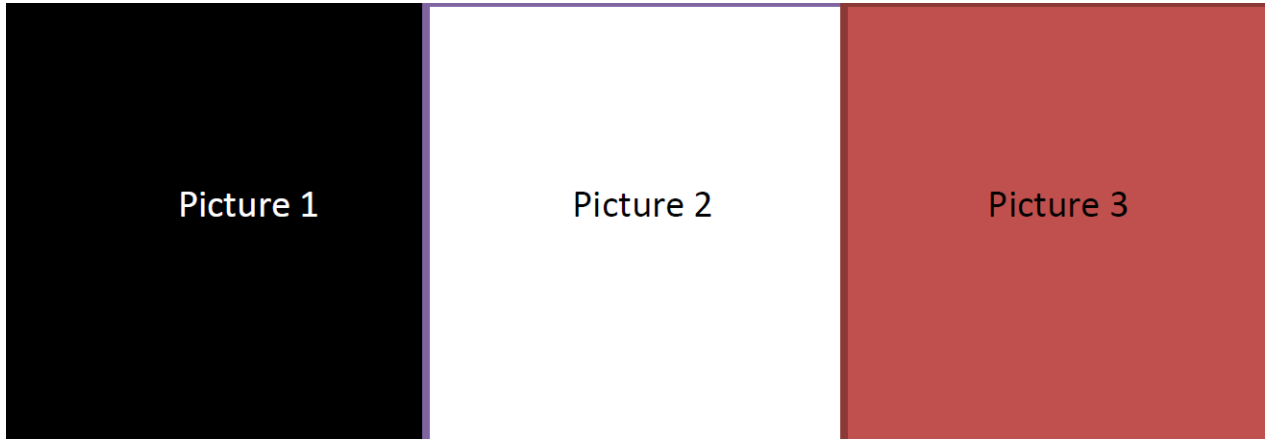
Immediately after the experiment, the earnings for the other two players from their contributions to their private and public account will be disbursed.

Amount you would like to contribute to the Public Account

Amount you would like to keep in the Private Account

Total

(page break)



Scenario 2: Please indicate how you would like to make your allocation in this scenario. Please note that the total amount from both accounts must add up to your endowment (\$15).

Immediately after the experiment, your earnings from your contributions to your private account and the public account will be deposited to your Husky Card Account.

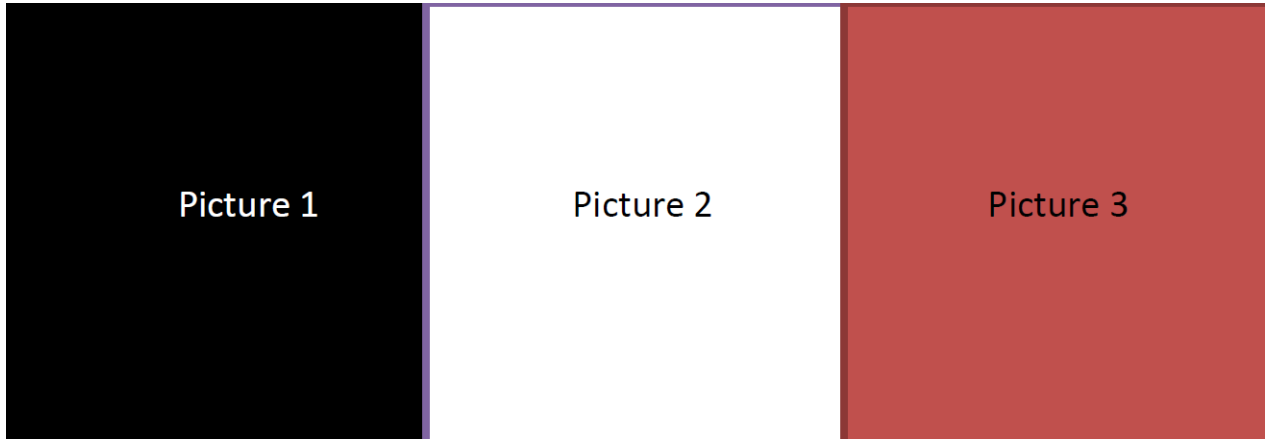
After 15 days, the earnings for the other two players from their contribution to the public account will be disbursed.

Amount you would like to contribute to the Public Account

Amount you would like to keep in the Private Account

Total

(page break)



Scenario 3: Please indicate how you would like to make your allocation in this scenario. Please note that the total amount from both accounts must add up to your endowment (\$15).

Immediately after the experiment, your earnings from your contributions to your private account will be deposited to your account.

After 15 days, your earnings from your contribution to the public account will be deposited to your Husky Card Account.

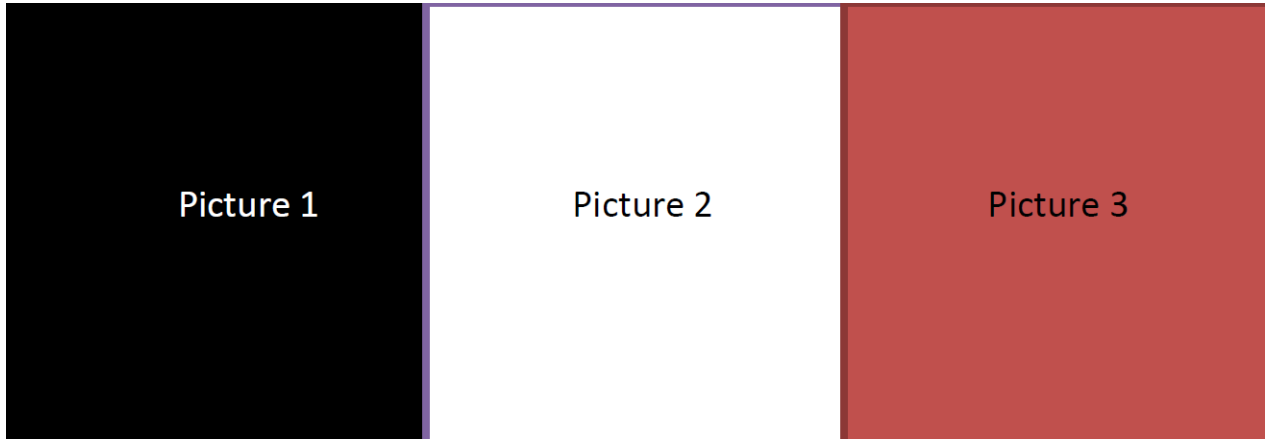
Immediately after the experiment, the earnings for the other two players from their contribution to the public account will be disbursed.

Amount you would like to contribute to the Public Account

Amount you would like to keep in the Private Account

Total

(page break)



Scenario 4: Please indicate how you would like to make your allocation in this scenario. Please note that the total amount from both accounts must add up to your endowment (\$15).

After 15 days, your earnings from your contributions to your private account will be deposited to your account.

After 15 days, your earnings from your contribution to the public account will be deposited to your Husky Card Account.

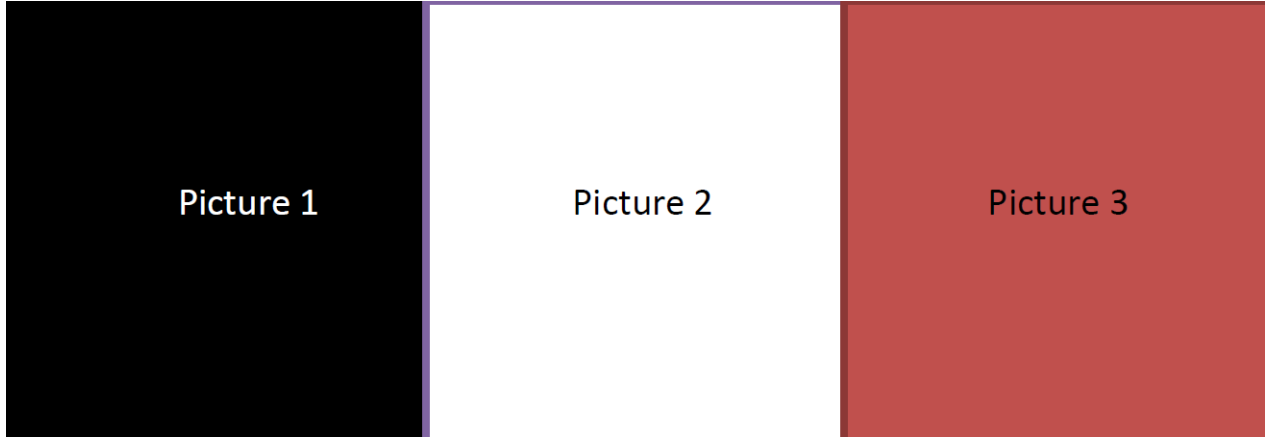
After 15 days, the earnings for the other two players from their contribution to the public account will be disbursed.

Amount you would like to contribute to the Public Account

Amount you would like to keep in the Private Account

Total

(page break)



Scenario 5: Please indicate how you would like to make your allocation in this scenario. Please note that the total amount from both accounts must add up to your endowment (\$15).

Immediately after the experiment, your earnings from your contributions to your private account will be deposited to your account.

After 5 days, your earnings from your contribution to the public account will be deposited to your Husky Card Account.

Immediately after the experiment, the earnings of the other two payers from their contribution to their private account will be disbursed.

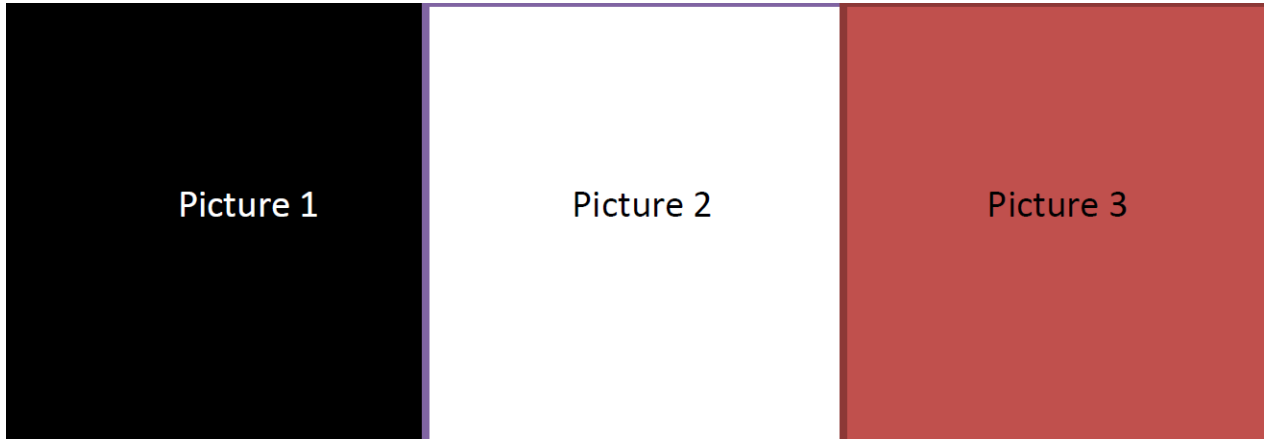
After 5 days, the earnings for the other two players from their contribution to the public account will be disbursed.

Amount you would like to contribute to the Public Account

Amount you would like to keep in the Private Account

Total

(page break)



Scenario 6: Please indicate how you would like to make your allocation in this scenario. Please note that the total amount from both accounts must add up to your endowment (\$15).

Immediately after the experiment, your earnings from your contributions to your private account will be deposited to your account.
After 15 days, your earnings from your contribution to the public account will be deposited to your Husky Card Account.

Immediately after the experiment, the earnings of the other two payers from their contribution to their private account will be disbursed.
After 15 days, the earnings for the other two players from their contribution to the public account will be disbursed.

Amount you would like to contribute to the Public Account

Amount you would like to keep in the Private Account

Total

(page break)

This is the final part of the experiment. Please answer the following questions.

What is your gender?

Male

Female

Did you personally know any of the other two participants with whom you were matched? If yes, on a scale of 1-10 how well do you know them (1 being as an acquaintance, and 10 being very well)?

(page break)

Thank you for participating in the study!

As per the initial instructions, we will randomly select one of the scenarios, and your earnings from that game will be deposited to your Husky Card Account. We will email you within a day after all participants complete allocations to inform you how much you earned.

Please click below to submit your response. Thank you for your participation.

Best Wishes,
Research Team

Appendix B2: Consent Form to Participate in Study

UNIVERSITY OF WASHINGTON CONSENT FORM RESEARCH ON DECISION-MAKING

**Researchers: Doctoral Student Pradeep Singh; Professor Ann Bostrom
Daniel J. Evans School of Public Affairs, University of Washington, Seattle. Phone:
206.685.8198**

Researchers' statement We are asking you to be in a research study. The purpose of this consent form is to give you the information you will need to help you decide whether to be in the study or not. Please read the form carefully. You may ask questions about the purpose of the research, what we would ask you to do, the possible risks and benefits, your rights as a volunteer, and anything else about the research or this form that is not clear. When we have answered all your questions, you can decide if you want to be in the study or not. This process is called "informed consent." We will give you a copy of this form for your records.

PURPOSE OF THE STUDY The purpose of the research is to investigate the role of time in social interactions. The research explores decision-making when costs and benefits are spread over time.

STUDY PROCEDURES

As part of the study, your Husky ID picture will be used and you will be matched with two other individuals with whom you play an experimental game. In the game you will be given tokens worth \$15 dollars – you can allocate the tokens into a private account – amount deposited in this account is guaranteed to you – and a public account – the return from the amount deposited in this account depends on how much the other two participants in the group contribute. The contribution to the public account is doubled and divided equally among the participants in a game. For example, if the group account holds a total of \$30 – the number of tokens will be multiplied by 2 ($2*30 = \$60$) and divided equally among the three of you ($\$60/3 = \20 ; each individual receives \$20 from the contributions to the public account). You will be asked to make allocations under various scenarios whereby the time of benefits received may be now or at different intervals in the future. For example, both you and the other participants may receive the benefits from your contribution to the public account **in the future**. Or, you may receive the benefits received from your contribution to the public account in the future, but the other two participants may receive their benefits from the public account immediately. And so forth. Besides having to make the allocations when matched with two other individuals, you will be asked to provide demographic information such as age and sex. You will also have to provide your Husky Card Number for us to be able to make payments to you. You may refuse to answer

any question or item in any game or questionnaire. It should take you approximately 30 minutes to complete the study. One of the allocations you choose will be randomly picked by a computer and will be your actual earning from the game, which will be deposited in your Husky Card after the experiment if your pay-off day is today, or on the relevant day. The longest delay in your payment could be 10 weeks from the day of experiment, which is the duration of the study.

RISKS, STRESS, OR DISCOMFORT We don't anticipate that you will experience any risk, stress or discomfort from participating in the experiment.

BENEFITS OF THE STUDY

You will be compensated \$5 for your time to participate in the study. You also have the opportunity to earn \$15 or more from your participation in the experimental game. Additionally, through your participation in the study, you will be contributing towards a better understanding of decision-making when the costs and benefits are spread over time.

OTHER INFORMATION You may refuse to participate and you are free to withdraw from this study at any time without penalty or loss of benefits to which you are otherwise entitled. As per the University of Washington's institutional policy, we are required to ask you for your name and address. However, this information is voluntary; you are not required to provide it and we can compensate you whether you provide it or not. We will retain the link between direct identifiers and information you provide for the duration of the experiment, which is 10 weeks from the start of the experiment, to enable us to verify that we have deposited your compensation in the correct account. By the time the study ends, all direct identifiers and information you provide, including your picture, will be de-linked from the data and destroyed.

Appendix B3: Box-plot and Density plot representation of Social and Temporal Treatment

Figure 12: Box-plots showing Voluntary Contribution in Treatment 1

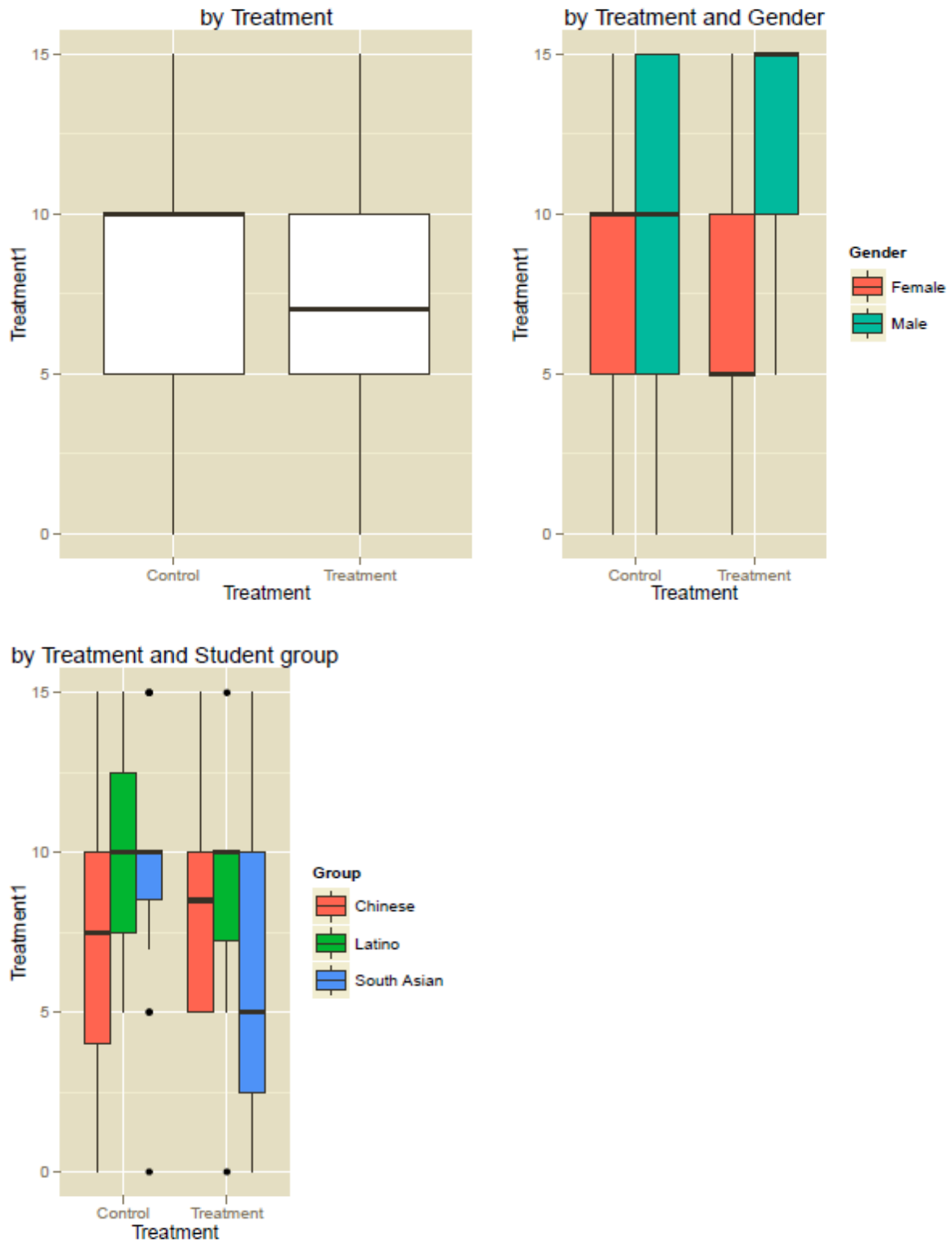


Figure 13: Box-plots showing Voluntary Contribution in Treatment 6

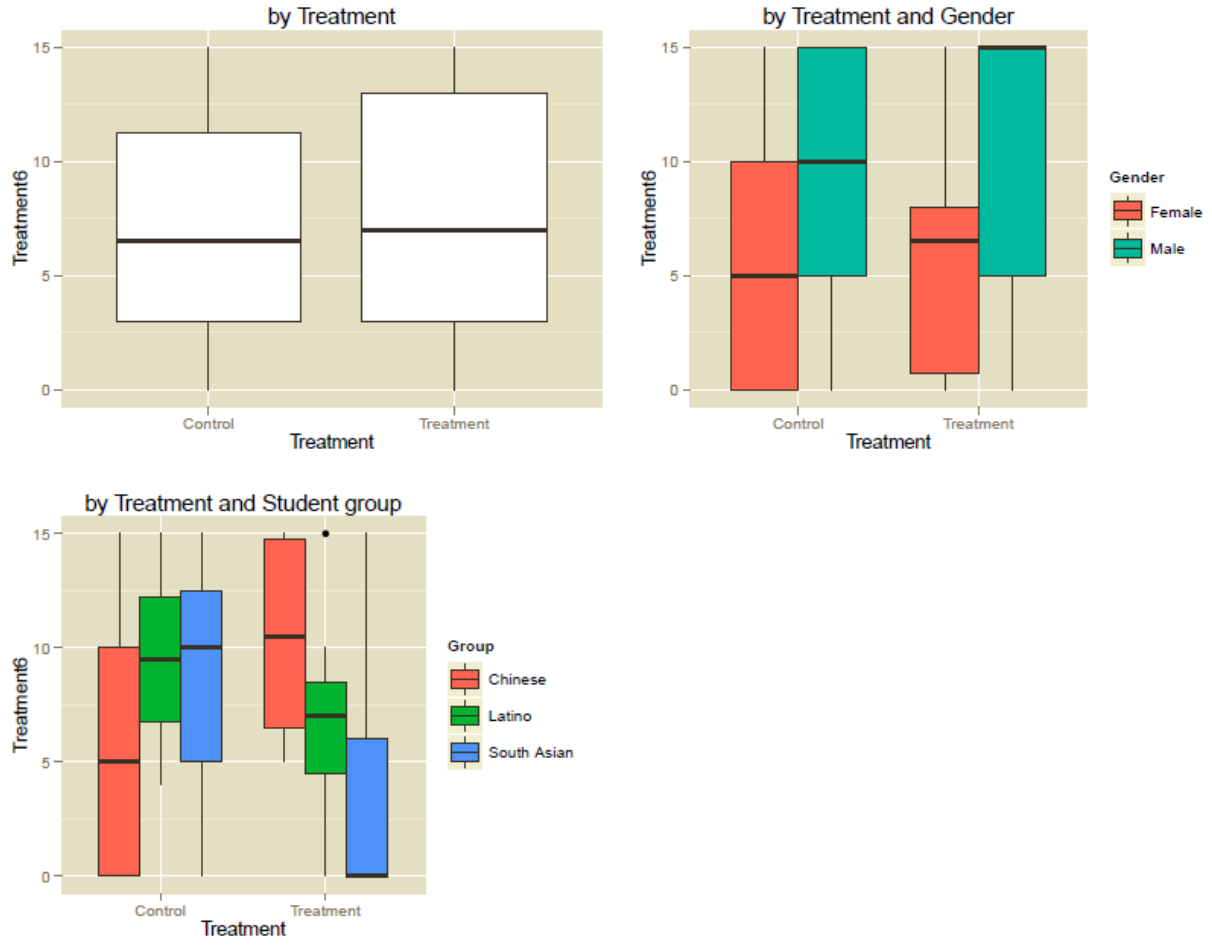
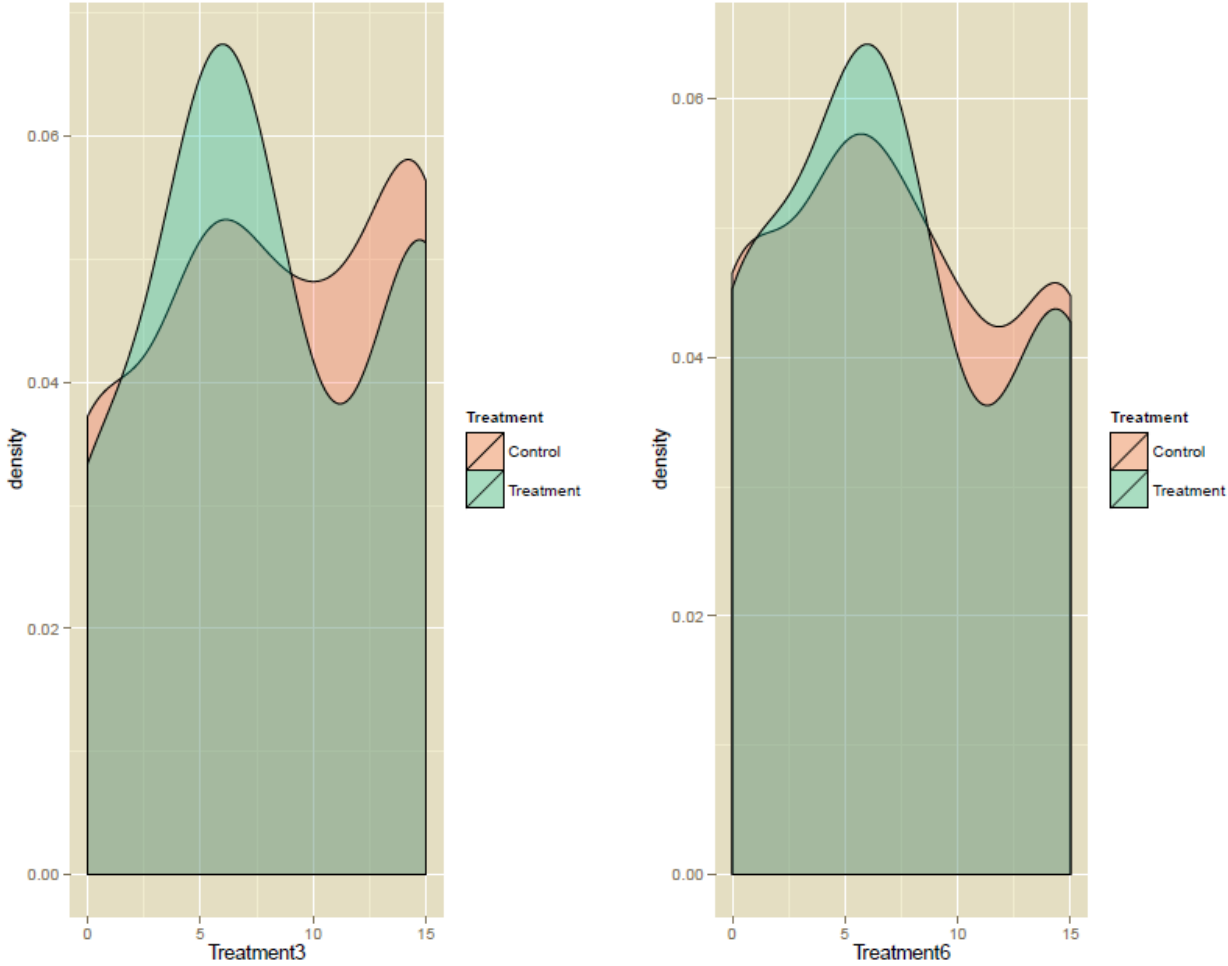


Figure 14: Density-plot showing the comparison of the distribution between Treatment 3 and Treatment 6



Chapter 3

The Effect of Conflict on Agricultural Investment: Evidence from Nepal

“We are very poor people with just a bit of land that feeds us. My husband and sons have gone away to work in the city. I live alone with my daughter. Every so often, men in uniform come to my house to ask for food. It is my duty to feed guests, so I try my best, though I have little to spare. But I don’t ask any questions about who they are, because it is safer not to know. They can be the army. They can be Maoists. Both are dangerous” – (45 year old woman, Human Rights Watch Interview, March 2004).

3.1 Introduction

A civil war is not an uncommon occurrence in most countries, and is likely a nation's most important historical event (Miguel and Blattman, 2010). Yet, the consequences of civil war on household behavior have yet to be fully understood. This paper aims to investigate how a change in the likelihood of dying induced by civil war affects an intertemporal choice such as investment in agriculture. John Rae (1934), credited as being one of the earliest scholars of intertemporal modeling, argued that an individual's time preferences can be explained by their "effective desire for accumulation," which in turn is influenced by the bequest motive, self-restraint, uncertainty of human life, and excitement of immediate consumption. Later, challenging the descriptive validity of the Discounted Utility (DU) model (discussed in more detail below), Becker and Mulligan (1997) investigated the endogenous determination of time preferences and identified wealth, mortality, addiction, and uncertainty as some of the variables that shape individuals' time preferences. Similarly, Yaari (1965) argued that uncertainty of survival leads households to discount the future more heavily since the individual has to survive a period in order to derive utility from consumption in that future period. While uncertainty of life, or probability of mortality (likelihood of dying), has been posited to shape an individual's time preferences, empirical evidence quantifying the effect is scarce (Voors et al, 2010 and other exceptions discussed below).

Intertemporal choices involve making trade-offs between present consumption and future consumption. An individual's rate of time preference is the rate at which they substitute the value of goods received now for goods received in the future. The rate of time preference (δ) underlies many important economic decisions, such as savings, investment in assets, human capital accumulation, and health decisions, among others. In making intertemporal trade-offs, individuals expect future utility to compensate for some foregone utility that they would have derived from present consumption. Compared to an individual with a high rate of time preference, an individual with a low rate of time preference confers greater weight on future benefits – consequently, they save more, invest more, make healthier lifestyle choices, and make other decisions that maximize the welfare of their future selves.

The canonical model of utility maximization in economics – the DU model -- assumes that individuals make optimal intertemporal decisions such that individual rate of time preference – or, individual rate of substitution between current consumption and future consumption – is constant across time and different states of nature (Samuelson, 1954). Recent findings in behavioral economics, however, have sought to unpack the black-box of individual discount rates and documented several empirical anomalies; one of the most robust conclusions in this growing literature is that individuals have a declining rate of time preference (δ), or, in other words, they exhibit hyperbolic discounting behavior (Thaler, 1981). A growing literature in behavioral economics has also found that individual preferences are not constant across different states of nature but rather are malleable and context-dependent (Tversky and Simonson, 1993).

A few studies have shown that individuals in developing countries exhibit substantially more pronounced hyperbolicity than in Western countries (Poulos and Whittington, 2000; Anderson, Dietz, Gordon and Klawitter, 2004). The consequence of such hyperbolically discounting behavior manifests itself in the form of intertemporal choices such as under-investment in education and assets, lower savings, and under-investment in agriculture and business assets. At the same time, less-developed countries are also more likely to suffer from violent internal conflict; it has been estimated that 40% of the 20 countries ranked the lowest in terms of income per capita or Human Development Index have experienced major conflict in the last quarter century (Stewart et.al.,1997). Civil wars impede, if not regress, economic development and are accompanied by destruction of physical capital and breakdown of social norms and institutions (Fearon and Latin, 2003).

The higher exposure to civil war in lesser developed countries – and the influence of mortality probability on discounting behavior -- raises the question of whether civil wars further hinder economic growth by altering the time preferences of individuals exposed to war, producing a more pronounced ‘present bias.’ Voors et.al. (2010) conducted a field experiment in 35 randomly selected communities in Burundi that were exposed to varying levels of conflict to examine whether civil war caused individuals’ preferences to change. Their study shows that, ex-post, individuals exposed to greater conflict exhibit greater altruism, greater risk-seeking behavior, and have higher discount rates.

This study differs from Voors et.al. (2010) in that it examines intertemporal decisions during a period in Nepal when the civil war was still on-going. Investment in agriculture, the outcome variable of interest in our model, is an appropriate and relevant variable to investigate household discounting behavior. The standard way of eliciting individual discount rates is to ask respondents to choose between two certain outcomes that differ in terms of when they are received. For example, if an individual is indifferent between receiving 100 dollars in two weeks and 150 dollars in three weeks, we can infer that their discount rate is 50% for a week. However, as investment in agriculture involves an assessment of the costs and benefits in the present as well as the future as a consequence of one's decision, it can be used to reveal discounting behavior --- in neoclassical economics, Q theory, considered to be an important model, seeks to capture intertemporal investment as an "adjustment to long-run capital stock" given the expectations and operating environment (O'Toole et.al, 2011). In the case of Nepal, where a large majority of the households are engaged in agriculture, and the agricultural sector contributed 40.22% to the Gross Domestic Product in 1995/96 (CBS, 1996)¹¹, the assessment of investment in agriculture is particularly relevant.

Existing studies investigating the role of mortality probability on one's rate of time preference have examined how perception of war influences saving behavior (Russett and Lackey, 1987; Russett, Cowden, Kinsella and Murray, 1994; Russett and Slemrod, 1993). While these papers add to the explanatory power of models on intertemporal decision-making, one of the limitations of these existing studies investigating the effect of fear of war on intertemporal decision-making stems from their reliance on professional opinion and public perception about the possibility of war in trying to gauge the relationship. Consequently, these studies fail to capture the visceral risk-based experiences of the subjects exposed to the war. Literature on risk-perception posits that laypeople perceive experience-based risk that is visceral in nature differently than description-based risks that are abstract and time-delayed (Slovic, Fischhoff and Lichtenstein, 1981; Weber, 2006). Furthermore, it has been posited that social influences play a critical role in how individuals construct their perception of risk (Slovic, 1999). Previous studies investigating the relationship between mortality probability and intertemporal choice have relied on description-based measures of risk; however, lay perceptions of abstract measures of mortality

¹¹ Central Bureau of Statistics, Nepal. URL: www.cbs.gov.np

risk likely differ from their visceral reactions stemming from experienced risk of mortality. To address this potential problem, this study relies on data from an actual civil war in Nepal, employing as a proxy measure of ‘fear of war’ the proportion of conflict-related deaths per district per 1000 individuals. This proxy allows a direct test of how fear for one’s life affects intertemporal decision-making.

The rest of the paper is organized as follows: section 3.2 provides a background on the relevant literature on uncertainty, probability of mortality and discounting, the Maoist civil war in Nepal, and household agricultural decision-making; section 3.3 discusses the data sources and the descriptive statistics, section 3.4 outlines the methodology and discusses the results. Section 3.5 concludes.

3.2 Background

A. Uncertainty, Mortality Probability and Discounting Behavior

We frequently consider how our actions will play out over time when we make decisions in everyday life. The Discounted Utility (DU) model, proposed by Samuelson, assumes that individuals’ intertemporal preferences can be characterized by a single discount rate and that the subjective value of a good drops by a fixed percentage for every unit of time that the consumption of the good is delayed. This suggests a discounting curve that is exponential in nature. However, recent findings in behavioral economics suggest that as the reward is pushed further into the future the discount rate declines, which suggests discount functions that are hyperbolic or quasi-hyperbolic in nature (Ainslie, 2001). Samuelson himself acknowledged his reservations about his model’s congruence to reality. He wrote: “It is completely arbitrary to assume that the individual behaves so as to maximize an integral of the form envisaged in [DU]. This involves the assumption that at every instant in time the individual’s satisfaction depends only upon consumption at that time, and that furthermore, the individual tries to maximize the sum of instantaneous satisfactions reduced to some comparable base by time discount” (Samuelson, 1937, pg. 159). In other words, the rate at which an individual makes a trade-off between now and tomorrow is no different than the rate at which they trade off the costs and

benefits between the twentieth and twenty-first day. Advances in behavioral science, however, have challenged the descriptive validity of the model, arguing that this assumption is not in congruence with how people behave in everyday life. Thaler (1981) provided the first empirical evidence suggesting that individuals exhibit a present-bias; he demonstrated that individuals' rate of time preference (δ) declined over time. How individuals actually make choices over time has since emerged as a vibrant line of inquiry that has empirically demonstrated several anomalies to the DU model (Frederick et.al., 2002 provide an overview).

A body of work in economics and psychology has emerged that suggests the perceived risk in waiting for delayed rewards shapes human behavior temporally. The implicit risk hypothesis (Benzion et.al, 1989) posits that since delayed rewards are uncertain, individuals are justified in adjusting their subjective value of the delayed rewards to take into account their perceived probability of actually receiving the pay-off (Prelec and Loewenstein, 1991; Dasgupta and Maskin, 2005; Rachlin et.al, 2008). This view is prominent especially in the behavioral ecology literature where uncertainty is highly prevalent in the form of risks such as losing food to competitors (Houston, Kacelnik and McNamara, 1982). Using the analogy of a blackbird waiting around a particular raspberry bush for a fruit to ripen, Dasgupta and Maskin (2005) argue that the blackbird should discount the payoff of getting the fruit -- "where the discount rate is the hazard rate of the 'crow-arrival' process." As the future can never be predicted with certainty, time preference and uncertainty are inextricably connected. Benefits in the future require a period of waiting before they actually materialize, which in itself is not without uncertainty.

Scholars have argued that perceived probability of the future benefits materializing decreases as the waiting time increases thereby causing individuals to weight benefits immediately and in the near future more heavily (Mazur, 1989; Prelec and Loewenstein, 1991; Rachlin et.al., 2008). The perceived probability of promised rewards materializing, it has been argued, can exert a strong influence on intertemporal choices. Individuals' intertemporal decisions are inextricably associated with uncertainty and the perception of uncertainty (Epper, Fehr-Duda, Bruhin, 2009).

The influence of mortality probability on one's rate of time preference has been investigated in the context of intertemporal decision-making in the shadow of a nuclear war. Russett and Lackey (1987) combine cross-sectional time-series data on personal savings with cross-sectional survey data on public perception of war in the U.S. and several European countries and find that

expectation of war decreases the likelihood of savings. Similarly, Russett, Cowden, Kinsella and Murray (1994), using a time-series analysis in the U.S., show significant impact of war expectation on saving between 1948 and 1993. Using individual-level survey data, Russett and Slemrod (1993) find that fear of war had an independent effect on savings when controlling for many individual demographic, economic, and psychological characteristics. Regarding the more important question of why individuals exhibit impatience in the shadow of war, the authors posit that individuals decision-making regarding the cost-benefit analysis of intertemporal choices depend “not only on perceived benefits obtainable from forgoing present consumption, but also on the perceived probability of actually receiving the future benefit” (Russett and Slemrod, 1993). Future events are by nature uncertain – the uncertainty is further exacerbated in the presence of a war.

While previous studies have investigated discount rates in developing countries as well as studied the economics costs of civil conflict, to the best of this author’s knowledge, no previous study has examined discounting behavior during a civil conflict -- as noted previously, past studies have shown that individuals in developing countries exhibit substantially more pronounced hyperbolicity than in Western countries (Poulos and Whittington, 2000; Anderson, Dietz, Gordon and Klawitter, 2004) and that developing countries are more likely to experience civil conflict (Stewart et.al, 1997). The question this paper aims at answering is whether civil conflict acts as a ‘double-edge sword’ by not only contributing towards the destruction of physical infrastructure and social institutions, but also by changing the future perception of individuals.

B. Civil War in Nepal

Nepal is a land-locked country in South Asia, bordered to the north by the People’s Republic of China and to the south, west, and east by the Republic of India. Nepal is a relatively small country with an area of 147,181 square kilometers (56,827 square miles). With a population of around 30 million, the per capita income in 2007 was \$340. According to the UN Human Development Report (2010) about two thirds of female adults and one third of male adults in the

country are illiterate, and agriculture is the major driver of the economy, employing two-thirds of the workforce.

Until 1990, Nepal was a monarchy under King Birendra Bir Bikram Shah Dev. After widespread protests demanding a democratic government, King Birendra relinquished power in 1991 and the first elections were held to establish a multi-party democracy. The fledgling democracy however failed to address the issue of socioeconomic inequality and discrimination based on caste and ethnicity, which some see as the major cause of the armed insurgency known as the “People’s War” waged by Communist Party of Nepal –Maoist (CPN-M) (Murshed and Gates, 2004). Demanding the establishment of a people’s republic, the Maoists declared an armed insurgency against the state on February 13, 1996.¹² The civil war between the Maoist rebels and the state officially began in 1996 when the Maoists attacked a police post in the Rolpa district of Western Nepal. During the initial phase of the conflict, the lesser developed districts experienced the highest conflict (Do and Iyer, 2007), and the intensity of conflict was found to be highest in districts with greater income inequality (Murshed and Gates, 2004). The conflict intensified subsequently when the Royal Nepalese Army mobilized to confront the Maoist Rebels in 2001. By late 2002, 73 of the 75 districts in Nepal had experienced violent conflict (Kok, 2005).

Civil war ensued until November 2006, when the Maoists signed a peace agreement with the democratic parties to hold elections to the Constituent Assembly and to abolish the monarchy, which under then King Gyanendra had taken full executive control having dissolved the parliamentary government of Prime Minister Deuba. The decade-long civil war resulted in the deaths of around 13,000 people (Do and Iyer, 2007), with 667 individuals reported as ‘disappeared’ according to data sources from INSEC. Based on the number of casualties and disappearances, the decade-long civil war in Nepal has been called one of the highest intensity internal conflicts in recent times (Murshed and Gates, 2004). There exists considerable variation in terms of the intensity of conflict across Nepal with the Western Region facing the brunt of the casualties, whereas the number of casualties was comparatively lower in the Far Western Region (Do and Iyer, 2007). While several studies have investigated the determinants of the civil conflict in Nepal (Do and Iyer, 2007; Murshed and Gates, 2004) with poverty, inequality, geographical

¹² The precise summary of the list of demands made by the Maoists remains elusive.

factors being posited as critical, this paper investigates how, at the micro-level, household intertemporal behavior – specifically, investment in agriculture -- was influenced by the civil war.

Nepal is composed of 75 districts and is categorized into five geographical areas: Eastern, Central, Western, Mid-Western, and Far Western. The figure below shows the variation in intensity of conflict across the 75 districts.

Mortality Probability by Districts

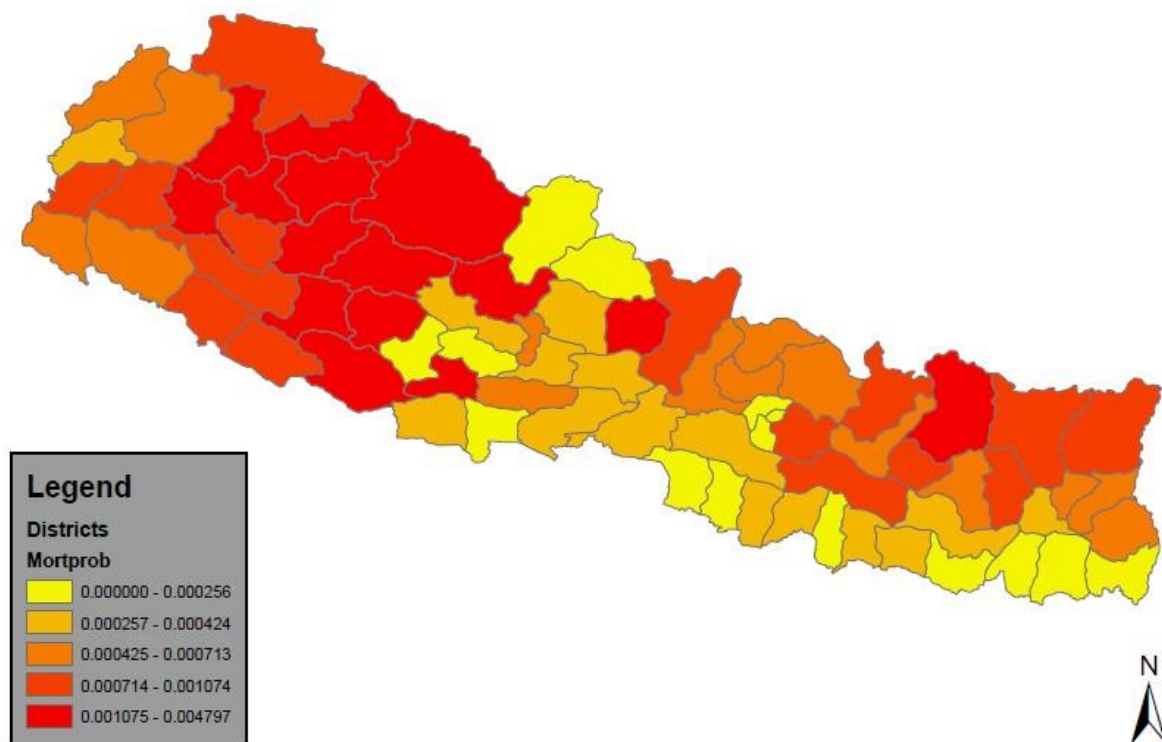


Figure 15: Intensity of Conflict – or mortality probability – across the 75 districts in Nepal. Data Source for Total Conflict-Related Deaths per district (includes deaths from the start of the conflict till 2002/03): INSEC, 2008; Data Source for District Population: Central Bureau of Statistics, Nepal. Population Year: 2003.

C. Household Agricultural Decision-Making during Conflict

To consider how households in Less Developed Countries' (LDC) make decisions during conflict, it is informative to consider the existing standard neoclassical models of an agricultural household's allocation of resources during peace-time, and to assess the assumptions on which they are built. The Singh, Squire and Strauss (SSS) model (1986) is considered a standard neoclassical household model – their model assumes that given a set of exogenous constraints such as land, technology, prices and climate, households maximize their utility given budget and time constraints. The main contribution of the SSS model was to predict behavior from farmers who are both producers and consumers, although the model did not incorporate risk preferences to model production. Furthermore, the model assumes the existence of nearly perfect markets with exogenously determined prices, i.e. households are price-takers. The SSS model is often considered to be analytically tractable but behaviorally unrealistic. The Binswanger and McIntire (BM) model aims to incorporate household behavior that is more in congruence with reality by assuming that many rural markets are incomplete or missing (for example, the lack of lending institutions in the neighborhood, or the lack of a proximate marketplace to sell produce) and the presence of a variety of risks. In the BM model, households are assumed to maximize income while striving to smooth consumption and income in the face of possible negative income shocks. One of the limiting assumptions of the BM model is that it does not incorporate output markets.

Both the SSS and the BM model are structural equation estimations where the parameters to be estimated have an interpretation in terms of primitives of economic behavior given the preferences and constraints. Conflict affects several important structural parameters in the above models which are important to consider. Bruck (2001) discusses the limitations and relevance of the SSS model and the BM model in post-war households, and argues that the BM model is a useful starting point. The behavior of a household is determined by the exogenous constraints it faces (Binswanger and McIntire 1987; Dasgupta 1993). During war, the constraints a household faces is changed, in addition to the mode of rural production, households preferences such as time preference, and the endowment of household (Bruck, 2001). I consider household behavior during conflict in a similar spirit to Bruck (2001), who note that reduced-form functions which require fewer assumptions might be more useful in evaluating household behavior in the face of

conflict than structural functions that define household behavior. The modeling approach allows inferences to be made from the data based on the exhibited behavior of the households. Based on past studies, several factors have been identified to be important determinants in the allocation of resources by an agricultural household¹³.

At the household level, land size (Rosenweig and Wolpin, 1993; Ikegami, 2008), age of household head and age-squared (Rosenweig and Wolpin, 1989; Grun, 2008), education of household head (Foster and Rosenweig, 2002; Grun, 2008), off-farm income (Harris, 2010), household size (Ikegami, 2008), and gender of household head (Grun, 2008) have been posited to influence investment in agriculture.

Analyzing investment in Bullocks in rural India, Rosenweig and Wolpin (1989) argue that age of household head is an important variable as it acts as a proxy for return to farming experience. Including the age-square variable in the model, the authors find that the relationship to take a quadratic form, with investment peaking at age 45. Foster and Rosenweig (2002) similarly find that education plays a critical role in increasing investment when technological progress is rapid. Ikegami (2008) make an improvement on existing models of investment by also considering household composition. He argues that household composition also changes the availability of labor thereby causing investment decision to change.

Based on the variables considered to be important determinants of agricultural investment at the household-level in the above studies, the section below aims to present a statistical summary of the characteristics of a typical Nepali household – both during a time of peace (1995/96) and during a time when the civil war in Nepal was on-going (2003/04).

¹³ It is important to note that treating a household as a unit of analysis (Bergstrom 1997, Strauss and Thomas 1995) does not consider the intra-household bargaining dynamics that lead to the decision. Such a discussion is beyond the scope of this paper.

3.3. Data Sources and Descriptive Statistics

To gauge the effect of conflict on agricultural investment at the household level, I combine data from three sources. The first data set comes from the World Bank Living Standard Measurement Survey (LSMS) collected in 2003/04 (administered from April 2003 to April 2004) and the LSMS data collected in 1995/96. The final sample size of the cross-sectional LSMS data in 2003/04 consists of 3912 households enumerated from 334 Primary Sampling Units (PSU), whereas the cross-sectional LSMS data in 1995/96 consists of 3,373 households. Household weights have been provided to supplement that data to ensure that the data sets delineate a nationally representative sample. This data set provides information on household characteristics during the two time periods – the pre-war time period (95/96) when the civil war in Nepal hadn't started, and the during-war time period (03/04), when the civil conflict in Nepal was at its peak. I combine the LSMS data set from the two time periods with data on conflict collected by INSEC, a non-profit group promoting human rights. The data set from INSEC is rare in terms of the detail provided on conflict-related measures, in particular the geographical distribution of conflict. I supplement this with data made publicly available by Do and Iyer (2009) on road density and forest cover. Table 10 below summarizes the descriptive statistics of household characteristics during the 1995/96 and the 2003/04 time period.

Variables	Descriptive Statistics 1995/96			Descriptive Statistics 2003/04		
	Obs	Mean	Std. Dev.	Obs	Mean	Std. Dev.
Total Agricultural Investment (in NRs.)	2508	1983.87	4799.25	3007	3976.10	10338.6
Sex of Household Head (Male=1; Female=0)	3359	0.86	0.34	3905	0.81	0.39
Age of Household Head	3359	44.68	14.42	3905	45.49	14.23
Marital Status of Household Head (Married=1; Other=0)	3463	0.82	0.38	3908	0.85	0.35
Whether Household owns any land (Yes=1; No=0)	3359	0.76	0.43	3904	0.73	0.44
Whether household has borrowed any money (Yes=1; No=0)	3359	0.57	0.49	3904	0.65	0.48
Whether household plans to sell produce in market (Yes=1; No=0)	2530	0.33	0.47	2849	0.53	0.50
Nominal Total Household Income (in NRs.)	3359	57095.86	127729.9	3905	115678	595507.2
Size of Household	3359	5.59	2.77	3905	5.18	2.51
Education of Household Head (0=Illiterate; 4=Beyond 11th Grade)	3356	0.96	1.30	3905	1.17	1.36
Total area of land owned by Household (in Ropani)	2555	7.11	12.51	2839	7.88	11.36
Proportion of household land that is irrigated	2555	0.29	0.35	2839	0.41	0.40

Table 10: Descriptive statistics of household characteristics during the 1995/96 and the 2003/04 time period

The descriptive statistics above show that in 1995/96, 851 households from the nationally representative sample did not answer the question regarding how much they invested in agriculture thereby reducing the number of observations to 2508. On average, a household invested Nepalese Rupees (NRs.) 1983.87 during 1995/96, with 638 households responding as having invested 0. The dependent variable, investment in agriculture, incorporates expenditure in seeds, fertilizer, labor, irrigation, transportation, storage, land improvement, and equipment including thresher and tractor¹⁴. The sample size for the total household income variable includes 3,359 households as 14 households whose total income was zero or less than zero were dropped from the sample. The total income variable includes income from farm, non-agriculture wage, agricultural wage, enterprise, remittance, and other income. The descriptive statistics show that the average household in 1995/96 consisted of 5.6 individuals, with 86.5 % of the households headed by males. The average age of the household head was 44.7 years – with the youngest household head being 11 years old and the oldest 92 years. While it is highly unusual for a household head to be 11 years old, they perhaps reflect the cultural ethos of reporting the oldest male as the household head by some. Household education is categorized from a scale of 0-4, with 0 being Illiterate and 4 being education above 11th grade – 1,878 household, or 55.96% of the sample household heads are Illiterate, while only 222 household, or 6.62% of the sample have received education more beyond the 11th grade. 76.1% of the households report owning some land in 1995/96, while the rest either rented or leased land. On average the total land owned by a household is 7.10 katha¹⁵ -- household land area reported in various units was first converted into kathas, before summing up the total land area. The irrigation variable takes a value of 0 if a field was not irrigated and 1 if it was irrigated – as a household may own several plots of land, with some being irrigated and some not, the number of plots owned by a household was divided by whether the plot is irrigated or not, thereby giving the variable a range between 0 and 1.

The descriptive statistics of household characteristics summarized in Table 10 show that in 2003/04, on average, a household invested NRs. 3,976.1 in agriculture. 444 households reported their agriculture investment as being zero. Of the 3,912 households sampled in 2003/04, 7

¹⁴ All households that filled out the agricultural questionnaire are included as agricultural households. This includes urban households (except Kathmandu) where it is not uncommon for households to practice agriculture.

¹⁵ 1 Bigha = 2,880 square feet

households had income that was computed to be less than or equal to zero – these households were dropped from the data set, thereby reducing the sample size to 3905. The average income of a household in 2003/04 was NRs. 115,678. The average household size was smaller than in 1995/96, with the average household consisting of 5.18 individuals. 1,876 household heads, or 48.04% of the sampled household heads, were illiterate in 2003/04, which is a decrease from 1995/96, but still a significant proportion. 80.7% of the household heads in 2003/04 were headed by a male – the proportion of female headed households increased by 5.8% between the two time periods, with the civil conflict likely contributing to the change (Bohra et.al, 2011). 72.7% of the households owned some land during 2003/04, with 52.6% selling their agricultural output in the marketplace, an increase from 1995/96.

3.4. Methodology and Analysis

Measuring the causal effect of conflict is not an easy task as the dependent variable of interest – in our case, investment in agriculture – is likely to be co-determined by other variables that might affect investment in agriculture. Using the conflict variable – number of deaths in a district per 1000 population -- to estimate how it affects investment in agriculture is therefore likely to yield spurious results as it ignores the endogeneity issue related to conflict. In the case of Nepal, Do and Iyer (2010) have shown that regions with higher rates of poverty were also likely to experience higher levels of conflict. This makes it essential that to gauge an unbiased effect of civil conflict on investment in agriculture, the endogeneity issue needs to be tackled head-on. The present paper relies on a difference-in-difference (DID) strategy developed by Angrist and Kugler (2008), and adopted in the context of Nepal by Menon and Rodgers (2011) to gauge the causal effect of conflict on investment in agriculture. Before proceeding with a discussion of the DID approach, I first present a simple model that ignores the endogeneity issue discussed above – this Naïve model provides a qualitative benchmark against which to compare the DID estimates discussed later.

Naïve Tobit & Log-Normal Double Hurdle Model

The effect of conflict, conditional on household characteristics, on investment in agriculture is captured by an equation with the following form:

$$Y_{ijt} = \alpha + \beta C_{ijt} + \theta H_{ijt} + \omega_j + \tau_t + \varepsilon_{ijt} \text{-----(1)}$$

Y_{ijt} denotes investment in agriculture by household i in region j and time period t . H_{ijt} captures the characteristics of a household (in region j and time period t) that influence their decision to invest in agriculture – it includes total household income, household size, age of household head, sex of household head, education of household head, whether the household owns land, the total size of land a household owns, whether the land a household owns has irrigation, and whether the household plans to sell their output in the marketplace. C_{ijt} captures the effect of conflict – above and beyond the effect of household characteristics – on investment in agriculture. The conflict variable is defined as the number of deaths per 1000 people in a sub-region during the time period – there are 15 sub-regions in the model, which have been constructed by aggregating information from three districts into one region. Since the LSMS data set provides household weights, using it information at the district level is retained at the sub-region level. ω_j captures the sub-region specific effect, τ_t captures the time-effect (0 in 1995/06 and 1 in 2003/04) and ε_{ijt} is a household-specific error term.

As a non-negligible proportion of households reported their investment in agriculture to be zero (0), an OLS model that ignores the zero values and only models households who invest more than zero is likely to result in biased and inefficient estimates, in addition to discarding potentially useful information contained in the zero answers (Amemiya, 1984). A Tobit model, first proposed by Tobin(1958), takes the censored nature of data in account; however, a Tobit model is considered to be restrictive in some instances, as it assumes that a single mechanism generates the zero, say, a decision of whether to invest or not, and the non-zero values, say, a decision of how much to invest once a household has decided that it wants to invest. As a result of this limitation, the partial effect of a discrete or continuous covariate always has the same sign in the above described two-steps using this model (Wooldridge, 2009). Cragg (1971) introduced a double-hurdle model that takes into account the different scholastic decision-process of the two steps, also extending the model to log-normal double hurdle models, where the distribution of the positive outcomes takes on a log-normal distribution. Borrowing on the terminology used by Wooldridge (2009), the general Log-Normal Hurdle model can be expressed as:

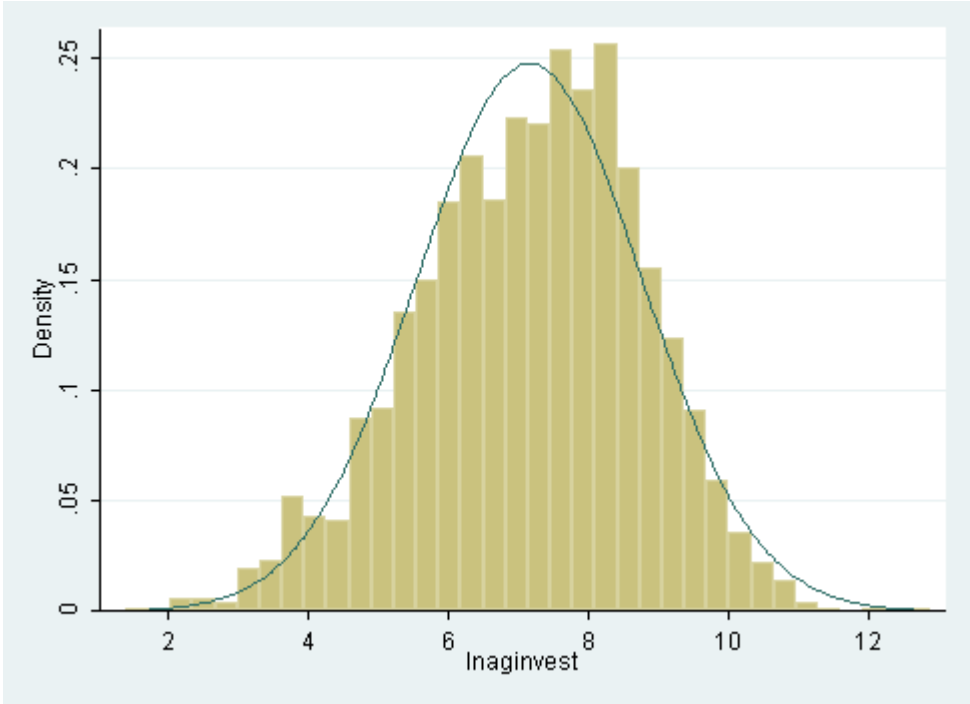
$$y = w.y^* = \mathbb{1}[x\gamma + \upsilon > 0] \exp(x\beta + \mu)$$

Where y^* is a non-negative, continuous random variable, w is a binary variable that determines whether y is zero or strictly positive, and υ and μ are error terms for the first-step and the

second step decision process and are assumed to be independent of each other, and to follow a bivariate normal distribution with respect to x (Wooldridge, 2009). A probit model is used to estimate the first step, which is whether the dependent variable takes a zero value or a positive value, and a tobit model is used to model the second step, which is the level of the value.

A graphical analysis of the observations greater than zero reveal that the data better approximates a log-normal distribution rather than a normal distribution (please see Figure below). As a result, a Log-Normal Double Hurdle Model, which is an extension of the Cragg Double-Hurdle Model, is preferred over a Truncated Normal Hurdle model for the comparison.

Figure 16: Distribution of Log Agriculture Investment



I test both models, the Tobit Model and the Log-Normal Double Hurdle model, to gauge which model is better suited for the present analysis. As the two models are non-nested, a Vuong Test is used to decide which model better fits the data.

Table 11 below presents results from the Naïve Tobit and the Naïve Log-Normal Double Hurdle Model.

Naïve Tobit and Log-Normal Double Hurdle Estimates

EQUATION	Model I: Naïve Log-Normal Double Hurdle Estimates		Model II: Naïve Tobit Estimates
	Step 1: Whether to invest Wheinv	Step 2: How much to invest Model	1 model
Total Number Killed (per 1000 population)	-0.13*** (0.04)	-0.24*** (0.04)	-932.5*** (270.2)
Year (1995/96=0; 2003/04=1)	0.31*** (0.06)	0.36*** (0.05)	1476*** (339.4)
Sex of Household Head (Male=1; Female=0)	-0.07 (0.07)	-0.16** (0.06)	-731.8* (404.9)
Marital Status of Household Head (Married=1; Other=0)	-0.008 (0.07)	0.07 (0.06)	328.9 (413.0)
Whether household owns any land (Yes=1; No=0)	0.09 (0.10)	0.46*** (0.09)	1535*** (551.9)
Whether household has borrowed any money (Yes=1; No=0)	0.16*** (0.05)	0.07* (0.04)	893.3*** (272.5)
Whether household plans to sell produce in market (Yes=1; No=0)	0.50*** (0.05)	0.67*** (0.04)	2733*** (265.2)
Log of Total Household Income (in NRs.)	0.28*** (0.037)	0.57*** (0.03)	2731*** (187.1)
Size of Household	-0.02 (0.01)	0.03*** (0.008)	70.83 (52.82)
Education of Household Head	0.11*** (0.03)	0.23*** (0.02)	1138*** (123.6)
Age of Household Head	0.002 (0.002)	0.01*** (0.002)	49.94*** (9.854)
Household lives in urban or rural neighborhood	-0.09 (0.09)	0.17*** (0.06)	1193*** (409.6)
Sub-Region Dummy Constant	YES -2.61*** (0.44)	YES -1.23*** (0.35)	YES -38623*** (2263)
Observations	5375	4391	5265
Log-Likelihood	-7280.04	-1858.58	-46500.5

Standard errors in parentheses

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

As the two models above are non-nested, a Vuong test was conducted between the Tobit model and the Log-Normal Double Hurdle model to assess which model is better suited to modeling the dependent variable of our model, investment in agriculture. The sum of the Log Likelihood for the Log-Normal Double Hurdle Model was calculated following the method by Wooldridge (2009)¹⁶ and along with the Log Likelihood of the Tobit model is used to calculate the Vuong Statistic. The Vuong Statistic was calculated according to the transformation of the Log Likelihood functions of the two models as described by Humphreys (2010)¹⁷. As the Vuong Statistic of 68.3 is greater than the critical value of the standard normal distribution, this provides evidence that the Log-Normal Double Hurdle model better fits that data than the Tobit model, and that investment in agriculture can be better viewed as a two-step decision process.

The results of the naïve tobit and log-normal double hurdle model above, which show that the direct measure of conflict – number of deaths per 1000 population – is significant in various model permutations, provide some preliminary evidence that the civil war did in fact affect investment decisions in agriculture. The direction of the coefficients of the control variables are also in the expected direction and are comparable in the second step of the log-normal double hurdle model and the tobit model -- except that household size is significant in the log-normal DH model, but not in the tobit model. The variable on whether households have borrowed money from any source shows that households that borrow money, on average, invest more than households that don't. This coefficient is slightly counter-intuitive, and perhaps captures the credit-constrained environment most households face. The results of the log-normal Double Hurdle model show that, once households decide to invest in agriculture, investment in agriculture increases with household size, household income, education of household head, and age of household head – these results are in line with findings from past literature. The results also show that households that own land and plan to sell their produce in the marketplace, invest more in agriculture. Also, the results indicate that female-headed households, on average, invest less in agriculture than male-headed households. The probit results from Step 1 of the log-normal

¹⁶ This involves summing the Log Likelihood of the probit model used estimate the binary step 1 decision and the Log Likelihood of the Tobit model used to estimate the second step decision and subtracting it with the mean of the (logged) dependent variable times the number of observations.

¹⁷ The Vuong Test Statistic can be calculated as $[(\sqrt{N} * LR1)/wn]$, where LR1 is the difference between the Log Likelihood function of the Log-Normal Double Hurdle Model and the Tobit Model, and wn is $(1/N)[(LR1)^2 + [(1/n)LR1]^2]$ (Humphreys, 2010)

Double Hurdle model above indicate that education of household head, total income of a household, and household's that have borrowed money and plan to sell their produce in the market, on average, are more likely to invest in agriculture. Greater conflict decreases the likelihood of a household to invest in agriculture versus to not invest. The comparison of the two-steps indicate that age of household head, sex of household head, household size, and whether household owns land have no significant effect on the decision as to whether to invest in agriculture, but once that decision to invest is made, they effect the level of investment. It is important to take the above results with caution since they are naïve estimates that do not address the issue of endogeneity. The above results serve as a qualitative benchmark against which we can compare the difference-in-difference estimates below.

1.4.A. Difference-in-Difference Approach

As discussed above, the naïve tobit and Log-normal Hurdle Model model does not provide a causal estimation of civil conflict on investment in agriculture since C_{ijt} in equation 1 above, is likely endogenous, thereby ignoring bias due to omitted variables and/or unobservable effects. In order to gauge the causal effect of civil conflict on investment in agriculture, I rely on the DID method developed in the context of Nepal by Menon and Rodgers (2011) whereby they exploit the intensity of conflict during the civil war, which was higher in regions that were forested, had fewer roads and were at a higher altitude. Investigating the intensity of conflict in Nepal a few previous studies have also supported this view (Do and Iyer, 2010; Bohara et.al, 2011) arguing that since the Maoists were far out-numbered by the government armed forces, the aforementioned terrain was more conducive to guerilla warfare thereby causing higher conflict.

The information on the number of deaths and the geographical variables are originally at the district level. Nepal is categorized into 75 districts. However, since our estimation captures region specific effects using a region fixed effect, having the information in the form of districts could result in a significant loss of degrees of freedom. To assist with the parameter estimation, the 75 districts are aggregated into 15 sub-regions – five development regions (Eastern, Central, Western, Mid-Western, Far-Western) interacted with three types of physical terrain (Mountains, Hills, Terai) thereby giving us 15 sub-regional parameters. This aggregation is also similar to the

one used by Menon and Rodgers whereby the weights at the district level are retained at the sub-regional level (2011).

The difference-in-difference approach is appropriate when there are two comparable groups and two time periods (before and after). If the two groups are comparable and not systematically predetermined in the before time period, and subsequently, one group is exposed to the treatment and the other is not, the DID approach helps gauge the unbiased effect that was caused due to the treatment. In the present paper, the “treatment” is conflict.

Following Menon and Rodgers (2011) to gauge whether forest cover serves as an appropriate proxy for conflict intensity, in the “first stage” the predictive power of the “instruments” – forest cover, road density, elevation – is tested. This is done by running a regression with the conflict variable – number of deaths per 1000 population in the sub-region – as the dependent variable, on proportion of sub-region covered with forest, total length of road network normalized by total area, and elevation. Menon and Rodgers also use rainfall as an additional predictive variable for conflict, but due to unavailability of the dataset I have not included the variable. The geographical variables used are from 1994 in order to avoid any feedback effect. The regression results are presented in Table 12 below. Forest cover is used as a continuous variable in one regression, and as a categorical variable (greater than 50% of sub-region being forested categorized as 1 and less than 50% being forested categorized as 0) in another. Forest-cover is significant in both forms, including when other geographical controls are included, thereby validating its choice as a proxy variable for conflict intensity.

Table 12: “First Stage” Regression for Conflict Intensity

VARIABLES	(1) nKilled1	(2) nKilled1	(3) nKilled1	(4) nKilled1
Forestregion	2.80*** (0.05)	2.47*** (0.05)		
elevation1		0.03*** (0.003)		0.09*** (0.003)
road1		-0.73*** (0.03)		-0.43*** (0.03)
forested75			0.94*** (0.02)	0.89*** (0.02)
Constant	-0.37*** (0.02)	-0.20*** (0.02)	0.53*** (0.008)	0.31*** (0.02)
Observations	3474	3474	3477	3477
R-squared	0.46	0.58	0.38	0.57
Standard errors in parentheses		*** p<0.01, ** p<0.05, * p<0.1		

***Column 1 and 2 uses the continuous region forested variable; Column 2 and 3 use the dichotomous (0/1) Forested/Non-Forested Variables**

The categorical 0-1 forest cover is used as an instrument in the subsequent analysis – in order to ascertain that the forested and non-forested areas before the conflict were comparable to each other; Table 13 summarizes the descriptive statistics of both groups.

Variable	Forested-Region		Non-Forested Reg		Difference		
	Mean	Std. Error	Mean	Std. Error	Mean	Std. Error	T-stat
Total Agri Investment	1580.03	617.23	1837.49	365.83	257.46	711.30	0.36
Household Size	6.33	0.47	5.46	0.25	-0.87	0.51	-1.72
Sex of HH	0.84	0.04	0.86	0.03	0.02	0.05	0.34
Age of HH	42.52	1.20	45.99	1.22	3.46	2.19	1.58
Education of HH	0.64	0.07	0.64	0.09	0.003	0.16	0.02
Total Income	43450.12	7950.19	37507.26	4036.44	-5942.86	8178.54	-0.73
Marital Status HH	0.87	0.03	0.83	0.02	-0.04	0.03	1.44
Whether owns land	0.92	0.04	0.85	0.05	-0.07	0.08	-0.86
Has borrowed money	0.59	0.04	0.63	0.03	0.04	0.05	0.80
Total Land Owned	5.44	1.81	7.94	1.95	2.50	3.47	0.72
Plan to sell produce	0.32	0.09	0.32	0.05	-0.002	0.10	-0.02
Proportion Plots Irrigated	0.32	0.06	0.25	0.04	-0.06	0.07	-0.92

Table 13: Comparison of Forested and Non-Forested Regions

The above table shows that the means of the two categories are comparable in terms of the descriptive statistics. The descriptive statistics show that the forested and non-forested regions are very similar in terms of the characteristics before the war– a t-test of the difference of means of the various characteristics showed that none of the variables are significantly different at the 10% level before the war. The fact that the variables that influence investment decisions, as well the level of agriculture investment before the war, are very comparable give us confidence that the “parallel trend assumption” that is central to difference-in-difference models holds.

As we now have two comparable groups and two time periods – our instrument, the categorical forest-cover variable interacted with the time period provides us the exogenous change in investment in agriculture caused due to the civil conflict. Equation (1) specified above is modified as follows:

$$Y_{ijt} = \hat{\delta} + \sum_b \beta_{0b} \mathcal{F}_{jb} + \theta H_{ijt} + \omega_j + \tau_t + \varepsilon_{ijt} \text{-----}(2)$$

Equation 2 above is similar to equation 1 except for the use of the interaction between the categorical forest cover variable and the time period variable -- $\sum_b \beta_{0b} \mathcal{F}_{jb}$ -- that captures the difference-in-difference term instead of the direct measure of conflict used in the first equation.

The table below summarizes the Difference-in-Difference estimates of investment in agriculture using the Log-Normal Double Hurdle Model.

Different-in-Difference Estimates using Log-Normal Double Hurdle Model

Step 1: Whether to Invest in Agriculture

Step 2: How much to invest

VARIABLES	Model 1	Model 2	Model 3	Model 1	Model 2	Model 3
	Wheinv	wheinv	wheinv	model	Model	model
Forested*Post	-0.09 (0.11)	-0.03 (0.11)	-0.07 (0.11)	-0.49*** (0.11)	-0.35*** (0.11)	-0.49*** (0.11)
Post	0.21*** (0.05)	0.26*** (0.06)	0.16*** (0.06)	0.26*** (0.04)	0.37*** (0.05)	0.22*** (0.04)
Sex of Household Head	-0.08 (0.07)	-0.03 (0.07)	-0.05 (0.08)	-0.16*** (0.06)	-0.06 (0.07)	-0.18*** (0.06)
Marital Status of Household Head	-0.004 (0.07)	0.005 (0.08)	-0.003 (0.08)	0.06 (0.06)	0.06 (0.07)	0.05 (0.06)
Whether the household owns any land	0.08 (0.10)	0.08 (0.10)		0.44*** (0.08)	0.46*** (0.09)	
Whether household has borrowed money	0.16*** (0.05)	0.16*** (0.05)	0.15*** (0.05)	0.07* (0.04)	0.07* (0.04)	0.07* (0.04)
Plans to sell produce in the market?	0.50*** (0.05)	0.50*** (0.05)	0.49*** (0.06)	0.67*** (0.04)	0.67*** (0.04)	0.61*** (0.04)
Log of Total Income (in NRs.)	0.28*** (0.04)	0.28*** (0.04)	0.23*** (0.04)	0.57*** (0.02)	0.58*** (0.03)	0.51*** (0.03)
Size of Household	-0.015 (0.01)	-0.01 (0.01)	-0.02 (0.01)	0.03*** (0.008)	0.03*** (0.008)	0.03*** (0.008)
Education of Household Head	0.11*** (0.023)	0.11*** (0.02)	0.10*** (0.03)	0.24*** (0.02)	0.23*** (0.02)	0.21*** (0.02)
Age of Household Head	0.002 (0.002)	-0.004 (0.01)	0.002 (0.002)	0.01*** (0.001)	0.01 (0.008)	0.009*** (0.002)
Urban or Rural neighborhood	-0.11 (0.09)	-0.09 (0.09)	-0.09 (0.09)	0.14** (0.06)	0.15** (0.06)	0.04 (0.06)
Sex of Household Head*Conflict		-0.09** (0.04)			-0.20*** (0.05)	
Proportion Land Irrigated			0.59*** (0.07)			0.55*** (0.05)
Total area of land owned			0.003			0.01***

			(0.002)			(0.001)
Sub-Region Dummy	YES	YES	YES	YES	YES	YES
Constant	-2.57***	-2.512***	-2.26***	-1.25***	-1.36***	-0.27
	(0.44)	(0.47)	(0.45)	(0.35)	(0.38)	(0.35)
Observations	5375	5375	5073	4391	4391	4141

Standard errors in parentheses

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

Table 14: Difference-in-Difference Estimates of Investment in Agriculture

The results from the difference-in-difference model above provide more convincing evidence that the conflict in Nepal did, in fact, affect the decision of households' to invest in agriculture. The difference-in-difference variable in the above table i.e. interaction between forested dummy variable and the post dummy variable, shows that total agricultural investment was lower for households in more forested area (who were more exposed to conflict) as compared to their non-forested area counterparts. The direction of the coefficients and the covariates that are significant are very similar to the naïve model above. Similar to the naïve log-normal Double Hurdle model, the results also show that once households decide to invest in agriculture, as the education and age of household head increases, households tend to invest more in agriculture. As do households with higher income. Households that have borrowed money from any source, that plan to sell their produce in the market, that own land, that are headed by male headed households, and have a larger proportion of their fields irrigated, on average, also tend to invest more. The level of household investment also increases with household size and total area of land owned. As with the naïve Log-Normal Double Hurdle Model, the DID Log-Normal DH model also show that age of household head, sex of household head, household size, whether the household owns any land, and how much land a household owns, do not have a significant effect on the decision as to whether to invest in agriculture, but once the decision to invest has been made, they significantly affect the decision-making process. The coefficient of the dependent variable in the second-part of the model indicates that conditional on investment being positive, households in forested regions that were more prone to violence, on average, invested between 35% and 49% less in agriculture.

Specification Test

In order to gauge the robustness of the results obtained above, a specification test in the form of a Two Stage Least Square (2SLS) procedure was conducted. As discussed above, since the variable measuring conflict – number killed per 1000 population – can possibly be endogenous in the equations, a possible strategy to deal with the issue is to calculate the predicted values of conflict, and then interact it with the year/time variable. The interaction of the predicted conflict variable and the year dummy, along with the rest of the controls, aims at gauging the exogenous effect of conflict on investment in agriculture. The results presented in the table below give further credence to the hypothesis that conflict did have a negative effect on investment in agriculture decisions in Nepal. Furthermore, the results from the 2SLS procedure summarized below also show that the significance of the variables and their direction are consistent across the two steps in the naïve model, the DID model and the 2SLS models.

Table 15: Two-Stage Least Square (2SLS) Log-Normal Double Hurdle Model Estimates

EQUATION	Step 1: Whether to Invest		Step 2: How much to invest	
	Model 1 Wheinv	Model 2 Wheinv	Model 1 model	Model 2 model
Predicted Conflict Variable*Year	-0.09 (0.11)	-0.08 (0.12)	-0.52*** (0.11)	-0.52*** (0.11)
Year (1995/96=0; 2003/04=1)	0.26** (0.10)	0.21* (0.10)	0.54*** (0.09)	0.50*** (0.088)
Sex of Household Head	-0.08 (0.07)	-0.05 (0.08)	-0.17*** (0.06)	-0.18*** (0.06)
Marital Status of Household Head	-0.004 (0.07)	-0.003 (0.08)	0.06 (0.06)	0.05 (0.06)
Whether household has borrowed money	0.16*** (0.05)	0.15*** (0.05)	0.07* (0.04)	0.07* (0.04)
Whether household plans to sell produce in market	0.50*** (0.05)	0.49*** (0.05)	0.67*** (0.04)	0.61*** (0.04)
Log of Total Household Income	0.28*** (0.04)	0.23*** (0.03)	0.58*** (0.03)	0.51*** (0.03)
Household Size	-0.015 (0.01)	-0.02 (0.01)	0.03*** (0.008)	0.03*** (0.008)
Education of Household Head	0.11*** (0.03)	0.10*** (0.02)	0.24*** (0.02)	0.21*** (0.02)
Age of Household Head	0.002 (0.002)	0.002 (0.002)	0.01*** (0.002)	0.008*** (0.002)
Proportion of household land irrigated		0.59*** (0.07)		0.55*** (0.05)
Total area of land owned by household		0.003 (0.002)		0.017*** (0.002)
Whether household lives in urban or rural neighborhood	-0.11 (0.09)	-0.09 (0.09)	0.14** (0.06)	0.041 (0.07)
Whether household owns any land	0.08 (0.10)		0.45*** (0.09)	
Sub-Region Dummy	YES -2.57*** (0.44)	YES -2.26*** (0.46)	YES -1.26*** (0.35)	YES -0.27 (0.35)
	5375	5073	4391	4141

3.5 Discussion

The above results provide evidence that the civil war in Nepal negatively affected agricultural investment. The naïve estimates, the DID estimate, and the specification test using the 2SLS procedure all show that conflict negatively affected the level of investment in agriculture once households decide to invest in agriculture, but not the decision of households as to whether to invest in agriculture. The DID estimation strategy takes into account the endogenous nature of conflict while gauging the affect on investment in agriculture – while several statistical tests were conducted to ensure that the two comparison groups (forested and non-forested) were identical before the war began (1995/96), other factors such as climactic variables for the relevant time-period that are not included in the model could affect the estimation¹⁸. The strong evidence suggesting that households tended to decrease their investment decisions in response to the civil war is aimed at supplementing evidence provided by a few existing studies showing how households cope with conflict at the micro-level. Results indicate that in addition to causing the destruction of physical capital, life and the deterioration of social norms, the civil war was associated with changes in future-oriented decision making and inhibited household investments in the future¹⁹. Low investments generates low income – the evidence suggests that the civil conflict in Nepal further exacerbated the existing poverty levels by inhibiting investment levels further pushing households deeper in the chasm of a “poverty trap.” Post-conflict recovery initiative should focus on promoting a sense of security among households most affected by conflict, which would consequently help facilitate higher levels of investment.

¹⁸ The interaction of the sub-regional parameters that take into account each of the five development regions and the three distinct terrains of the country exploit the variation in climactic terrain across the country, thereby moderating the concerns slightly.

¹⁹ It is worth noting that the present analysis focuses on modeling change in investment in agriculture induced by the conflict in Nepal. While the analysis of agricultural investment is presented through the lens of an intertemporal assessment of present and future costs and benefits, it does not offer a direct test of discounting behavior.

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