The Relationship Between Participation, Social Networks, and Cooperation: How Social Networks Influence Voter Turnout through Mobilization and How Both Networks and Turnout are Related to Cooperation

by

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To my mother and father.
I hope to be as good a parent to my future children.

A C K N O W L E D G M E N T S

Writing this dissertation and completing my PhD has been by far the most difficult thing I have ever done. There have been so many times over the years that I have almost given up. Truthfully, I have not given up because the people who have supported me would not allow me to quit and despite having tried all of their patience, they never gave up on me. Before acknowledging and thanking people for their individual contributions and support, I first wish to credit everyone listed herein collectively.

First, I begin by thanking the most supportive committee I could possible imagine. I will always be grateful to Ted Brader, M. Kent Jennings, James H. Fowler, Michael T. Heaney, Vincent L. Hutchings, Greg Markus. If it had not been for any of them individually, I know this work would not have been completed. Each person in their own way were necessary for me to complete this journey. I would like to extend particular appreciation to Ted and Kent who jointly decided to not permit me to fail. Words cannot describe how much I needed and will always appreciate you all.

When I went Honduras many years ago to begin this journey, I did it with D. Alex Hughes. Before leaving for Honduras, we were friends. After what we went through there and afterwards, we became family. None of this would have been possible without Alex. My two brothers Brian Stafford and Matthew Perry were also huge parts of this work. Brian supported me in myriad ways and Matt even flew down to Honduras to give surveys for a couple weeks.

Finally and most importantly, I wish to thank my parents, Edward and Neelu Stafford. Everything I have ever done is because of the opportunities they have provided me.

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ABSTRACT

**The Relationship Between Participation, Social Networks, and Cooperation: How
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This dissertation is organized around three papers that illustrate the codependence of cooperation, political participation and social networks. It takes advantage of a unique project, the 2010 Rural Social Network Study that comprehensively mapped the social relationships of residents in 32 small Honduran communities. These data are paired with survey questions and behavioral observations of subsamples in incentivized settings.

The first paper, "Cooperation and Popularity," reinforces the claim that cooperation and friendship share a strong positive relationship. Friendship and social networks may have evolutionary roots in cooperation, but this work is the first to demonstrate a relationship between the number of friends one has and the propensity to cooperate. Number of friendships predicts cooperation in a public goods game. Specifically, I find that individuals with more friends are more likely to cooperate in earlier rounds, and that a group's total amount of money earned increases with the aggregate number of friends of its members.

The second paper, "Habituated Cooperation and Voter Turnout," provides empirical support for the claim that voting is a cooperative act. Prior theoretical work argues for a link between cooperation and voter turnout. I demonstrate that there is a robust empirical relationship been those who cooperate in public goods games and self-reported voting.

The final paper, "Social Networks and Mobilization," demonstrates that mobilization occurs more commonly when strong affective relationships are present. This study is the first to demonstrate how one's position within a social network can affect the ability to mobilize others for participation in a community meeting. Specifically, the greater the number of connections a person is away from a mobilizer, the less likely she is to attend a community meeting. I also show that as mobilizers are more central to the network, the percentage of those who attend the community meeting grows.

Together these papers illustrate that cooperation, social networks, and participation are linked to one another thereby contributing to the understanding of the interrelationship between social, political, and economic dynamics in the political process. These findings could be used to augment political participation and community cooperation through social networks.

CHAPTER 1

Introduction: The Relationship between Cooperation, Friendship and Participation

1.1 Introduction

In social dilemmas, group and individual interests conflict. These collective action problems are used to illustrate that under certain circumstances when people act in accordance with their self-interests, it can create suboptimal outcomes for the entire group. When a critical threshold of individuals in the group refrain from purely self-interested behavior, the group and often the individual can benefit especially in repeated games. Cooperation is the strategic decision to suspend the pursuit of individual self-interest to work with others for group benefit that may also translate to individual gains in the long term.

One of the more common means of understanding cooperation is the public goods game which is also called an n-player prisoner's dilemma. Each subject is allocated a set amount of currency and given the choice to *cooperate* by investing the money into a community pot or *defect* by keeping their endowment. After each iteration, interest is added to the funds from the community pot. This larger community sum is then divided equally amongst all people playing the game not just the people who cooperated. A defector then earns the original sum plus an equal share from the invested money so it is always in the best interests of the individual to defect.

Social dilemmas like the public goods game are ubiquitous and have been linked to issues as wide ranging as over-fishing, trade and commerce, international security and a variety of problems with pollution (Ostrom, 1990). Not coincidentally, one of the earlier studies on collective action problems also associated social dilemmas with political participation (Olsen, 1972).

According to rational-choice theorists, cooperation and therefore efficient group outcomes should rarely occur, but most empirical studies report significantly higher than expected cooperation levels (Fowler and Christakis, 2010). Although there is a large liter-

ature on the effects institutions have on increasing cooperation levels (Yamagishi, 1986), there is also a growing discussion about how the social environment can affect cooperation (Camerer, 2003; Casari and Plott, 2003; Fischbacher, Gächter and Fehr, 2001; Fehr and Schmidt, 1999; Ostrom, 2001).

People may also cooperate out of sense habit; if a subject has learned to cooperate through trial-and-error in their real life, they might simply become cooperators (Peysakhovich, Nowak and Rand, 2014). Cooperation across different game types also tends to be consistent across different games (Rand et al., 2009). It is possible then that cooperation is a heuristic, an informational shortcut people use because in general it has tended to work well (Seabright, 1993). But it is in this statement that lies the conflict between theory and practice: if theory states that cooperation in terms of outcomes is a losing strategy and yet people's experience dictates that cooperation is the preferred strategy, what might explain the difference between theory and practice?

I suggest that cooperation may carry tangential but significant social benefits, which can lead to further economic benefits. In other words, cooperative people have more friends and friends are valuable resources. It is also likely that people who have more friends learn to cooperate more than those with fewer friends.

Friendship can be defined as long term non-reproductive and non-kinship relationships (Hruschka, 2010). While that definition is a bit detached, given that human beings tend to maintain friendships (Krause, Lusseau and James, 2009), what evolutionary need does friendship serve? Cooperative behavior is often associated with friendship and it has been speculated that human beings evolved the capacity to make friendships because of the advantages cooperation provides in terms of fitness (Hartup, 1998).

When friendships are aggregated across social systems, the resulting structure is a social network. Social networks can vary in type and form, but for the purpose of this study, I am using social networks to refer to the interconnected web of strong affective relationships that bind most of society together. [1] Although it is easier to study friendship though singular dyads, theories about reciprocity and the evolution of cooperative behavior implicitly depend upon assumptions about the structure of social networks (e.g. Nowak and Sigmund, 2005; Rand et al., 2009). Numerous empirical studies on social networks have demonstrated that despite some variation, those structural assumptions facilitate cooperation across diverse sets of networks (Onnela et al., 2007; Barabási and Albert, 1999; Apicella et al., 2012).

Therefore, cooperation has a strong theoretical and empirical relationship with social

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[1]A larger discussion of what these ties are and how I operationtionalized social networks and connections can be found in Chapter 4 and the technical appendix.

networks, but social networks are also influential across a wide swarth of human behavior including obesity, contraceptive use, smoking, depression and even injuries from gun violence (Valente et al., 1997; Christakis and Fowler, 2008; Fowler and Christakis, 2010; Papachristos, Meares and Fagan, 2012). Social influence, though not conceptualized through networks, has also been shown to affect political participation (Gerber, Green and Larimer, 2008).

In political science, participation refers to the different actions people undertake to express their opinions. Among many other mechanisms, participatory acts could include donating money, organizing meetings, tweeting or even art. Although this study speaks broadly about political participation, I focus exclusively on two forms of it: mobilization and voter turnout.

Mobilization too can take many forms. Regardless of its variations, mobilization is the act of engaging or motivating other people to participate in politics (Rosenstone and Hansen, 1993). It is therefore explicitly social because it requires interaction with others. Some acts of participation like joining a civic organization or donating money to a candidate could be decisions citizens make without the influence of others and can be predicted through their income, education, unemployment, and internal and external political efficacy. However, mobilization is a social effort designed to push people off the equilibriums predicted by these demographic categories (Brady, Verba and Schlozman, 1995). I assert that not only are strong friendship connections important in predicting who gets mobilized, but also people who occupy more central locations in a social network are more likely to be effective at being mobilizers.

Although people mobilize others to participate in various activities, mobilization is most often in reference to influencing others to vote in elections. Understanding why people turnout to vote has been a pursuit of political scientists for decades (Campbell et al., 1960; Rosenstone and Hansen, 1993; Verba, Schlozman and Brady, 1995; Wolfinger and Rosenstone, 1980). Many scholars have turned to rational choice models to approach this question, but similar to theories on cooperation, these models tend to severely underestimate the voter turnout (Downs, 1957; Riker and Ordeshook, 1968). This is because in these models there is always a tangible cost for voting but the benefit an actor derives from the difference between two electoral outcomes must be weighted by the probability that her vote is the difference in the election, which approaches zero in the limit. Accordingly, these models add a valence term that represents the utility people derive from the act of voting. Not surprisingly, there is considerable evidence that voting is a social act, which could help explain the valence term and further explain why social networks are influential in determining who votes (Bond et al., 2012).

Voting may be influenced by social networks, but the incentives at play also make it a cooperative act (Olsen, 1972). While all share in the distributed benefits from an informed electorate participating in the democracy, the incentive to free-ride and not participate is high. I suspect that one of the reasons voter turnout is higher than expected in the rational-choice models is because participation and cooperation in general make people more central or popular in their social networks thus acting as a side payment. The social reward can be represented in the unspecified valence term from the voter model, but there is no such term in cooperative models. Consequently, there are strong theoretical reasons cooperation, social networks and participation should be tied together. This study explores that relationship in an unusual but informative setting.

1.2 Honduras as a Rural Social Systems Laboratory

This study on the interrelated nature of participation, mobilization, cooperation and social networks drama exclusively upon data from the Rural Social Network Study.[2] This study is from a rural region in Honduras in which a near census of 32 distinct social systems was given. This census had a brief survey that included standard demographic controls, a few variables of political interest, and questions designed to map the social networks of the community. After the census, a few games from experimental economics designed to collect measures of participation, mobilization and cooperation. Unfortunately, while all of the towns received the census, some of the 32 aldeas did not receive each of the economic games because of cost considerations. This is the reason why at times the analysis in this study will list 32 social systems and at other times a few less. This section provides further information about the research site and opens a discussion about the strengths and weaknesses of applying the RSNS to studies on mobilization, participation, cooperation and social networks.

1.2.1 Notes on La Union, Lempira

Honduras contains 18 federal departments, which are further subdivided into municipalities. In the La Union municipal region of Honduras's Lempira department, approximately 32 small towns surround a central city, which has a population of about 5,000 people.

The farming of coffee, beans and corn is the dominant form of employment and the average household earns about two dollars a day. The beans and corn are the primary source

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[2]Please see the technical appendix for a complete description of the RSNS and all of its procedures. The RSNS was a joint research product conducted with D. Alex Hughes, a PhD candidate in political science at the University of California, San Diego.

of subsistence for people in these communities and the coffee is exported for profit. The number of purchasers is limited, which gives these intermediaries tremendous bargaining power and reduces the purchase price the farmers receive. Furthermore, the wealthier processors of coffee offer loans to the farmers who cannot afford agricultural inputs that are both usurious and contractually obligate the farmers to sell to the given processor at below market values when the loan cannot be repaid in full.

To try and supplement nutritional intake, many people also grow a few additional fruits or vegetables like plantains and bananas. The mountainous climate, while ideal for coffee production, limits other possible crops. Although chickens regularly run through the makeshift roads and paths, the chickens are rarely eaten because they supply the families with eggs.

There is little diversification of labor. People in La Union are predominately coffee farmers though some of the wealthier land owners do traffic in cattle. Every town has at least one store but these merchants run this business out of their homes for supplemental income. The stores may carry a few dozen items but the only products sold regularly are lard and Coca Cola. The land may appear plentiful, but the largest portions of it are owned by a few families who are the remnants of an old aristocratic regime. These wealthy few have, for the most part, left La Union for the nation's cities.

The network of rocky roads that connect these towns are rugged in fair weather and treacherous during the rain. The roads were not built nor maintained by the government. Local coffee farmers pool resources and coordinate road repair to maintain the capacity to export their commodity. During the rainy season there are weeks when passage in and out of any given town is infeasible. The vast majority people have never visited towns only a few miles up the mountain because of the harsh conditions of these roads.

The roads are not the only basic governmental service that the Honduran national and local governments have deserted and left to the people. The police are occasionally a presence in the center town, but officers are rarely if ever seen in the villages. Without police courts or prisons, the system of justice is also informal. The preponderance of formal laws has no relevance to or mechanism of enforcement for the people in La Union. There are of course the most basic codes of conduct against murder or theft, which are enforced sporadically albeit brutally by people from the victim's family and/or the community. For instance, if a member of the community drinks too much of a local hallucinogenic moonshine and walks through the village firing a gun at houses that jump out at the person, the rest of the community stays away from the windows to avoid the line of fire, and the next morning a group of men find the offending person and beat him. This informal justice system is of course inconsistently applied and depends on context.

The origins of the different villages are fairly uniform. From several oral histories gathered to understand this process, we learned that normally a family would settle on a piece of land. If the government did not actively enforce the legal boundaries of their land, then that family eventually took over ownership of the land. As the family grew and found profit through cultivating the land, others would marry into the family and additional families may move to the land to share in the labor and revenues. The groupings would then grow in a similar manner over the next several generations. Eventually, 32 of these would be communities survived and an unknown number of other social systems did not.

1.2.2 Systems Laboratory

La Union may seem like a bizarre site for investigating cooperation, social networks, and participation. The simplicity of its economic system, the geographic and cultural isolation, and the relative absence of government make these communities seem like an atypical setting for studying concepts that are often staples of discourse on politics in more developed nations in political science. Rather than hide from the differences that demonstrate Honduras is a world away from politics in more developed nations, I include the previous section to highlight them.

I cannot state definitively how well a study from La Union, Honduras, generalizes to social systems of more urban and developed communities like those in the United States. But often experiments and studies are done with smaller, non representative samples like college students or the city counsels of small towns. Some experiments and observational studies are impossible or prohibitively expensive in large, dispersed, or representative samples, but if the internal validity of the study is strong enough, then such studies may still hold considerable scientific value.

It is precisely because of the site's simple economy, geographic isolation and absence of government that La Union offers an ideal place to study cooperation, social networks, and participation. As a social system's anthropological and economic complexity increases so too does the complexity of the relationships of the people who inhabit them. This makes capturing the multiplexity of those relationships more difficult. Also, assessing a persons position in a social network (e.g., through measures like eigenvector centrality and indegree) becomes less accurate as the study populations response rate decreases. As the size and complexity of the social system increases, its boundaries also become less clear. So doing a study like the Rural Social Networks Study in modern communities that are interconnected not just through face-to-face contact but through various forms of technology, would make the cost increase exponentially and decrease the accuracy of the measures. Fi-

nally, the absence of government signifies that these communities for the most part evolved endogenously. Formal and informal norms were not imposed on these communities from the outside, but grew naturally from within. This process increases the likelihood that there could be variation across these communities in the norms that govern cooperation, social networks and participation.

1.3   Outline for the Dissertation

The dissertation is composed of three papers which analyze experimental data from Rural Social Network Study (RSNS) to demonstrate the interdependence between cooperation, social networks and participation. Each of the three papers illustrates a relationship between two of the three concepts.

The RSNS included a small initial survey that focused on measuring connections between people in small isolated social systems, and observational studies that incentivize social interactions like participation and cooperation. The strength of the study lies in the nearly complete census of each aldea's social network. The unusually high willingness from the people in these communities to be a part of the study permitted a more complete and accurate analysis of each respondent's structural position within the social network.

The second chapter, "Cooperation and Popularity," explores the relationship between friendship and cooperation. More specifically, I ask the question, does having more friends make a person more likely to cooperate? The study's social network data is particularly important because ascertaining the number of friends each subject has is fraught with conceptual problems if not measured through nearly complete social networks. Cooperation is operationalized through subject participation in iterated public goods games. The results indicate that there is a robust relationship between subjects' popularity and their willingness to cooperate, especially in early rounds of the experiment before the strategies of other players become intertwined. I also demonstrate that the aggregate popularity for each group positively relates with the amount of money each group wins.

The third chapter, "Habituated Cooperation and Voter Turnout," demonstrates that cooperators in public goods games are also more likely to vote. I argue that as with theories about altruistic voting that individual preferences about group welfare and cooperation may explain why people vote. This direct relationship between cooperating in the experimental setting and voting is in line with other studies on voter turnout and economic behavior (Fowler and Christakis, 2010). The voting measures are however self-reported and in Honduras it was not possible to verify these responses with better measures. Nonetheless the finding strengthens evidence that there is an important link between social cooperation

and acts of political participation. This chapter indicates that activities known to increase group-oriented and cooperative behavior may also have an effect on voter turnout.

The fourth chapter, "Social Networks and Mobilization," begins by presenting evidence that strong positive affective interpersonal relationships are important in predicting attendance to a civic meeting. In what I call the Mobilization Game, five people across dozens of small villages were incentivized to bring as many people as possible to a meeting about the introduction of a microfinance nonprofit the region. The people who attended that meeting were then asked who brought them to the meeting. I find that distance from nearest mobilizer is predictive of meeting attendance out to three degrees. I also find that more central or popular actors make for more effective mobilizers. Finally, I correlate the aggregate centrality of each aldea's mobilizers with the percentage of the town that attends the meeting. Taken together, these results suggest that not only are social networks related to participation, but that there is also variation in the distribution of interpersonal influence people have which can be explained through network position.

The final chapter that concludes the dissertation has two sections. The first section is a brief discussion on the importance of using data that is more systems-oriented in political science, and the limitations and benefits of doing so. The section is a brief discussion of the relationship between the chapters and an inference about the theoretical role social networks play in cooperation and participation.

These three chapters leverage the comprehensive mapping of social networks in small communities and data from survey and behavioral economics games in order to study the links among cooperation, social networks, and political participation. Taken together, these papers provide strong empirical support for the claim that these facets of social and political life are mutually reinforcing. As with all studies, there are limitations and caveats to the inferences we can draw from the data presented herein, and I endeavor to make those clear. Nevertheless, these papers take advantage of simple and relatively closed social systems to shed important new of light on the interrelated nature of social ties, cooperative behavior, and political participation.

CHAPTER 2

Cooperation and Popularity

2.1   Abstract

Collective action problems are situations in which the incentives of the group diverge from the interests of the individuals who comprise the group. Public goods is a common archetype of social dilemmas and is often characterized by free-riding, which leads to inefficient group outcomes. Solving these collective action problems is one of the primary theorized reasons that human beings evolved social behavior. If, on a group level, sociality is related to solving collective action problems, then it stands to reason individuals who cooperate are more likely to have friends. I journeyed to rural Honduras and mapped the social networks of 32 distinct social systems, and then explored the relationship between friendship and interpersonal cooperation in field experiments and real-world collective action problems. I find that there is a robust relationship between cooperation in the first 10 rounds of a 20 round iterated public goods game but the effect disappears in the latter half of the game. This result suggests that number of friends is a significant predictor of people who cooperate out of habit, but as the iterations continue group dynamics are also important. I also find that as the aggregate popularity of people in the group increases so does cooperation. This relationship is an important contribution to the literature and sociality and cooperation. Although the data and analysis prevents a true casual claim, it suggests that popularity may be a side-benefit for cooperation, which may in part explain some of the variation seen between theory and empirics in experimental economics. Finally, friendship and cooperation may seem like an usual place to begin a study in political science. As I will demonstrate in subsequent chapters, the number of friends a subject has is a major driver in the effectiveness of people who mobilize others for participation and that turning out to vote is a cooperative act that is strongly correlated with cooperation in a public goods game.

2.2 Introduction

Social dilemmas are situations in which the narrowly defined self-interest of individuals departs from the interests of the group (Samuelson, 1954). This divergence in incentives leads to group outcomes that are suboptimal. Social dilemmas are pervasive and topics as far ranging as carbon emissions, security threats, democratic participation, commerce, and over fishing may all be characterized as social dilemma (Ostrom, 1990). Collective action problems should result in inefficient group outcomes and yet, real social systems normally exhibit cooperation that exceed the expectations of rational-choice models. Changing institutions affects the choices of actors in social dilemmas (e.g. Yamagishi, 1986). These institutional changes are costly and can be impracticable in real world settings. There is also a growing discussion among social scientists about how the larger social, economic and political environment shapes the outcomes of social dilemmas (Camerer, 2003; Casari and Plott, 2003; Fischbacher, Gächter and Fehr, 2001; Fehr and Schmidt, 1999; Ostrom, 2001). Often, social dilemmas are at the heart of debates regarding the appropriate place of government and are one of the primary theorized reasons human behavior evolved a unique level of sociality.

These dilemmas, pervasive and far-reaching, are inherently social because they require the interaction of at least two people. Even the player with the only move in a "dictator game" still determines outcomes for another often unseen player in the way that a person's decision to litter has consequences for an untold number of who live in that community. Unsurprisingly, there is a theoretically strong link between sociality and cooperation (Bowles and Gintis, 2004; Henrich et al., 2004; Gintis, 2000; Bowles and Gintis, 2004; Majolo et al., 2006). Other studies may have linked societal friendliness to cooperation and efficient group outcomes (Putnam, 1993, 1995) and friendship (Hruschka and Henrich, 2006), but how cooperation impacts an individual's position in the social structure has not yet been studied. In particular, if the correlation between friendship and cooperation is strong, are cooperators more likely to be popular?

While the literature is decidedly ambiguous on this question, this study demonstrates that indeed popularity and cooperation are positively correlated. Although there may be some *a priori* expectation that a person's number of friends would be correlated with her cooperative behavior, prior to this research it has not yet been empirically verified. In fact, strong counter-hypotheses could be made. For instance, strict adherence to self-interest could be linked to increased personal wealth, which may also increase the number of friends a person has. It seems likely that popularity and cooperation are correlated, but it is certainly not a foregone conclusion.

2.3 Theory: Friendship and Cooperation

Although other species socialize with one another(Krause, Lusseau and James, 2009), depending on the definition of friendship, human beings diverge from other species in their ability to maintain friendships, or long term non-reproductive and non-kinship relationships (Hruschka, 2010) and these friendships are characterized by cooperative behavior. Even in early childhood and adolescence, people define friendship in terms of cooperation (Hartup, 1998) . Between two people, a friendship is a dyad but when aggregated across a social system these relationships form social networks of immense size and complexity. Theories about the evolution of cooperative behavior through reciprocity depend upon implicit assumptions about the structure of social networks the existence of communities, small world properties, and scale free degree distributions(Ohtsuki et al., 2006). Despite variation in size, social networks exhibit similar structural characteristics (Barabási and Albert, 1999) that facilitate cooperation (Apicella et al., 2012).

While the structure of a network can influence the cooperative behavior of the social system, individual actors have different positions within this structure: some are more central than others, some act as bridges between communities, some share more connections with their friends' friends than others. Recent research has demonstrated that number of friends and position in a social network may also be rooted in genetics (Fowler and Kam, 2007). If friendship evolved to facilitate cooperation in human beings then presumably individuals with more friendships, people occupy the center of social networks, should also exhibit greater levels of cooperative behavior. This study explores the relationship between number of friends and cooperation in the provision of a public good.

2.4 The Provision of a Public Good

The provision of public goods is one of set of social dilemmas in which group and individual incentives depart. Public goods are products or services that are both non-rivalrous and non-excludable. In other words, consumption by any single consumer does not decrease the availability of that good for any other consumer, and no consumer is capable of excluding any other person from consuming that good (Samuelson, 1954). However, if enough people consume the public good without investing, the asset depletes and the group as a whole loses the opportunity to consume more in the future. Common examples of public goods are clean air or water, fisheries, invention, and roads.

Public goods are subject to traditional problems with free-riders. Because public goods are non-rivalrous and non-excludable, there is no individual incentive to invest in their pro-

duction or maintenance. These dynamics characterize the decisions involving commerce, the provision of public services, the overconsumption of natural resources and many environmental problems. To fail to solve, or even understand these dilemmas has serious consequences on local and global scales. Widespread defection leads to suboptimal outcomes like polluting the environment and the depletion of natural resources (Ostrom, 1990). The public goods game places subjects in an experimental setting designed to mimic these incentives of real collective action problems and is thus an ideal means of measuring cooperation in laboratory settings.

2.4.1 Measuring Cooperation: Public Goods Games

In the traditional form of the public goods game, n-players receive some payment. That payment is generally most effective when scaled at about one-day's pay for the subject because the payoff must be high enough that it is a meaningful value to subject. Each subject then simultaneously decides to cooperate or defect. By choosing to cooperate, a player places that payment in a common pool to which the experimenter then adds some form of interest before the common-pool is divided equally among all players, not just the cooperators. For the individual actor, regardless of what any other player does, defection always yields a higher payout than cooperation. However, if everyone defects, the group loses the possible interest payment, thus reaching an inefficient group outcome.

Cooperation is particularly difficult in blind n-player games that do not provide a formal sanctioning mechanism. As the number of players increases, it becomes exceedingly difficult to deduce the behavior of other players and punishing people through defection becomes diluted across all the players (Olson, 1965). Accordingly, as the number of players increases, cooperation should decrease. Under these circumstances, an n-player game with blind simultaneous moves, cooperation is a high standard, and yet, in the real world cooperation is plentiful, if not the prevailing state of society.

2.5 Cooperation: Individual Behavior in Group Settings

2.5.1 Core Theory

Blind n-player public goods games are ideal for measuring the level of cooperation is a group, but there are difficulties with using an n-player game and infer that the behavior of each individual is independent of the behavior of the other participants in the game. In fact, subjects should and do adjust their behavior based on group dynamics. Overtime in large

n-player games, people often change their strategies from cooperation to defection, but this change cannot simply be explained through learning (Isaac, Walker and Williams, 1994) because when given the opportunity to play with different people, subjects often revert to their previous default behavior (Andreoni, 1988).

There is strong evidence that people cooperate conditioned on the cooperation of other people in the game (Fischbacher, Gächter and Fehr, 2001; Brandts and Schram, 2001). Agents seem to have an internalized narrative that states "It's alright for me to be selfish if other people are," and conversely that "if others cooperate, so should I." Conditional cooperation is not sustainable in repeated games with anonymous interactions and stable group membership (Ledyard, 1995). Under these conditions, the first iteration of a public goods game on average yields high levels of cooperation, normally more than half of the population. The presence of a significant minority of defectors then leads to a rapid decay of cooperation in subsequent trials (Fehr and Gachter, 2002).[1]

Another theory suggests that these actors could change the behavior from cooperation to defection not because of the aforementioned narrative association with conditional cooperation but instead from a desire to punish defectors (Andreoni, 1995). Without a formal method of punishing defectors, withholding the amount the defectors would make is the only available means of sanctioning. Other research demonstrates that, when provided that formal method of punishment, subjects will punish defectors even at considerable cost to herself (Dawes et al., 1986; Sato, 1987).

Players enter each game with priors or heuristics about social dilemmas. The player's behavior in the first round is a default to strategies that have generally worked in prior social dilemmas. The default is not, however, static over the course of the game. A cooperator may observe defectors profiting from her cooperation and decide to punish those cooperators with subsequent defection. Conversely, a defector may observe a critical mass of cooperators in the game and choose to conditionally cooperate in the future. In either case, the default behavior from in the initial iteration is 1) likely to be repeated in subsequent games with different actors (Andreoni, 1995), and 2) independent of the behaviors of other players in the group because those behaviors are yet to be revealed. In this study, I expect the number of friends a person has to significantly predict the level of their cooperation early in iterated public goods games, especially the first iteration, and wane as the the game continues.

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[1]The rate of defection remains high unless the rules provide for a direct means of social sanctioning (Yamagishi, 1986).

2.5.2 Potential Casaul Relationship

The data from the public goods game is meant to measure the subjects' general cooperative tendencies that mimic their behavior in a variety a real world social dilemmas with similar incentives. I do not have a measure for changes in cooperation over time, nor have levels of cooperation been experimentally manipulated. Similarly, the indegree of a subject is a snapshot of a person's number of friends and therefore an approximation of their popularity.

Given the nature of the data, I can not make a casual claim, but that does not mean there is no potential inference about causation in this a strong empiric relationship between popularity and cooperation. For instance, in child development, play often serves a means for children to learn about cooperative behaviors like sharing or group problem solving (Brownell and Carriger, 1990). It would not be surprising to learn that children who learn to share and cooperate with their peers also manages to create more or better friendships. In turn, Having more friends would also provide the child with more opportunities for social interactions with those friends, which could reinforce earlier cooperative behavior. I expect these socialized behaviors to extend from childhood development to adulthood. This mutually self-reinforcing behavior could lead to the coevolution of cooperation with popularity over time.

2.6 Data

2.6.1 The Rural Social Networks Study

In the summer months of 2009, a research partner and I collected data from the mountainous regions of Honduras country for the Rural Social Networks Study part I (RSNS1). To complete the project, we directed and trained a team of 25 American research assistants and another 25 Honduran surveyors. The data includes a nonrandom sample of 32 rural villages of varying sizes totaling about 5,000 persons. The population of aldeas includes many more smaller towns than larger towns with the median town containing about 120 residents. The largest town has a population of more than 600 and the smallest is about 30. From each of the satellite towns, the project gathered five types of data: standard respondent attribute information and relational data obtained from surveys, geographic maps, GPS coordinates for all edifices in the communities, records of subject behavior under incentivized experimental conditions, and historical community-level data regarding collective action problems like road quality and mobilization for public health activities. The purpose of RSNS1 is to explore the relationship between social networks and collective economic behavior.

Honduras is a relatively poor nation by comparative Latin American standards, and

La Unión is a comparatively poor municipality within Honduras. More than 60% of the residents of La Unión are in the lowest quintile of Honduran Income distribution. Residents of La Unión have less access to potable water, more residents without access to latrines, lower television penetration, and fewer residents who continue to secondary education.

2.6.2 Measuring Networks

Social networks were ascertained in 32 villages. Each network is the concatenation of relationships determined by name generators designed to measure friendship, filial, and spousal relationships. Figure 2.1 displays an example of one of the networks.

Networks were ascertained in a three step process. First, in each town we created a map of the geography of the town and the locations of each home within the town. Each home was assigned a unique identification number. Second, the following day, we returned to the village and conducted a census of the village. At each home, the number of residents were identified, photographed, and had very basic demographic information recorded. This information was subsequently coded into a computer program, Netriks, designed specifically to be used for social network elicitation in rural settings (Stafford and Hughes, 2010). Third, we returned a third time to each village to conduct surveys and generate the social network data. Each individual was queried to provide the names of friends, siblings and their spouse. Because many residents of the region have very similar or identical names (e.g. Jose Hernandez), the subject confirmed the intended relationship by viewing a picture of the individual. Eighty-seven percent of the residents of the towns participated in the survey.

The 32 social systems in this one municipality may seem like an odd sample population to study cooperation particularly because norms governing collective action problems vary cross-culturally (Henrich et al., 2004) However, La Unión does have three distinct advantages: homogeneity, isolation, and anthropological simplicity. First, social systems vary across many different social, economic, political, and cultural categories. Currently, collecting a large enough random sample of social systems to control for these differences is prohibitively expensive. These 32 distinct social systems are nearly identical across those variables but do differ in the structure of their social networks. In a sense, La Unión is a rural laboratory that we can use to explore how variations in structure and structural position relate to behavioral outcomes.

Second, the region's rugged mountain landscape, extreme poverty, and dangerous roads limit communication between these 32 villages and with the rest of the world. The villages also have well-defined geographic borders, which permit clean boundary specification for

the data gathering procedures. Thus, isolated and with clean boarders, these social systems can be treated as independent units of analysis.

Third, although the classification of societal complexity is not an exact science, the majority of the communities studied would seem to be villages (Johnson and Earle, 2000; Henrich et al., 2004). A village is a clustered human settlement in rural areas that usually ranges in population from one hundred to a few thousand. These settlements consist of about five to 30 families and the primary source of economic production is the cultivation of the land around the clustered homes. Some villages may settle around a different natural source of production, like a river for fishing. Because of the relatively small population size, the dearth of formal organizations, and the undiversified labor, villages represent a simpler societal unit in anthropological terms. In a more complex society, social structure could be derived from the structure of many types of relationships. In La Union, the simplicity of relationships permits strong-tie affective relationships to be an appropriate framework to study influence.

The structures of social networks exhibit remarkable similarity across cultures and types of data. Social networks tend to have skewed degree distributions, show degree assortativity, and have high levels of transitivity (Apicella et al., 2012). Assortativity is the property of similar people connecting to one another. Therefore degree assortativity means that people with a large number of friends connect to others with large number of friends. The reverse is also true. Meanwhile high transitivity means that when a respondent names an alter as her friend, the alter is also likely to name the original respondent as a friend. Our networks are broadly representative of those social networks in terms of those statistical categories as well.

2.6.3 Measuring Popularity

Friendship can be defined simply as long-term non-reproductive and non-kinship relationships (Hruschka, 2010), but the concept is complex. For instance, friendship can describe agents working together towards a joint goal , and can vary in terms of quality and conflict,or be about confidence and trust. In other words, not all friendships are equal. Since cooperation is tied to long-term reciprocity, I contend strong affective ties would be the best manner to conceptualize friendship. This is not the only means of measuring a relationship[2]. They could be conceptualized as a list of everyone a person knows or even just familial relationships. Being casual friends with someone on Facebook is not likely to signify the complex set of reciprocal interactions that characterize a cooperative relationship.

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[2]For a more indepth discussion of these concepts please see the technical appendix.
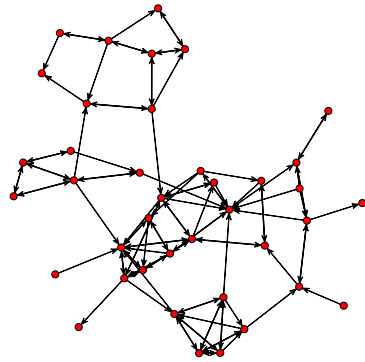
Figure 2.1: Friendship Network. A friendship network in one of the villages of the study. Here, red circles (nodes) represent an individual who lives in the village, and the directed arrows are friendship relationships. The arrow points "from" an individual "to" the alter she names as a friend.
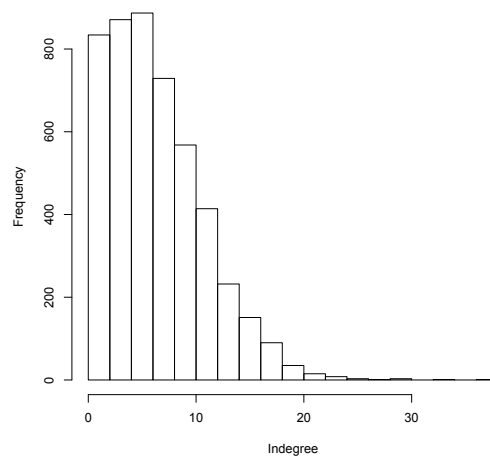
Figure 2.2: Histogram of Indegree Histogram of Indegree in 32 village networks. Following Apicella (2012), the networks ascertained in Honduras are consonant with networks gathered in a series of other locale. Here the x-axis is number of social connections, and bars are bins of frequency of observation.

Also, gathering whole social networks is important in ascertaining the number of friends each subject has. A measure of self-reported number of friends is likely to be subject to measuring error because the meaning of friendship may vary across subjects, and social desirability could cause some subjects to overstate his/her number of friends.[3] To account for these errors, it is more important to have a person's *indegree* than their *outdegree*. In social network analysis, a person's indegree refers to the number of people identifying that person as a friend. Conversely, outdegree is the number of people that person identifies as a friend. Across an entire network, the aforementioned measurement error is likely to be randomly distributed producing a more accurate measure of the number of friends.[4]

Figure 2.2 presents a histogram of indegree, the number of relationships that point toward an individual. The form of this distribution is typical of social networks.

As is common is similar social networks, the distribution is skewed (Barabási and Albert, 1999) This structural consistency with other social networks provides further evidence that indegree, the measure for used for popularity, is coming from a data source that is inline

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[3]Social desirability could also correlate with the dependent variable in this study, cooperation, which makes limiting the error particularly important.

[4]Therefore uncorrelated with the dependent variable.

with other network studies.

2.6.4 Public Goods Game

The research followed what are generally accepted experimental best practices[5]. I informed the subjects of the incentive structure before them and gave a brief, five question, quiz for understanding. Ten randomly sampled subjects from each town played an iterated game in each experimental session. Care was taken to ensure that communication was not possible. For instance, desks were arranged in a large classroom building to minimize the ability of subjects to observe one another, and the subjects were instructed to refrain from any verbal communication with their peers.

In each round subjects were endowed with ten Lempira (Honduran currency) and the subjects could either cooperate or defect, which I framed as "placing money in a community bank" or "keeping the money for yourself." Money provided to the bank was combined in each round, increased by 50/

The payoff to each individual was:

$$\Pi_i = \frac{1}{10}\left(1.5 * \sum_{\forall j \neq i} C_j + C_i\right) - C_i,$$

where Π_i is the payoff to player i; C_j is the Contribution to the Public Good of all other individuals; and C_i is the Contribution to the Public Good of individual i. It is immediately evident by checking first- and second-order conditions that the Dominant Strategy that maximizes payoff to individual i is to contribute nothing to the public good – each subject should keep her endowment because she can always earn more by free-riding than by contributing to the public bank.

After making a decision subjects placed their money in one of two envelops labeled "bank" and "personal." The experimenters then collected all of the "bank" envelops, tallied the number of subjects who cooperated and defected, announced this to the experimental group, and disbursed earnings. I then repeated the process for twenty iterations, but never informed the subjects of how many iterations they would play. It was theoretically possible a subject could receive as little as 10 Lempira or as much as much as 470. In fact, individuals averaged around 120 Lempira, just more than the wage paid for a days labor. No subjects earned fewer than 80 Lempira.

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[5]For more on these practices, please see the technical appendix.

2.7 Results

2.7.1 Variation in Public Goods Game Strategies: Town Level Variation

While all of the villages in the study frame were broadly similar across covariates, there emerged significant differences in strategy profiles within the Public Goods Games (PGG) across the towns. Likely, some of this heterogeneity was a result of simple random sampling error – in some towns I randomly sampled individuals that were more cooperative than in other towns – but my subsequent analysis tests if there is more than random sampling error driving the differences.

Figure 2.3 presents the difference in strategy profiles between villages. Some villages, for example Agua Zarca (North West corner) display a strategy profile broadly in line with the literature. Initial contributions are marginally lower that fifty-percent contribution and as subjects progress through the rounds contribution rates continue to decrease (Andreoni and Miller, 2002). Conversely, some villages like El Cedral (North East corner) play a strategy more cooperative than predicted in the literature, and continue to become *increasingly* cooperative. Quiscamote (South West) is more cooperative in early rounds than the literature would predict but cooperation decreases in rounds, consonant with other's findings.

It should be noted that the reported cooperation figures are the average of the ten subjects sampled to participate in the Public Goods game. Any individual participant was able only to Cooperate or Defect. For example, in Agua Zarca (North West corner) the first data point indicates that an equal number of subjects cooperated as defected in the first round – five. Likewise, in the 20th Round two subjects cooperated and eight defected. As such, there is the possibility that despite the observation of no round-to-round changes in cooperation rates, (i.e. eight people cooperate in the second round and eight cooperate in the third round) a distinct cohort of individuals may be responsible for the observed patterns.

These differences in individual and group strategies also led to variation in group outcomes. As Figure 2.4 indicates, the payouts were distributed normally across the groups with an average of about 2,500 Lempira per group. One outlier, however, was able to win more than 6,000 Lempira by cooperating.

2.7.2 Popularity and Cooperation

To estimate the relationship between popularity and individual cooperation in the PGG, I estimate a logit regression modeling the likelihood of cooperation as a function of indi-
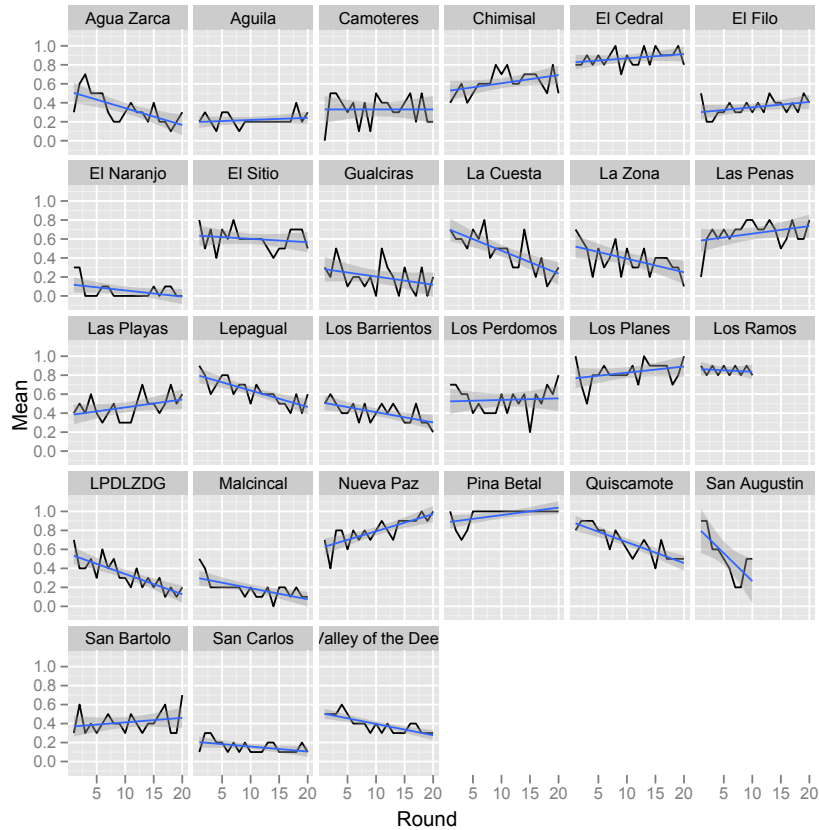
Figure 2.3: Mean Public Goods Provision, by Round. Mean contribution in a linear public goods experiment. Rounds are on the x-axis and contribution rates on the y-axis. A least-squares line (blue) is fit to the data. The formula fit is $Y_i = \beta_0 + \beta_1 * ROUND$.

vidual social and demographic covariates. In particular, to measure popularity, I use the indegree metric generated from the social network measurement; for demographic covariates, I include variables describing subjects' age, years of education, and gender. I include age, gender, and education because I expect that there may be differences in how the the old and the young, or males and females, or the high and the low educated play the public goods game.

In the first model I estimate, reported in Figure 2.5, I pool subjects' decisions in all rounds in a single model. This effectively provides twenty observations per individual; to correct for these multiple observations, I cluster the estimates of the standard errors at the individual-level. As predicted by my theory of popularity and cooperation, there is a clearly positive relationship between indegree and individuals' propensity to cooperate (OR = 1.067, 95% CI: 1.014–1.123).

An alternative specification to clustering the standard errors might separate each round

Distribution of Total Game Earnings
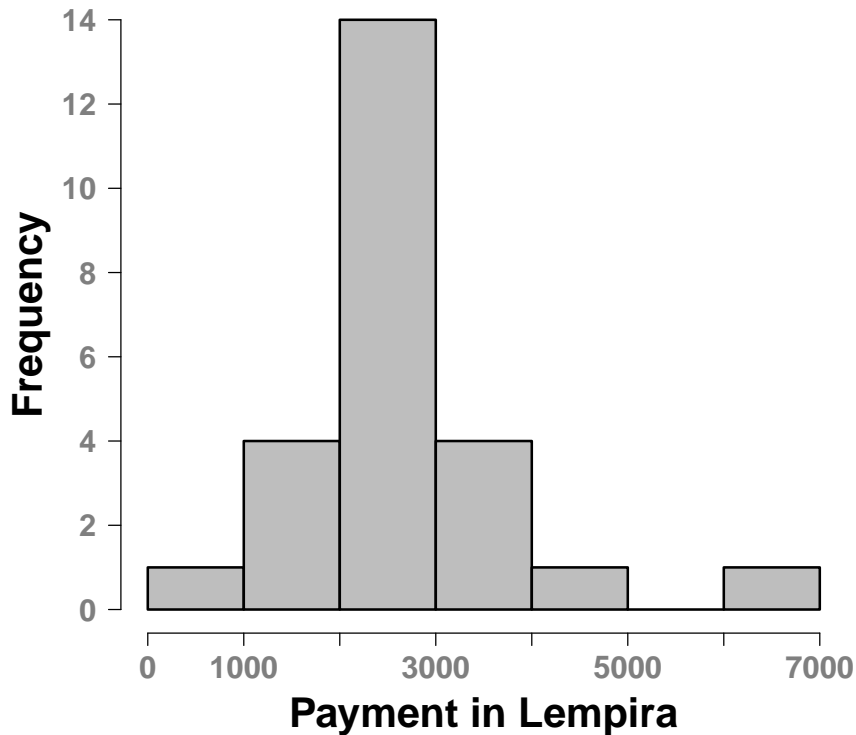
Figure 2.4: Distribution of payment in each game. This plot reports the total earned by all participants in a game, for each town.

and village using fixed effects, effectively breaking down the dependencies between re-peated observations of the individual. Table 2.2 Model (1) estimates the model with round fixed effects, and Model (2) estimates both round and town fixed effects. The results from model one are remarkably similar to the results estimated in Figure 2.5 (OR = 1.067, 95% CI: 1.046–1.088). In Model (2), the magnitude of the relationship between indegree and likelihood of cooperating is somewhat smaller as a consequence of including the Town fixed effect, but it remains strongly statistically significant (OR = 1.038, 95% CI: 1.010–1.067).

These models ignore the "time" component that is built into the game – it is possible that there are dynamics that are built into the game – people learn and or bring their real-world behavior into the game. It may not be possible to separate out these explanations for individual level variance in the context of an iterated large-n prisoners dilemma. Here I report the effects of the models when I estimate the same model on subsets of the data for each round. Rather than including the model results here, instead, I include a plot that

Table 2.1: Association between Indegree and Cooperation without round or Town Fixed Effects

	Dependent variable:
	Contribute to PG
Age	0.018**
	(0.008)
Male	0.043
	(0.218)
Years Edu	−0.037
	(0.035)
Indegree	0.065**
	(0.026)
Constant	−1.037**
	(0.434)
Note:	*p<0.1; **p<0.05; ***p<0.01

shows the point-estimate of the coefficient on indegree for each of these "round" estimates.

As discussed earlier, I expect for the initial strategy employed by each subject to be symptomatic of her default strategy and for the effect to wane over time as the player reacts to other players in the room. If friendship and sociality are related to cooperation, then indegree should be positively correlated with cooperation in the first round of the public goods game. I do not believe this result will hold across all twenty iterations however. For instance, if the player cooperates in the first round and learns that other subjects defected, in the second iteration she may defect either as a response to conditional cooperation or as a means of punishing defectors. Also, by the twentieth iteration, every player's strategy should more or less determined by how the group dynamics impacting earning in the previous 19 iterations; and thus, by the final round indegree or any other variable for that matter, should not be correlated with the likelihood of cooperation.

In Round 1, an individual with an indegree of one has an odds ratio of 1.11 (95% CI: 1.02–1.19). Using only information from the second round, there is no statistically detectable relationship between indegree and likelihood of contributing to the public good. This is consistent with the theory that individuals strongly update consistent with the porter

Table 2.2: Association Between Indegree and Cooperation, With Town and Round Fixed Effects

	Dependent variable:	
	Contribute to PG	
	(1)	(2)
Age	0.018***	0.009**
	(0.003)	(0.004)
Male	0.042	0.263***
	(0.067)	(0.085)
Years Edu	−0.038***	−0.051***
	(0.013)	(0.017)
Indegree	0.065***	0.038***
	(0.010)	(0.014)
Constant	−0.762***	−0.684**
	(0.184)	(0.274)
Round FE	*Yes*	*Yes*
Town FE	*No*	*Yes*
Observations	4,090	4,090
Log Likelihood	−2,731.268	−2,091.470
Akaike Inf. Crit.	5,510.536	4,280.941
Note:	*p<0.1; **p<0.05; ***p<0.01	

actions of others in the first round. However, again in the second through the tenth rounds, there is a positive, significant relationship between subjects' indegree and the likelihood they contributed to the public good. While this relationship moves around somewhat, it is reasonably consistent at about a ten percent increase in the odds of contributing to the public good. Altogether, these analyses tell a consistent story: while indegree is not always significant, it is always positive and more likely to be significant in the first of half of the public goods game than the latter half.

2.7.3 Group Dynamics, Popularity and Cooperation

As suggested by the literature and prior results, both group dynamics and population are important in predicting aggregate levels of cooperation. If the public goods game is sensi-

**Relationship between Indegree
and Provision**
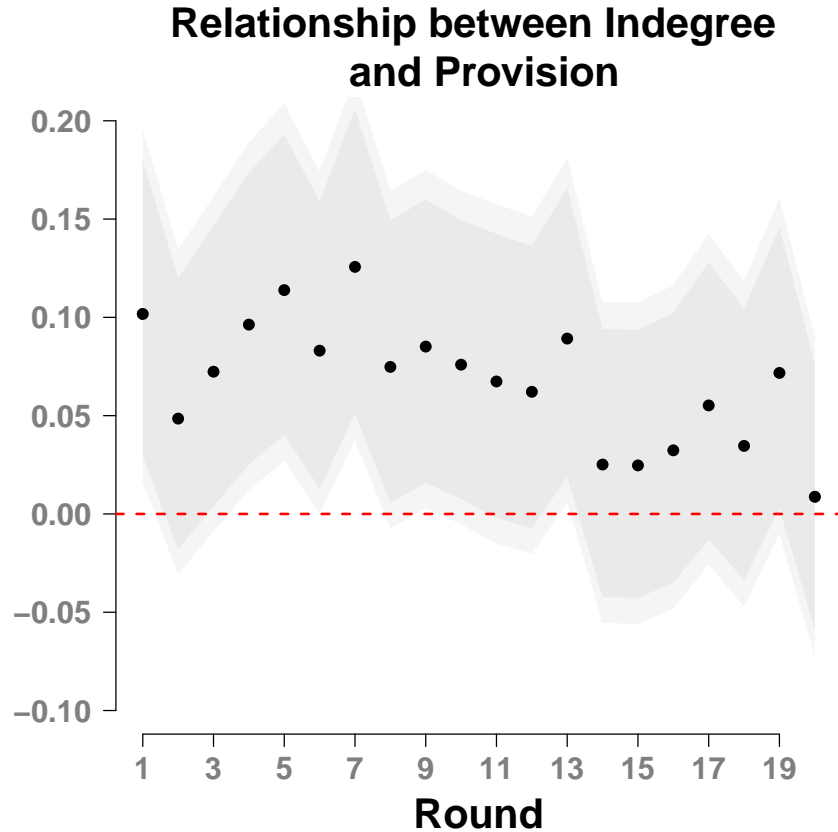
Figure 2.5: Plot of regression coefficients estimated on round-subsets of the data. Points are the point estimates of the relationship between indegree and provision from a fit logit-model. The dark-grey region represents the 90% confidence interval of the point estimate; the light-grey region represents the 95% confidence interval of the point estimate.

tive to initial conditions and more popular people are more likely to cooperate, especially in early iterations, then it should hold that the aggregate indegree or total popularity for each subject group, should be positively correlated with the total payout received by each group. Figure 2.6 illustrates this relationship.

The sample size is too small to control for town-level variables that could also explain the variation, but taken together with the previous models and analysis, this look at the aggregate levels of popularity and cooperation gives more credence to the idea that more popular people are more likely to be cooperators

2.7.4 Early Contributions Shape Later Contributions

It makes sense that subjects would begin an iterated public goods game employing different strategies then they use at the end. Entering a new strategic environment has costs like

Increasing Connectedness in Room Increases Cooperation
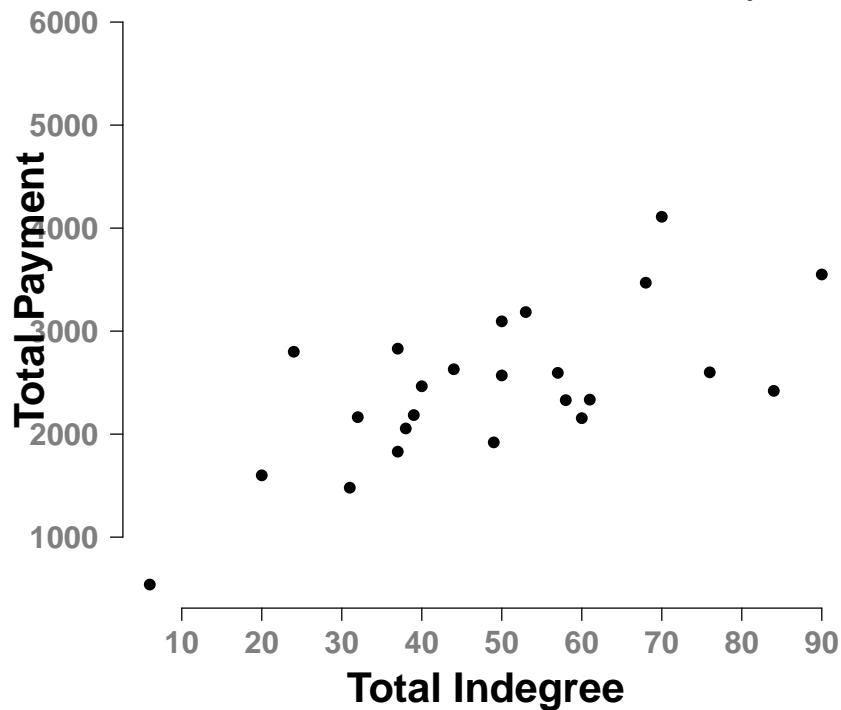
Figure 2.6: Increasing indegree participating in the game is associated with both increasing total contribution to the public good, and also increasing total payoff to the game (shown in this figure). On the x-axis is the total indegree of all individuals participating in the game; a sum of the 10 people in the room. On the y-axis is the sum of all payouts made in the game.

learning the rules, observing the behavior of other players, and the figuring out the incentives. If routinely cooperating costs the player while their peers defect, then reasonable players may change their behavior from their default. Over the rounds people may update through trial and error or through mimicking the behavior of others. The end results in public goods games are also sensitive to initial conditions; the more others cooperate or defect in the first few rounds the more likely it is that additional people will cooperate or defect respectively in subsequent rounds (Camerer, Ho and Chong, 2003). Because of this variation, subjects may change strategies over time.

Regardless of the reason, subjects play public goods games differently at the beginning than they do at the end. That subjects return to similar cooperation levels when playing games in new settings with new people, is indicative that each player has a default level
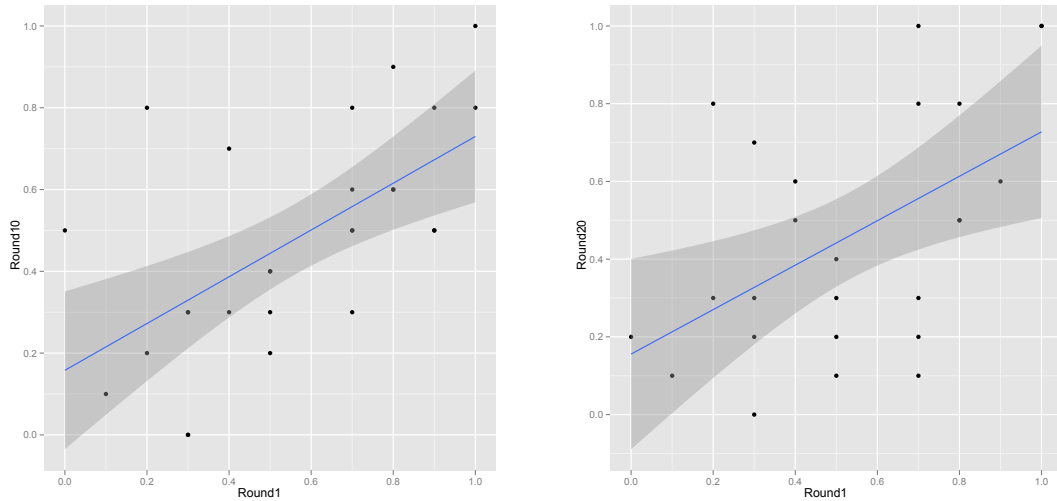
Figure 2.7: Relationship between early and later provision to the public good. On the x-axis are plotted the proportion of subjects who contributed to the public good in game round one. On the y-axis are plotted the proportion of subjects *in the same town* who contributed in round ten (left panel) and round twenty (right panel). Each point represents a single town. The blue line is the best linear fit line through this relationship.

of cooperation with which she approaches social dilemmas. Higher than expected levels of cooperation in the first iteration are strong evidence that either the default behavior for many people is cooperation (Seabright, 1993).

Accordingly, the default behavior observed in initial rounds of a blind iterated public good's game can be thought of as the general level of cooperation the subject demonstrates. As the game continues, and subjects observe behavior of the group and strategies should update. Early behavior in iterated n-player games is more indicative of a subject's customary behavior than the strategies employed by the subject at the end of the game. It follows that later rounds can be attributed to the group dynamics of that particular sample of subjects playing the n-player games.

2.8   Discussion

To my knowledge, this study is the first that uses the social networks of whole social systems to estimate the popularity of people and link that behavior to cooperation in an experimental setting. The study is unique in that measuring the number friends a person has requires an approximate of a social system's full social network and the vast majority of studies on social networks do not approach the total population response rates of the RSNS. The data from Honduras include multiple distinct social systems increasing the validity of

this study's measure of popularity. Perhaps obviously, I find evidence to support the conclusion that there is a distinct positive and significant relationship between cooperation and popularity.

As expected, across multiple models, I find a relationship between subjects' popularity and cooperation in a public goods game. First, on the individual level across various logit models, I find that indegree is correlated with cooperation, and in the most conservative model the correlations is stronger in the earlier rounds and wanes over time. I interpret these results to indicate that the a subject's default level of cooperation is strongly correlated with the number of friends she has. Conversely, in later stages of the game, subjects react to other subjects also playing the game. By pooling both the indegree and total earning for each group, I also find that in general the more popular the people are in a group, the more likely they are to earn more in a public goods game.

It may also be possible that this relationship between popularity and cooperation is particular to rural Honduras. I see no reason to assume this phenomena would be limited to Honduras but further research is needed to confirm similar relationships in other societal contexts. But those studies should also include full social networks and experiments with economics to be able to properly measure popularity and cooperation respectively.

Perhaps the key distinction between a study done in a modern American city and this one from rural Honduras would depend on how those scholars would measure friendship and popularity. Does being popular mean a person has a large number of Facebook friends or does friendship mean something more than liking someone's Instragrams? In this study, I measure friendship as a strong affective relationship and popularity as the aggregation of the relationships. I suspect that these types of relationships involve a great deal more reciprocity than online friends. As such, I would expect that if scholars could accurately measure the aggregation of those strong affective bonds in more modern contexts, popularity and cooperation would also be correlated.

These findings are significant because they should help influence the way scholars look at cooperation. In positivist models, the cooperator is the person who loses, who forsakes money by not playing as strategically. But real economic games are not played in laboratories; they are played in real social systems where there are social punishments and rewards for behavior. If friends are the reward for cooperation, then people may have learned over time that the benefits of popularity offset or outweigh the benefits of defection.

Are more popular people more likely to be cooperators? The answer seems to be "yes", a person's early cooperation is predicted by the number of friends they have, but as time passes popular people adapt their behavior and can learn to defect based on their environment. The question is now does cooperation lead to more friendships or do people with

more friendships learn to cooperate. It seems likely that these behaviors coevolve together; as people develop socially they learn to work together and the more they work together the more others want to be their friends.

CHAPTER 3

Habituated Cooperation and Voter Turnout

3.1 Abstract

That anyone turns out to vote in mass elections is a long-standing puzzle. Rational actors, knowing that their vote is but one of a very large total, should weigh the cost, and rationally abstain. Yet, people do vote, and at rates that suggest present rational choice accounts are inadequately describing voters' decision- making processes. I argue that since voting is a cooperative act it is more likely that people who cooperate in a laboratory settings will also be more likely to vote. From a unique sample of 5,000 residents of Honduras, I randomly select about 300 and use a laboratory task to estimate individuals' general levels of cooperation; I find a relationship between measured cooperation and voting behavior. This finding implicates the role of the social setting in shaping outcomes, and broadens the previous finding of altruistic voting to suggest that any activity that increases group-oriented, or cooperative behavior, not only voting, might increase voting turnout.

3.2 Introduction

For decades, political scientists have tried to understand why people vote (Campbell et al., 1960; Rosenstone and Hansen, 1993; Verba, Schlozman and Brady, 1995; Wolfinger and Rosenstone, 1980). Many scholars have approached this question through rational choice, but, these models tend to poorly predict observed levels of voter turnout. To account for this unexplained variance, the calculus of voting includes a term to account for citizen duty or goodwill. While these models stop short of calling this term altruism, recent papers have demonstrated a link between altruistic behavior in experimental economics and voting (Edlin, Gelman and Kaplan, 2005; Jankowski, 2007; Fowler, 2006). These findings suggest the possibility that any activity that increases voters' altruistic behavior might also increase

their propensity to vote. Habitual cooperation is another possible motivation that could explain the difference between actual and predicted participation (Fehr and Gachter, 2002).

This benefit to others is one possible factor in the decisions citizens make when considering to vote: although the likelihood that any individual's vote affects the outcome of an election approaches zero, the number of people who enjoy the distributed benefits of the preferred outcome in an election is large and increases with the size of the election. As such, people who care more about general group welfare should be more likely to vote but regardless of the other voters' behaviors it is in the best interest of any individual voter to stay home. This makes aggregate participation a public good.

Rational choice theories of participation in political science have difficulty predicting participation, but this is hardly a challenge that is unique to rational choice models from political science. Research in experimental economics also finds that humans consistently cooperate at much higher levels than models based solely on self-interest would predict. Subjects routinely incur costs to provide for group welfare (Henrich et al., 2004); offer overly fair divisions of private resources (LeVeck, 2013); and, free-ride too little (Andreoni, 1988, 1995). These findings, which occur across a variety experimental conditions and subject groups, suggest that models of human behavior should account for motivations or strategies that are not as narrowly defined as self-interest.

The norms governing cooperation are likely to slowly evolve over time (Ostrom, 2014) through reciprocity and social sanctioning (Henrich and Boyd, 2001). Although voter turnout may present some unique challenges for monitoring and sanctioning (Gerber, Green and Larimer, 2008), cooperative norms are reinforced socially in a variety of incentivized settings (Axelrod and Hamilton, 1981). Identifying the nuances of each incentivized setting may be a "messy" process in which agents do not consider all of the relevant strategic elements, like the presence of monitoring, in these diverse cooperative settings. Perhaps, some people learn that generally cooperation pays or that on average defection is the better strategy. If people who cooperate in some contexts would be more likely to cooperate in others, then subtle changes in game dynamics may not be recognized or require time to learn (Doz, 1996).

Scholars have adjusted the calculus of voting to account for a sense of altruism and demonstrated the link between altruistic behavior in the laboratory and voting in real elections. Altruism is one possible motive for behavior in games that seems suboptimal from a self-interested perspective, but perhaps some people cooperate because their experience has taught them that cooperation is generally a good strategy. In this paper, I expand upon previous studies that demonstrate a correlation between altruism in the laboratory and voter turnout in the real world. Here, I demonstrate that people who cooperate (when individual

payoffs incentivize them to defect) turn out to vote at significantly higher rates. While previous studies have linked voter turnout to altruism as measured in economic experiments, this study uses similar to experiments tie cooperation to voter turnout.

3.3 Voter Turnout is Collective Action

In the "calculus of voting" model (Riker and Ordeshook, 1968), potential voters consider whether or not to vote based on a simple self-interested cost benefit analysis. Riker and Ordeshook (1968) suggest this calculation follows the form:

$$p \times B + D > C \rightarrow VOTE$$

Under this model, each potential voter will turn out if the benefit of voting weighted by the probability of that person's vote affecting the outcome ($p \times B$) of voting outweighs costs (C) of casting a vote like the time and effort to go to a polling location and staying informed (Downs, 1957; Riker and Ordeshook, 1968; Gerber, Green and Larimer, 2008). Riker's model is useful for analyzing equilibrium comparative statics and aggregate trends, but the model is not trying to accurately predict any individual voter's decision.

The primary problem with this simplified model is that the costs associated with voting are almost always non-negligible. Thus, because the probably of any vote affecting the outcome is very low, any cost typically overwhelms the probabilistic benefit. In fact, as the number of people eligible to vote rises, the probabilistic benefit approaches nearly zero. For many years scholars have attempted the explain aggregate turnout rates that are much higher than the calculus of voting would suggest, but are unable to do so without introducing concepts that are not purely based on self-interest. For instance, the unmeasured valence (D) term represents the utility voters derive from the act of voting itself, which is believed to come from a sense of civic duty or a preference for the long-run function of democracy (Downs, 1957; Riker and Ordeshook, 1968). These explanations tread close to notions traditionally associated with altruism (Olson, 1971).

In the past several decades, a growing literature in economics has suggested that people are also motivated by a sense of community and the welfare of others (Cox, 2004; Fehr and Schmidt, 2010; Henrich et al., 2004). Under experimental conditions that vary the number players, games, and payouts, subjects are willing to incur costs or take additional risks to provide benefits to other individuals, sometimes in the name of community welfare or other times for the equitable distribution of resources. In theory, this apparent divergence from what appears to be self-interested behavior observed in laboratory settings is very close

conceptually to the aforementioned valence (*D*). However, the motivations are difficult to parse from one another through surveys, which is why experimental design is often necessary to distinguish between motivations for voter turnout (Fowler and Kam, 2007).

While altruism is strongly correlated with voter turnout, it may not be the only behavioral economic explanation for voter turnout rates (*D*). If voter turnout is a collective action problem subject to free riding, then perhaps people turnout to vote because overtime many people have been habituated to cooperate. It seems possible that many people do not conduct a cost/benefit analysis before voting, but instead cooperate or defect based on already held norms about cooperation. This article will link habituated norms about cooperation to explain voter turnout.

3.3.1 Differentiating Between Altruism and Cooperation

Although altruism and cooperation may seem similar, the concepts are distinct and have different measurements. Altruism means caring about the interests or welfare of other people. It is a "*concern for other in general*" (Fowler and Kam, 2007). Stated another way, an altruistic person cares about the utility of others even if that utility comes into conflict with her own. Cooperation, on the other hand, is a strategic choice to work together for mutual benefit. Therefore a person who cooperates believes it is in their self-interest to work with others. This is an important distinction because altruism is a motivation whereas cooperation is a behavior.

These differences in meaning may seem small but they lead to changes in measuring both concepts. Surveys typically operationalize altruism using questions about involvement in charity and volunteering in the community (Knack, 1992; Jankowski, 2007). While these altruism indices correlate positively with voter turnout, they do not force respondents to make a choice between the benefits for herself or benefits for others; they are not behavioral measures. Instead, because these measures rely on self-reported behavior, they are potentially subject to a bevy of problems. For example, without measurable cost, it could be that subjects are simply responding to experimenter demand, and that subjects who feel pressure more strongly to say they volunteer also are more likely to feel the social pressure to report having voted. Thus measurement eror would lead to the spurious identification of altruism as the mechanism.

Similarly to altruism, It is possible to ask people about cooperative tendencies but as a concept economic cooperation is more nebulous. Although there are many real world examples of cooperative behavior like fisheries or grazing, these examples do not generalize to the entire population in the manner that charity more or less represents altruism. How-

ever, several tasks in experimental economics have developed methods to operationalize and differentiate these motivations.

3.3.2 Measuring Economic Behavior: Cooperation

In experimental economics, subjects are placed in incentivized settings and asked to make strategic choices that not only impact their utility but also the utility of others. For example, the "dictator game" endows one player (the dictator) with a sum of money, and simply provides the opportunity to give some quantity of that money to another participant. Because the other player in the game has no influence on the outcome, a self-interested, rational dictator would just keep all of the endowment for herself. A second game, the "ultimatum game" gives the second player some agency in the outcome. In the ultimatum game, like the dictator game one player is endowed with a sum of money, and can "offer" some quantity to a second player. Unlike the dictator game however, in the ultimatum game the second player can choose to accept the split proposed by player one, in which case both players receive the offer proposed by player one, or player two can reject the offer, in which case neither player receives any payment.

In the dictator game, the rational move is for the first person to keep all of the money and offer nothing to the second person. Empirically, subjects do not behave in this fashion. Studies have consistently demonstrated that a significant and robust portion of the population will offer money to their counterparts even under the strictest conditions of anonymity (Camerer, Ho and Chong, 2003). If a person does offer any money to the second person then she is revealing a preference for altruism or does not understand the incentives at play because she is giving money to another person without any possibility of retribution at some cost to herself. Thus, scholars infer altruism is the motivation because there seems to be few other motivations that could explain the strategic decision for one subject to give money to another at some cost to herself. While the "dictator game" is better than the alternative measures, altruism is more difficult to measure than other economic concepts because it is a motivation and not a behavior. Cooperation on the other hand is a behavior and has a fewer obstacles in measurement.

3.3.3 Measuring Habitual Cooperation

Like altruism, cooperation can also be operationalized through experimental economics. A public goods game is an n-player prisoner's dilemma. Each subject is endowed with a sum of money, and afforded the opportunity to *cooperate* by investing the money into a community pot or *defect* by keeping their endowment. At the end of each round of play,

the funds that are in the community pot are increased by a multiplier, typically between 1.3x and 1.5x. The grown community pot is then distributed evenly between all players in the game, regardless of whether they contributed to the community pot or not.

If all of the players cooperate, each individual receives the initial money she contributed and the return on investment; all subjects earn more if all invest. However, if a subject defects, she will receive the same equal split of the community pot, but will not have paid into it; this strategy pays considerably more than contributing to the community pot. This incentive exists for all players, so it is always in the best of interest of the individual to defect.

Cooperation is more likely in an iterated 2-person prisoner's dilemma because it allows player's to sanction the other player by defecting. Without an external formal mechanism for sanctioning in a public goods games of 3 players or more, punishment through defection is not possible because the effect of the penalty is diffuse across all the players in the game and can not be directed at a specific person. Thus, as the number of people in the public goods game increases the likelihood of cooperation goes down and free riding increases. When a truly large population has access to a public good like a representative voting populace, there is little if any direct incentive to cooperate.

Although there several possible reasons for cooperation in this environment (Fehr and List, 2004), there is no verified manner to consistently explain why many people continue to cooperate after repeated iterations in which others defect. This study cannot differentiate between these possible explanations or motivations for above expected cooperation rates. Whether actors are cooperating because of prior socialization, conditional cooperation, or concern for reputation effects, cooperating in a blind iterated 10 player public goods game that lacks formal or informal mechanisms for sanction (Sefton, Shupp and Walker, 2007) indicates that a subject's default in a new strategic environment is cooperation. Studies that demonstrate a link between altruism and voter turnout do not specify why some people are more altruistic than others. So too, this study is not interested in why cooperators vote at higher rates than defectors, but rather that there is a link between those who habitually cooperate and their propensity to turnout. It is however unlikely that voter turnout behavior would cause cooperation. Norms about cooperation are likely to have developed long before voter behavior.

The following section discusses the cooperation as habit, which is the theory I believe best describes why some people cooperate more than others. Essentially, cooperation as habit says that early in child development some people have cooperation positively reinforced more than others. This reinforcement leads to further cooperation which leads to further reinforcement. After some time these people simply become cooperators and co-

operate across a wide variety of settings. I conceptualize voter turnout as a cooperative setting, and thus cooperators should vote at higher rates.

3.3.4 Cooperation as a Habit

Core Theory Much is made of the cost of voting, but what of the cost of calculating the cost of voting? There are costs associated with entering a new strategic environment, including learning the new rules, the incentives at stake, and about the players who are in the game. For example, when a person moves to a different country many rules change. In the new country, different formal and informal institutions govern a similar set of interactions: Do people generally walk on the left or the right side of the sidewalk? What is the appropriate tip at a restaurant? When is a contract binding? What is the cost of a speeding ticket? In nearly all interactions, the expatriate will default into behavior that was custom or habit in their former country of origin. Ascertaining the dynamics of the new strategic environment is costly, will take time and will often result in suboptimal outcomes while the player is still learning.

Recent research in experimental economics has demonstrated that for some people cooperation may be a heuristic or, as one group of scholars have termed it, a "cooperative phenotype" (Peysakhovich, Nowak and Rand, 2014). Subjects who cooperate in one experiment are significantly more likely to cooperate in other games with different rules indicating subject behavior is not solely linked to the experimental conditions. Time constraints also affect subject behavior; for instance when respondents are forced to make economic decisions in less than 10 seconds, they are also more likely to cooperate. Taken together, these results suggest that although the strategic environment matters, some people cooperate out of habit.

Studies on the calculus of voting assume that people turnout limited to strategic considerations with a direct relationship to voting(Riker and Ordeshook, 1968). This assumption leads to a better understanding of the institutional dynamics that shape that decision, but potential voters may be uncertain of how to calculate the costs/benefits of turning out.[1] Figuring out the proper decision calculus has costs and rather than accept that cost potential voters may rely on strategies that have been successful in the past with similar incentives at stake rather than incur the costs of the assessment of turning out to vote.

Although game theory tends to limit analysis to a single type of interaction with the same types of incentives, people play many games over the years. Some strategic situations may parallel others but games are unlikely to be repeated in the exact same fashion. For

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[1]Particularly attaching probabilities to the outcomes.

instance, in the division of a public good, cooperation can depend on payoffs, monitoring, sanctioning and reputation effects. If there is uncertainty over any of features of the game or players do not understand the consequences of these features, then people may revert to previous strategies.

It makes sense that when people cooperated in the past and that cooperation paid off, people would be more likely to cooperate in the future (Seabright, 1993). Through simple conditions, cooperation can become a habit or the default strategic decision when the dynamics or outcomes of a game are difficult to diagnose or calculate. If more often than not defection rewards the person, so too can defection become a habit. This study places subjects in an experimental environment with similar incentives to turning out to vote and analyzes the relationship between their decisions and their likelihood of turning out to vote.

3.3.5 Potential Casual Claim

This study does not allow casual inference because although subjects played a game from experimental economics, this game-play is a means of collecting a measure of the general levels of cooperation exhibited by subjects in social dilemmas with similar incentives. The study is not an experiment because it does not manipulate a treatment and there is no control.

However, it seems unlikely that previous turnout behavior would affect the likelihood that a person would cooperate in an iterated public goods game. If voter turnout is an act of cooperation, then it seems likely that a person's general cooperative behavior would predict her likelihood of voting.

3.4 Research Design

3.4.1 Sampling Frame

In the summer of 2010, the Rural Social Networks Study (RSNS)[2] selected 32 villages from rural Honduras for a study on social networks and economic behavior. From the 32 villages, about 10 people each were selected to play iterated public goods games. RSNS also included a small survey with some demographic variables for controls and some political behavior including voter turnout in the previous two elections.

The subjects for the public goods games were not randomly sampled. People in the center of the networks were oversampled so network centrality measures could be included in

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[2]For a full description of procedures please see the technical appendix.

Variable	Non Participants	Public Goods Game Participants
Voted	56%	70%
Age	39.1	36.0
Male	45.1%	42.3%
Years of Education	8.1	4.6
N	3840	250

Table 3.1: Covariate balance. Column 1 reports covariate means of subjects assigned to not participate. Column 2 reports covariate means of subjects assigned to participate.

other analysis of the game. Table 3.1 shows that across age, gender, and education individuals who participated in the public goods game are not measurably different. Individuals who participated in the public goods game voted at higher rates than the general population who did not partipate in the public goods game.

One of the advantages to this study is that economics experiments in laboratories often use students, remove subjects from their normal environments, and are played anonymously. These features of university laboratories lower external validity whereas the public goods games from the RSNS trie to make the experiments as natural as possible: The games are played in the villages where people reside, among people with whom they have commerce, and are representative of the sample population.

3.4.2 RSNS Public Goods Game

Nearly all games were played with ten players[3]. Subjects knew the names and social identities of other subjects in the game, but at no point knew the specific strategies of the other subjects. Subjects were informed of the incentives in the game, and comprehension was tested using a 5-question quiz. If subjects did not answer four of the five questions correctly, the subject was paid a show-up fee, and substituted for a new player. At the beginning of each round, subjects were endowed with 10 Lempira.[4] In each round, subjects chose one of two options: invest[5] (cooperate) or keep the money (defect). Subjects were not allowed to invest/keep portions of the money; it was all or nothing. At the end of each round, the experimenter added 50 percent to the pooled money and distribute that money back to everyone in the classroom equally, including the defectors.

Each experimental session ran for twenty rounds. Subjects were informed that the

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[3]On 4 occasions one too many people were selected due to confusion from sampling.

[4]10 Lempira is roughly equivalent to US$0.50. We scaled payoff so that the mean subject would earn 200 lempira, a very fair daily wage for residents of the region.

[5]We used words like invest to help explain how a public goods game works. Although "invest" may have normative implications, so does "cooperation" and the levels of cooperation are similar to those found in other experimental goods games in rural developing nations.

session might take as long as 2 hours, but were not informed of the total number of rounds that would be run, nor were they cued about which particular round they were playing. In this way, subjects could not backward induct from the final round, nor could they anchor behavior on key (base-10 or base-5) round numbers. The players were also not allowed to communicate nor see the strategies of other players in the room. In sum, the game was a blind, large-n public goods game without sanctioning or reputation effects with a high rate of return. Individually-rational choice theory predicts that under these conditions cooperation should be scarce.

3.4.3 Results

Consistent with previous empirical results, subjects in these games cooperate at relatively high levels. As Figure 3.1 shows, across all towns, the mean provision was nearly 40%. Notably, however, there is considerable variation in levels of provision across towns. Pina Betal, the most cooperative town, contributed fully 90% of the endowment across all the rounds of play. In fact, four towns – Pina Betal, El Cedral, Los Planes, and Nueva Paz – contributed more than 80% of the endowment to the public good across all rounds. In contrast, four towns contributed amounts lower than 20% of the endowment. No easily identifiable town properties distinguish these two groups of outcomes. Malcincal and Gualciras are both large towns that did were low-cooperators, but Pina Betal and Nueva Paz were high-cooperators and these two towns actually have a slightly larger population.

Table 3.2 and Table 3.3 shows the main regression results. Each table looks at the correlation between cooperation in a public goods game and the self-reported likelihood that the subject turned out to vote. Self-reported voter turnout is not the ideal measure of turnout (Granberg and Holmberg, 1991), but in Honduras, I could not find a manner of independently confirming these self-reports.

The dependent variable in each logit regression is voter turnout and I use cooperation in the pubic goods game to predict turnout, but Table 3.2 and Table 3.3 differ in their measurement of cooperation. In Table 3.2, cooperation is the subjects' initial round of cooperation, whereas Table 3.3 includes the average cooperation level. For clarity in model building, I include four models in each table. Model 1 is the null model with only an intercept and term fit. Model 2 is fits the bivariate model including the key theoretical variable, *Contribution to the Public Good* in the experimental task. This effect is positive and strongly significant—individuals who contributed to the public good in the experimental task voted at roughly 1.75 the rate as those who did not contribute to the public good game. Model 3 includes additional covariates with contribution in the PG game. In this model, the effect
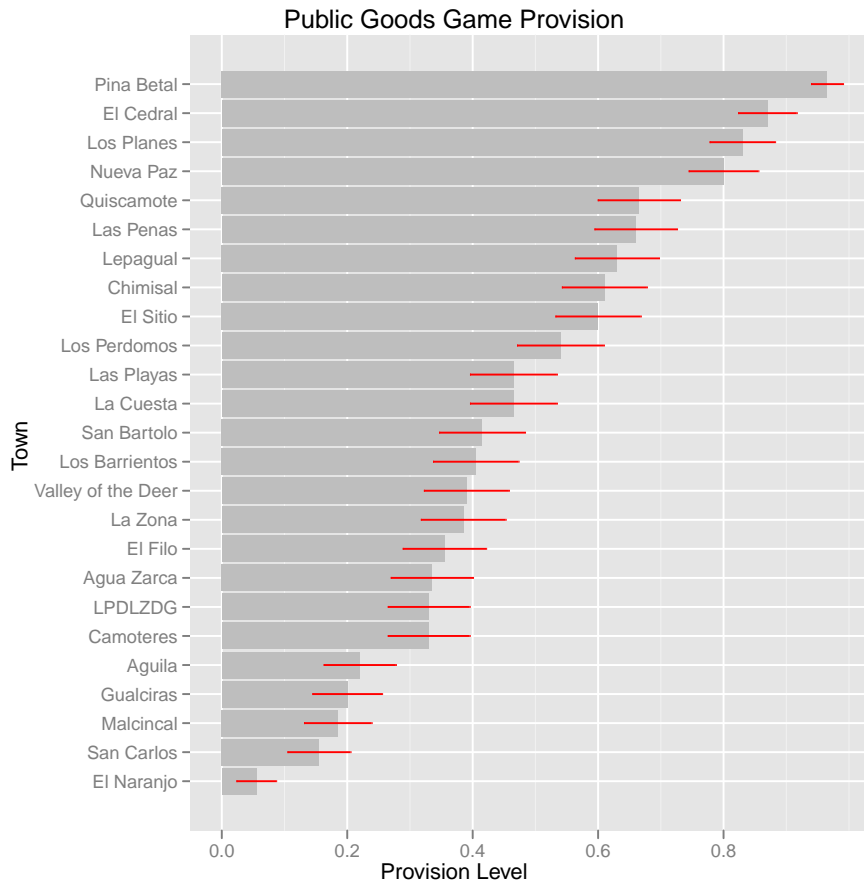
Figure 3.1: Average town cooperation in the public goods games. Reported cooperation levels are across all round, by all players. Error bars are 90% CI for the mean provision by round.

of contribution to the public good remains positive and significant, and of a very similar magnitude. Finally, Model 4 additionally includes fixed effects for the town that each individual lives in. Based on the AIC model fit criteria, including these additional town-level factor variables does not improve the model fit. In addition, once a model includes town level fixed effects, the relationship between contribution to the public good and voting is not significant, although the magnitude of the point estimate is unchanged. This is most likely a result of the test being underpowered to include the town fixed effects terms.

Another way to examine this question is to include more individual-level data in the estimate of this relationship between contribution to the public good and the voting. In Table 3.3 I estimate similar models as in Table 3.2, but rather than using only subjects' first-round contribution, I instead use the average of subjects' contribution in all 20 rounds. In this model, the explanatory variable ranges from subjects' who never contributed to the public good to subjects' who always contributed to the public good. The median contri-

Table 3.2: Logit Regression, Probability of Voting as a function of Contribution to Public Good, First Round Data Only

	Dependent variable:			
	Vote			
	(1)	(2)	(3)	(4)
Contribute to PG		0.561**	0.623*	0.677
		(0.271)	(0.320)	(0.457)
Age			0.132**	0.205**
			(0.067)	(0.096)
Age Squared			−0.001	−0.002
			(0.001)	(0.001)
Years Education			0.676**	0.807**
			(0.339)	(0.410)
Intercept			−0.093	−0.136*
			(0.060)	(0.079)
Constant	0.886***	0.630***	−2.031	−2.880
	(0.133)	(0.177)	(1.249)	(1.859)
Town FE	No	No	No	Yes
Observations	274	274	212	212
Log Likelihood	−165.470	−163.290	−119.670	−99.113
Akaike Inf. Crit.	332.940	330.570	251.350	260.230
Note:				*p<0.1; **p<0.05; ***p<0.01

bution by an individual is contributing in approximately 40% of rounds, while the mean contribution is about approximately 45% of rounds, the standard deviation is 0.37. Table 3.3 finds a consistently positive and significant relationship between mean contribution to the public good and probability that an individual voted the previous election. Indeed, this model predicts that an individual who always contributes to the public good will vote with probability 0.88 while an individual who never contributes to the public good will vote with probability 0.54.

Table 3.3: Logit Regression, Probability of Voting as a function of average of All Rounds Contribution

		Dependent variable:		
		Vote		
	(1)	(2)	(3)	(4)
Mean Contribute in PG		1.829***	1.362***	1.753**
		(0.407)	(0.463)	(0.808)
Age			0.107	0.179*
			(0.069)	(0.099)
Age Squared			−0.001	−0.002
			(0.001)	(0.001)
Male			0.695**	0.796*
			(0.344)	(0.418)
Years Education			−0.089	−0.124
			(0.062)	(0.080)
Intercept	0.886***	0.173	−1.739	−2.840
	(0.133)	(0.194)	(1.263)	(1.874)
Town FE	No	No	No	Yes
Observations	274	274	212	212
Log Likelihood	−165.470	−153.970	−117.000	−97.632
Akaike Inf. Crit.	332.940	311.940	246.000	257.260

Note: $^{*}p<0.1$; $^{**}p<0.05$; $^{***}p<0.01$

3.5   Conclusion

In this study, I used more than 300 people's strategies from public goods games to demonstrate a strong and robust correlation between cooperation and voting and conversely for defection and not turning out using relatively conservative analysis. The results are from a census of 32 rural communities in Honduras. It is possible but unlikely that the link between cooperation and turning out to vote in Honduras is unique to Honduras and as such further research to replicate these findings should be done in other countries. Although limiting the study to Honduras may have limited external validity, experimenting in more natural settings increases the study's internal validity. These subjects were learning to cooperate

with the same friends, neighbors, and family members with whom they decide whether or not to vote.

While previous studies have linked altruism to voter turnout, this study correlates cooperative behavior to voter turnout as well. Further research is necessary to introduce altruism and cooperation into the same model to tease out the effects of these economic behaviors on voter turnout. But altruism and cooperation are not at odds. As already mentioned, altruism is a motivation whereas cooperation is a behavior. These concepts do not tell different stories but instead both concepts illuminate voter turnout from different perspectives. Although this study does not control for altruism, it does suggest that cooperation is strongly correlated with voter turnout. More research is needed to differentiate between the effects of cooperation and altruism on voting.

Altruism can be conceived of as opposition to self interest[6]; people factor the utility of others into their own decisions. Whereas cooperation can align with self-interested behavior. Cooperation is working together with other actors for mutual benefit and in many strategic settings group and individual interests do not diverge. For instance, in repeated prisoner's dilemmas with an unspecified number of iterations that permit partner selection based on prior behavior, cooperation is a more "self interested" strategy than defection. Accordingly, this study raises interesting questions about how cooperation in some areas may lead to greater cooperation across a variety of strategic settings. This would indicate that increasing levels of cooperation may foment greater contributions to the public good than across many different domains.

Moreover, this study raises questions about how people react to new decision environments in general. Many subjects decided to cooperate in blind repeated large-n player public goods games for more than 20 iterations, games in which theoretically everyone should learn to defect. Not coincidentally, these are the same subjects that turnout to vote. Perhaps some people are just cooperators and continue to cooperate across many strategic settings even when changing small dynamics should affect the outcome. People may use cognitive shortcuts in decision environments and starting to view cooperation as a habit or a heuristic should change the way economic behavior is viewed. As already mentioned, there is a cost to calculating the cost of voting. People will try to minimize that cost.

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[6]Psychic benefits achieved from giving to others can be perceived as a part of self interest but broadening the definition of self interest to include altruistic tendencies risks broadening the definition of self interest to an extent that that the term loses meaning.

CHAPTER 4

Social Networks and Political Mobilization

4.1 Abstract

Presumably,[1] social networks matter because people are not simply isolates, and their be-
haviors result, at least in part, from interactions with other people. In other words, social
networks are important because people influence each other through relationships. Ag-
gregating these dyads into networks provides a structural framework for the analysis of
the informal relationships that underpin interpersonal influence; and yet, little is known
in natural settings for how structural position relates to interpersonal influence. Rational
accounts of voter turnout and civic participation are largely driven not by costs or bene-
fits, but by unmeasured valences, and typically perform poorly when predicting outcomes.
This paper explores the relationship between mobilization and structural position in social
networks. The Rural Social Networks Study gathered relational data from 32 geographi-
cally isolated towns comprised of nearly 5,000 respondents. Through a random assignment
field experiment, this paper explores the dual role social influence has in information dif-
fusion, political mobilization, and participation. The results show that information diffuses
through social-network pathways, and that variations in mobilization can be attributed to
social-network variables.

4.2 Mobilization and Elections

Why do some citizens choose to participate in political and civic activities and others do
not? In 2008, the American electorate selected Barack Obama as president and a plethora
of democratic candidates to majorities in both the House and Senate. Two years later, the
national electorate selected a cadre of Tea Party republicans. In a short period of time, the

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[1]An early version of this chapter was prepared jointly with Alex Hughes and presented at the Midwest
Political Science Association meeting. This chapter has been significantly revised since that presentation.

revealed preferences of the electorate shifted from liberal democrats to fiscally conservative candidates (Poole and Rosenthal, 2011). A shift in partisan identification is unlikely to account for the differences in those revealed preference because of its noted resilience (see esp. Jennings and Markus (1984); Berelson, Lazarsfeld and McPhee (1954); Campbell et al. (1960); Green, Palmquist and Schickler (2004)). Then the electorate's significant shift from 2008 to 2010 is likely driven by a change in the composition of *who* participated (Huckfeldt and Sprague, 1992; Rosenstone and Hansen, 1993; Stevens, 2006; Fowler, Baker and Dawes, 2008).

A growing body of research demonstrates that social networks are influential in shaping individuals' behavior. Notably, Fowler and Christakis have linked obesity, smoking, and cooperation to social networks (Christakis and Fowler, 2007, 2008; Fowler and Christakis, 2010). Earlier work has shown that medical innovation adoption (Marsden and Podolny, 1990), contraceptive choices (Valente et al., 1997), and adolescent smoking (Bearman, Jones and Udry, 2000; Alexander et al., 2001) can all be correlated with the behavior of peers. Social influence is also an important determinant in the decision to participate in politics. This is a non-controversial claim, but to date little empirical has studied the phenomenon (see e.g. Gerber, Green and Larimer (2008)). This paper demonstrates two distinct, but related, ways that social networks shape political participation: First, political information spreads through interpersonal relationships, and more importantly some agents in social networks are more influential than others because of their structural position within the network. Taken together, this research aims to fill a lacuna in the political mobilization literature noted by Brady, Verba and Schlozman: "*There are three reasons that individuals fail to participate in politics; they are unable to, they are uninterested, or nobody asked*, (Verba, Schlozman and Brady, 1995)." This paper answers the question; are some people better at asking than others.

4.2.1 Defining Participation and Mobilization

Participation and mobilization are distinct concepts. While participation is a stable, long-term, equilibrium outcome that has typically been explained using equally long-term independent variables (Rosenstone and Hansen, 1993). Accordingly, many scholars explain variance in political participation with characteristic variables like race, level of education, feelings of personal efficacy, and years in residing in community which are unlikely to shift over small periods of time and as such are fixed in the short-run (Rosenstone and Hansen, 1993). Brady, Verba and Schlozman (1995) expand the range of explanatory variables, but maintain a focus on long-term variables of civic skills and resources. For instance, an in-

dividual may accrue resources over time, and those may precipitously increase or decrease from exogenous shocks, but typically there is little movement in these *characteristics* between any two consecutive elections.

Conversely, mobilization is an attempt to push an individual's action off of the equilibrium determined by the aforementioned fixed participation variables; mobilization is an external push off an equilibrium. The "calculus of voting" model Riker and Ordeshook (1968) suggests that voters undertake a simple cost benefit analysis: if the probability weighted benefit (pB) of voting outweighs the structural and cognitive costs (C) of casting a vote, the voter turns out and casts a ballot (Downs, 1957; Riker and Ordeshook, 1968; Gerber, Green and Larimer, 2008). Although Riker's model is useful for analyzing equilibrium comparative statics, the model is not trying to accurately predict any particular voter's decision. Downs (1957) and then Riker and Ordeshook (1968) attach an unmeasured valence (D). The term functions identically even though the scholars have different title for the valence: Downs (1957) believes this term is a voters' preference for the long-run function of democracy, while Riker and Ordeshook (1968). The calculus of voting is represented as

$$pB + D > C \rightarrow VOTE;$$

and attempts to mobilize are an attempt to alter one of the short-term parameters of the calculus.

Mobilization is distinct from exogenous shocks to participation variables in that mobilization requires strategic action taken by an external third party. For example, if an actor wins the lottery, she may be more likely to participate because of the increase in resources that stem from the lottery. In this case winning the lottery would of course be an exogenous shock. If however there is a change in electoral registration laws which cause short-term changes in the participation of voters, then the legal changes could be exogenous socks but it would depend on whether the officials who changed the laws did so with the intent to influence participation rates. For mobilization to occur, the citizen must be intentionally moved off their equilibrium behavior and as such, after a mobilization effort ceases, the likelihood an individual participates should return to the pre-mobilization likelihood unless having participated increases one's likelihood of further participation. In which case, a new equilibrium would be established. Finally, mobilizers are often opinion leaders who increase the salience of a political issue with the intent to alter the likelihood of participating for a particular group (Bartels, 2006, 2008)[2].

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[2]See Also: Brooks and Manza 1997; Manza and Brooks 1999; Leege et al. 2002; Frank 2004; Shor, Bafumi, Park, and Cortina 2008.

4.2.2 Explanations for Participation

In the canonical argument for the effects of social economic status on participation, Rosenstone and Hansen find that income, education, unemployment, internal and external political efficacy, P=party Identification, church attendance, and mass-elite strategic mobilization form a model that correctly predicts the decision to turn-out to to vote in 75% of cases (Rosenstone and Hansen, 1993, p. 275). Brady, Verba and Schlozman (1995) updates Rosenstone and Hanson's argument to include a broader conception of SES, and concludes that people do not participate for three reasons: they are not able to, do not want to, or are not asked.

4.2.3 Explanations for Mobilization

Gerber, Green and Larimer (2008) and Gerber and Green (2000) investigate two central unexplored questions from Brady, Verba and Schlozman (1995); *if* voters are asked, does it matter *who* asks them and *how* they are asked? Although these are very broad questions, the authors contend that yes it matters who asks and how citizens are asked because different attempts to influence will activate different social norms. First, they find that the choice of media used to mobilize matters. Calls from a phone bank, mass mailings and house-calls by campaign activists do hot have the same effect on participation (Gerber and Green, 2000). Second, the authors find social pressure applied from a neighbor has a stronger effect in changing the likelihood of an experimental subject than social pressure applied from an unknown researcher and even state "Exposing a person's voting record to his or her neighbors turns out to be an order of magnitude more effective than conventional pieces of partisan or nonpartisan direct mail," (Gerber, Green and Larimer, 2008, pp. 34). Mobilization is just one type of social influence however. The following section will explain social influence and its relationship to political participation in a more general way.

4.3 Social Influence

For Gerber, Green and Larimer (2008), when a neighbor is *asking*, it increases the pressure for conforming to social norms. When a stranger asks the subject to participate, the same social norms are present, but the pressure is nonexistent. What differentiates the neighbor from the stranger is that the neighbor has a shorter social distance to the subject. In the future, the subject will interact with the neighbor again, and that neighbor may communicate with other neighbors about the subject's willingness or refusal to conform. Whereas the subject will never see the stranger again. Therefore, the neighbor has a greater potential to

increase the cost of defecting on and the rewards of conforming to social norms. If this social cost-benefit analysis is part of the decision to participate, then the next logical question is which neighbors are capable of exerting more social influence than others?

Social influence begins with the premise that people all people are seated in a social environment. This environment structures group pressures and the socialization of party identification (Berelson, Lazarsfeld and McPhee, 1954; Campbell et al., 1960). However, distinct from characteristics, without activation social influence does not necessarily hold a direct influence on behavior (Dasgupta and Serageldin, 2001; Lin, 2001; Smith, 2005). Similarly to mobilization, social influence requires intentional activation to alter behavior. However, unlike mobilization efforts, the effect of social influence need not attenuate through repeated use. Indeed, social influence may manifest positive feedback loops that build toward increased effectiveness through repeated use (Milgram, 1974).

Acemoglu and Jackson (2011) develop a formal model that captures the influence of history to shape behavior in social settings and creates leaders and followers. History and past patterns of play determine how information is received – agents who attain a *prominent* status send signals that are received without error, while all other agents send noisy signals – because members of the society know the prominent actors send pure signals, these leaders actions determine equilibrium outcomes. Hermalin (2012) further develops a model of leadership whereby a the leadership of a leader strengthens role normative behavior. Taken together, these two models suggest that early development of structure can lead to the further strengthening of that structure. The mechanism by which a person's social influence builds upon itself would follow a similar logic.

Moreover, the results from Gerber, Green and Larimer (2008) results probably underestimate the magnitude of social influence. The use of neighbor-ness is an intuitive proxy for social influence precisely because it differentiates the set of people with whom a person has iterated contact from the set of people with whom a person will never see again. While insightful, neighbor-ness captures a minute portion of the complex relationships that are embedded in the larger social environment. "The social in social cognition research is largely missing" (Kuklinski, Luskin and Bolland, 1991). The perceiver in this literature is a "passive onlooker, who...doesn't *do* anything – doesn't mix it up with the folks he's watching, never tests his judgment in action or inaction. He just watches and judges," (Neisser, 1980, pp. 603-604, emphasis in original). But, we are social beings, and theories of social cognition must, eventually take account of that fact (Krauss, 1981). Accordingly, this study intervenes within empirical communities and the experimental design allows precise operationalization and measurement of influence, and also allows for causal effects to be estimated. Although this study does not capture all of the complex relationships within the

social environment, it should represent a significant step forward.

4.4 Hypotheses

This study tests three hypotheses:

Hypothesis 1 *Being asked to participate is critical to action in politics. Subjects who are informed directly about future political activities by an outside organizer should be more likely to participate in political activities than subjects who are not directly informed of the meeting by the event organizer.*

Hypothesis 2 *Information is transmitted through social networks. Subjects who are nearer in a social network to a mobilizer will be more likely to attend a political meeting than people who are farther within the social network.*

Hypothesis 3 *Positions of greater social influence in a social network mediate the ability of an individual to mobilize others. Or stated a bit differently, mobilizers with greater centrality will be able to mobilize a greater number of people.*

4.5 Research Design

In this study there are two different roles: the *mobilizer* and the *citizen*. The *mobilizer's* role is active. Whereas *citizen's* role is implicitly passive. The *mobilizer* is informed that the group of researchers would like to hold a meeting with the town, but does not have the time to tell everyone in the town to come to the meeting. If the *mobilizer* will get as many people as she can to attend the meaning, the researchers will pay her a sum of money based on the number of people she mobilizes. This incentive was provided to stimulate the intent necessary to meet the definition of mobilization. The *citizen* has the passive role and will decide to attend the meeting or not. After arriving at the meeting, the subjects receive a second survey, in which they are asked who is responsible for bringing them to the meeting. This field experiment closely mimics the dynamics of electoral politics; for whatever reason certain individuals are active members in mobilization efforts in electoral politics, while the remainder of the passive population reacts to the mobilization efforts of the mobilizers. The meeting could not be explicitly political as we did not want to associate with the government or a political party, but *mobilizers* were told the meeting would be about microfinance, a common-pool resource, and would include elections [3].

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[3]Please see the technical appendix for a complete description of these procedures as well as a literature review tying microfinance to common-pool resources.

4.5.1 Setting

The field experiment was conduced in the La Unión municipality of the Lempira Department Honduras in the summer of 2009.[4] La Unión is located in north-west Honduras in a relatively remote coffee growing region.[5] This experiment was undertaken as a part of the larger Honduran Rural Social Network Project, a joint project between D. Alex Hughes [6] and I. The Rural Social Network Project selected La Unión as a field research site because network analysis data presents special conceptual and functional data-gathering challenges (esp. boundary-specification), and the Lempira region minimized these challenges.The core of the research was undertaken in the 32 communities that surround the municipal seat.

4.5.2 Study Population

Honduras is a relatively poor nation by comparative Latin American standards, and La Unión is comparatively poor within Honduras. Greater than 60% of the residents of La Unión are in the lowest quintile of Honduran Income distribution; residents of La Unión have less access to potable water, more residents without access to latrines, lower television penetration, and fewer residents who continue to secondary education. Given the comparatively low level of development in the region one might well ask, "How could a study undertaken with a population so unlike the United States population possibly generalize to the American context?" The core dynamics of American political mobilization are robust and active in the Honduran setting. Social groups are well defined – there are *fùbal*, sewing, agriculture and social clubs in every town; there is a diversity of religious beliefs; there is a robust, competitive party system; and, there is a widely varied distribution of incomes, both between and within the individual villages that surround La Unión. Although levels of education are significantly and income are drastically below US levels, the form of the distribution of these attributes is not-dissimilar to the US case.

The sample for the study was drawn from a census-penetration sampling frame in the 32 villages that surround La Unión. These villages range in population size from as few as 20 to as large as 650.[7] The process for generating this population list is described in the

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[4]Incidentally, the same summer as the Honduran coup.

[5]The trip to San Pedro Sula, Honduras, the nearest international airport, is 6 hours on dirt roads and 2 hours on paved roads by truck.

[6]Hughes is a University of California at San Diego PhD student

[7]*Los Perdomos* – "The Perdomos" – is a town that is derived from a single family extended family. This is not unusual, most villages began as a family and as the generations pass and an original family gains wealth people emigrate through marriage or employment. In contrast, San Bartolo is a village that houses a large coffee production center and is home to more than 500 residents.

Table 4.1: Lempira Summary Statistics

		Lempira	Honduras
Quintile of National Income Dist	Lowest	63.9	20.0
	Second Lowest	25.1	20.0
Water Source	In Home	8.4	15.1
	Outside of Home	56.4	32.4
	Ditch/Canal	22.2	10.2
Sanitation Service	Latrine with Water	38.7	19.2
	No Service	46.3	16.0
Consumer Durables	TV	15.1	62.2
	Telephone (landline)	3.4	23.5
	Telephone (moblie)	9.3	36.1
	Refrigerator	8.3	44.0
Household Structure	Female Head	19.6	26.0
	Number of Members	5.5	4.8
Schooling			
Less Than Primary	Female	78.4	54.3
	Male	79.1	58.5
Primary	Female	85.6	84.6
	Male	86.2	84.7
Secondary	Female	17.4	42.0
	Male	15.3	34.5

appendix. Across the 32 villages, the study averaged 87% population response rates.

4.5.3   Experimental Design

Generating reliable inference in social networks is challenging. "Given the number of confounding factors and some of the data requirements, it may be prohibitively difficult to substantiate the role of social networks...through survey methods alone" (Valente, 2005). Gathering whole-networks data is difficult, and most empirical research is either egocentric (see e.g. Marsden (1990)) or is repurposed sociocentric (see e.g. Fowler and Christakis (2010)).[8] Additionally, variance estimates for observational data within networks are typically downwardly biased because observations are frequently correlated across the network space and therefore violate *i.i.d.* assumptions critical to formulating standard error estimates (Valente et al., 1997). To get around these limitations of social network data, scholars are increasingly advocating the use of deliberate intervention on whole networks

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[8]Egocentric, or individually centered, networks are networks generated by the first order report of ties. As the number network actors – nodes – increases toward full coverage of the network, the egocentric network comes to approximate the full network. In contrast, sociocentric networks are whole-network based studies.

(Valente, 2005).

Since the hypotheses for this study are rooted in theories of social influence which depend on the placement within the larger social environment, the experimental design and data collection efforts take up the mantle of this challenge. To generate reliable estimates of the impact of social influence, this project employs a stratified-random assignment experimental design. Assignment was into one of two groups, *mobilizers* or *attendees*. Since the groups are mutually exclusive, and together exhaust the possible assignments, random assignment of the population into one of the groups (i.e. *mobilizers*) is effectively random assignment of the remainder of the population into the non-treatment group.

Assignment   Social systems organize themselves such that there are a large number of non-influential actors, and a very small number of influential actors (Williamson, 1975; Sidanius and Pratto, 2001). This study seeks out these influential actors, and is stratified by influence to over-assign influential actors to be mobilizers in order to improve power in subsequent analysis. To oversample these influential actors we relied on an inductively derived heuristic – geographic distance homes from the center of town. We arrived at this rough heuristic after preliminary conversations with residents and pre-testing. In each town, we assigned approximately 40 percent of the mobilizers from the 20 percent most centrally located homes.

Assignment as a mobilizer was determined as follows. The town was partitioned into two geographically determined sampling blocks, a center-town block and the rest of the town, or the out-skirts. As a part of the census-taking procedure, both the homes in the village and the residents of each home were numbered with unique identifiers. Once sampling blocks were determined, these unique identifiers were sampled and an ordered list of individuals to be assigned as a mobilizers was determined. We included on each list several extra names, in the event that one of the respondents was unable to be reached at the time of mobilization, although we took care to undertake this assignment process after the men and women had returned home from work for the day to mitigate the threat of systematic reasons for non-assigment. The initial recruitment of the mobilizer was typically successful, and there was no measurable systematic failure in the assignment procedure.

Because this experiment is set in a social setting, and measures the impact of social impact, the treatment groups take a unique form that is determined by the structure of the community. Through the stratified random-assignment technique, the assignment of the treatment is controlled, and the impact is measured after a "resonance" period during which the treatment passes through the system. Treatment (X) is an information and incentive perturbation to the randomly assigned mobilizers and the treatment effect (O) is proportion

of individuals who actually participate. However, as this treatment propagates through the network, individuals who are not mobilizers are effectively given a separate treatment: information plus social influence.

To make this more clear, it may be useful to imagine the subject pool as a small pond of water with toy sailboats floating on the surface, and the information and incentive perturbation as a child lobbing rocks into the pond. The point on the pond where rocks splash are the direct treatments or mobilizers, and the ripples across the pond are the indirect treatments. $X_{k,0}$ is the point where the kth rock splashes, and $X_{k,1}$, $X_{k,2}$ ... $X_{k,n}$ are the points on the pond 1,2 ... n units of distance from where the kth rock splashed. The treatment effects in this example are just the vertical displacement of each toy sailboat from each set of ripples.

4.5.4 Treatment

We informed five individuals in each town that we were to hold a town meeting two-days subsequent to the current date. We further instructed these individuals that they had been randomly selected to participate in an experiment and had been entered into a lottery with a chance to earn one day's wage. We informed these individuals that for each person who attended the meeting in two days, *and identified the experimental subject as the person who had informed them of the meeting*, they would have an additional ticket placed into the lottery.

Because we provided this information perturbation to five individuals in each village, there is a unique treatment structure because it is possible, and indeed very likely, an individual who did not receive the information bit, is a member of two overlapping treatment groups. To illustrate this point, refer to Figure 4.1. In this figure, each circle or triangle represents an actor in the town, and each line between circle or triangle a social relationship between the actors. Through the assignment procedure, the red circle and the black triangle are selected as mobilizers. Then, the red triangle is in a treatment group one degree-separated from both the red circle and the black triangle, and three degrees separated from the blue square.

Balance   The summary table (Table 4.2) suggests that while the individuals selected as mobilizers are largely indistinguishable from the larger population, there are some traits on which there are measurable systematic differences. Mobilizers were slightly older (3 years), somewhat more likely to be married, slightly better educated (1 year), slightly more likely to identify as liberal and were more likely to have voted in the most recent elec-

Figure 4.1: Visual Representation of Mobilization Assignment

Mobilization Example
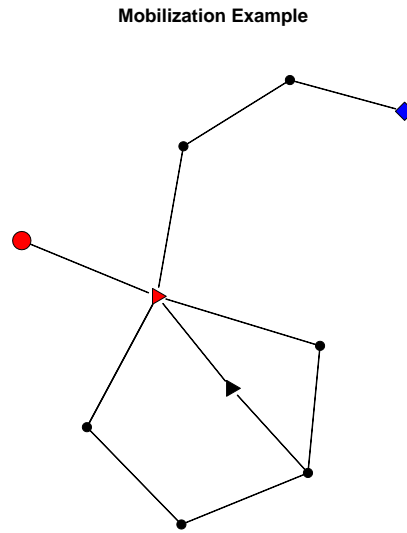
Example of two mobilizers and a passive attendee who is equidistant from each mobilizer. In this example each node represents an individual, while each edge represents a hypothetical social tie between individuals. The large red circle, large black triangle, and large blue square are each mobilizers, $X_{1,0}, X_{2,0}, and X_{3,0}$, respectively. Then, the red triangle receives treatment of $X_{1,1}, X_{2,1}, and X_{3,3}$ because it is one degree removed from the red circle and black triangle, and three degrees separated from the blue square.

tion and the election that preceded it – although none of these differences were statistically significant. These differences are to be expected because several aspects of our sampling strategy were designed to over-assign individuals from the center of villages to be mobilizers. Individuals who live near the center of the town are more likely to be educated, wealthy, participate, and so on; they are also more likely to be influential members of the community, precisely the reason for oversampling from this subpopulation.[9] However, these differences fade at even one-degree separated from a randomly assigned mobilizer.

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[9]Our principal concern in this oversampling was the nature of the distribution of influential individuals. Because social networks are scale-free (Barabási and Albert, 1999) with a large number of low-connection individual, and a very small number of very-highly connected individuals. The study sampled in this manner to ensure that in the random assignment procedure at *a minimum* number of these highly connected individuals.

4.6 Results

4.6.1 Information Diffusion

As expected, the individuals assigned to be mobilizers attended the meeting at significantly higher rates. The two-sample difference of proportions t-test demonstrates this point. The proportion of individuals assigned to be in a treatment group of degree separation 0, who are individuals we directly assigned as mobilizers attended the meeting at a rate of 70%. Individuals that were implicitly assigned to the citizens treatment group attended the meeting at a rate of 32%. A two-sample t-test soundly rejects null hypothesis that the mobilizers and attendees attended the meeting at the same rate, t = 7.84. Not surprisingly, people directly informed about the meeting and incentivized to come, attended at a higher rate. This result is consonant with Hypothesis 1.

If information flows through the social channels measured in this experiment, one would expect that among subjects who were not directly informed about the meeting, the nearer to a mobilizer a subject, the more likely the subject is to attend the meeting, with all else being equal. This expectation holds and is shown in Table 4.4 and equivalently in Figure 4.2. Mobilizers participated at significantly higher rates than non-mobilizers (Table 4.3, and replicated in Table 4.2). Figure 4.2 expands on these results, and shows strong evidence that information is transmitted through the social networks. All else probabilistically equal, mobilizers were significantly more likely to participate than any other class of subject. In the same way, subjects one-degree separated from a mobilizer were significantly more likely to participate than all classes of subject further removed from a mobilizer. Subjects two-degrees separated from a mobilizer were significantly more likely to participate than all classes three- or more-degrees separated.

Figure 4.2 reports t-values for two-sided difference in proportions hypothesis tests. In each test case, the null hypothesis is that the proportions are equal, and the alternative hypothesis that the two proportions are unequal. Test-statistics that are larger than 1.96 signify that at a 95% confidence level, the two proportions are different. The first substantive column in Table 4.4 reports that mobilizers are more likely to participate than all non-mobilizers. The next column (*Degree Separation from Randomly Assignment Mobilizer-1*) reports that subjects one degree separated from a mobilizer were more likely to participate than all subjects that were greater distances from the mobilizers. The next column (*Degree from Randomly Assignment Mobilizer - 2*) reports that subjects two degrees removed from a mobilizer were significantly more likely to participate than all subjects further removed. To state these finding colloquially: one's friends', friends manifest measurably distinct behavior in our experiment.

Figure 4.2: Attendance rates by Degree Distribution from A Mobilizer

Attendance by Degree
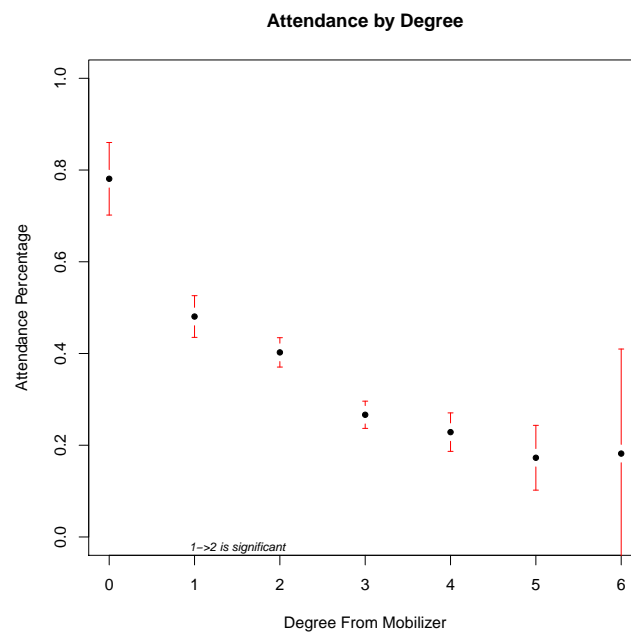
In this figure, points are the estimated likelihood of participating for each treatment group $O_{k,1}...O_{k,n}$ and the lines represent 95% Confidence Intervals around each estimate. Marginal differences are significant at the 95% Confidence Interval for degree separations 0-1, 1-2, and 2-3.

It could be that the mobilizers are attending the meeting with greater probability because they are more educated, affluent or participatory. To test for this possibility, a logit model that allows these relevant factors to covary and can identify that causal effects that influence the individual decision to attend.

$$P(Attend = 1|X) = X\beta + \upsilon$$

Here, $\upsilon \sim$ Bernoulli, and β is a vector of covariates that have causal implications on the likelihood of an individual participating in the meeting. This model makes a binary distinction between Mobilizers – subjects with a degree separation of 0, and non-Mobilizers – subjects with a degree separation greater than zero. For a discussion of covariate selection, please see the appendix. The results of this model are shown in Table 4.5.

Subjects assigned to the Mobilizer treatment are significantly more likely to attend. Setting all the covariates to mean values, a subject who was selected as a mobilizer is 35% more likely to have participated in the meeting than a subject who was not a mobilizer. That is, all else equal, informing a representative attender of the meeting increased their likelihood to attend by approximately 35%. Women were also more likely to attend the meeting (simulated first difference of 5%) and, interestingly, those subjects whose parents were raised in the village were less likely to have attended (simulated first difference of -11%). Unsurprisingly, individuals who reported voting in the last election were more likely to attend than those who did not (simulated first difference of 7.5%)

The next model allows for a finer distinction between classifying individuals as mobilizers or non-mobilizers, and takes takes advantage of the complicated treatment structure to fully identify the causal implications of social networks. The parameter estimates for the covariates are stable when compared to the dichotomous mobilizer/non-mobilizer distinction, suggesting an appropriate specification.

To allow for the potential of unobserved or unmeasured heterogeneity to exist at the town level, a town-level fixed effect model may be appropriate. In a fixed-effects model, unobserved differential effects, weather the day of the meeting, or a town history of non-cooperation, in a single town will not bias the estimates of parameter in the other towns. Table 4.8 compares the effect of including town fixed effects to a model that does not include fixed effects. There are no substantive differences in the parameter estimates between the two models, but note that there is an improvement in the Akaike Information Criteria of the Fixed Effect Model.

Minimum geodesic distance refers to the the smallest number of connections between any to individuals in a social network. In these models, minimum geodesic distance is

Figure 4.3: First Difference Kernel Density Plots

Density of First Differences in Min GeoDesic Distance
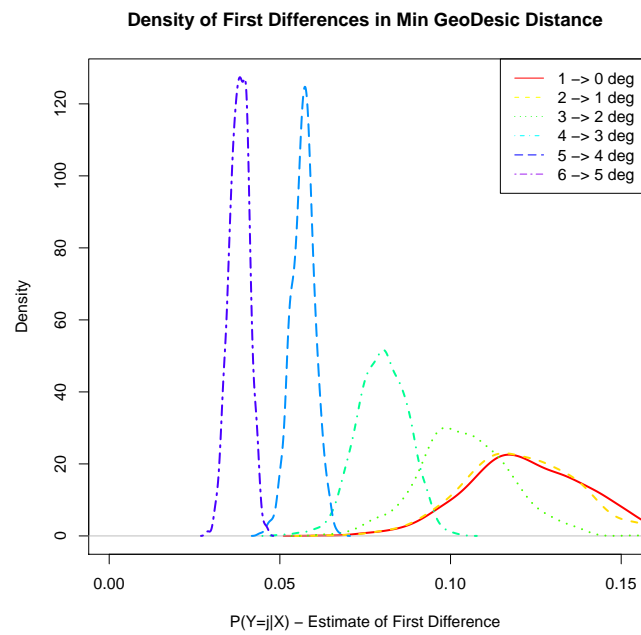
Kernel Density plots of first differences for a simulated change in distance from a mobilizer. Note that the overlap in the distributions does not signify a lack of significance because these are estimates of effect size. Also note that the effects are additive. A change from 3 −¿ 1 is the sum of the yellow and red distributions, or approximately 0.25.

significantly negatively related to likelihood of attending. Setting all other covariates to mean values, increasing the amount of social distance between a mobilizer and a subject decreases the likelihood of a subject participating. Simulating a change between zero- and one-degree of separation (from being a mobilizer to one degree separated from a mobilizer) decreases the likelihood of participating by 12.3%, while increasing one-degree of separation between five- and six degrees of separation decreases the likelihood of participating by 3.8%. These results, as well as the cumulative first differences are reported in Table 4.7.

To this point, the evidence suggests that there is a social influence in the decision to participate in political activity. All else equal, subjects nearer to a randomly assigned mobilizer in a social network are significantly more likely to participate in a political activity than were subjects further from the mobilizer. This marginal effect is significant up to three-degrees of separation from a mobilizer. The amount of this influence was quantified, and suggests that an individual one degree-separated from a mobilizer was more than 52% more likely to attend the political activity than an individual 6-degrees from a mobilizer. I interpret these results as an answer to the question posed by Brady, Verba, and Schlozman: *Asking someone to participate matters.* However, these results demonstrate a stronger impact: Not only does asking an individual to participate matter and change the behavior of the individual asked, but it also has effects that propagate/resonate through social networks, creating a measurably larger effect.

4.6.2   Authority and Mobilization

If asking matters, does it matter *who* asks? I present preliminary results that demonstrate that it does indeed matter. All else equal, mobilizers with higher eigenvector-centrality – one of a number of network centrality measures – are able to mobilize a greater number of individuals to participate. Some people are better at mobilizing others, and at least a part of this heterogeneity is caused by one's position in a social network. This suggests that not only is participation influenced by someone asking, but it also matters *who* it is that asks.

Eigenvector centrality, one of a class of centrality measures, is chosen for its unique ability to aptly summarize broad structural positions of actors within the whole, or global, network. Basically, another centrality measure, indegree, assumes that all connections are equally important and if indegree is your measure of centrality it refers to the total number of friends one has. In the social world, this assumption may or may not be true depending on context. For instance, in school being best friends with the most popular kid in school is perhaps more important for a child's own popularity than being best friends with the least popular child in class. Eigenvector centrality is a means through using a

system of equations to assess a node's centrality with respect to centrality of the nodes to which the original node is connected. Because Eigenvector centrality takes into account the popularity of one's friends, I feel that it is a bettie measure of social influence than indegree. Authority is one form of eigenvector centrality.

Other centrality measures instead calculate local (i.e. non-global) incidences of connections. The most local forms of this measurement count edges incident on the ego node (degree); when these measures are directed, the direction can also be included by counting the number of edges a focal node generates (out-degree) or the number of times a focal node is nominated (in-degree). For the purposes of the question of influence, hubs and authorities scores, a variant of eigenvector centrality is utilized. Authority scores applies an algorithm over a series of iterations uses mutual recursion to identify nodes that are likely to wield influence over larger parts of the network. This metric characterizes both the local influence an actor (ego) has through direct connections, but also the global influence that the ego may also have by characterizing the importance of the actors that the ego is connected to.

Authority and rates of Mobilization are both skewed distributions. A small number of subjects, around thirty percent of the subject pool, had eigenvector centrality scores greater than 0.1.[10] The remainder, 70 percent of the subjects had eigenvector centrality scores less than 0.1. Percentages of the town mobilized by each mobilizer follow a similar distribution, but the skew is even more pronounced. This skew is presented graphically in Figures 4.4 and 4.5.

Results Here, for ease of interpretation, I present a standard ordinary least squares model with log-transformed Mobilization (Dependent Variable) and Authority (Key Independent Variable). I include a standard set of covariates in this analysis: age, gender, marriage, a proxy for length of time in town, a measure of trust, and and proxy for past political participation. I also present a model that allows for an interaction between Logged Authority and Marriage, because a marriage tie may boost the calculated Authority score.

The columns of Table 4.8 report the results of this OLS regression. In the first column is a model estimated without an interaction term for Logged Authority and Marriage Status, while the second column this interaction is included. Because both the independent variable

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[10]Eigenvector centrality is a measure of importance that assigns high scores to individuals who are connected to individuals in the network with high scores. The eigenvector centrality of the ith actor in the network is:

$$x_i = \frac{1}{\lambda} \sum_{j \in M(i)} x_j \sum_{j=1}^{N} A_{i,j} x_j,$$

where M(i) is the set of nodes that are connected to the ith node.

Authority and dependent variable Mobilization are logged, a one unit percent change in the IV is associated with a one unit percent change in the DV. That is, in the first model, a 1% increase in a Mobilizer's calculated authority score is associated with a 0.48% (SE 0.116) increase in the number of individuals she is predicted to mobilize to attend the meeting. This result is significant across both model specifications, and is substantively meaningful.

Finally, in this section, I note that the coefficient on the interaction term is statistically indistinguishable from zero, and that an F-test for the restricted model does not find that it explains significantly more variance ($F_{7,52} = 2.6; p = 0.108$). However, each of these statistics approach significance, and a power test suggests that increasing the sample size by around 30 individuals, if the effect is constant, would generate a statistically significant result at the 0.05 level.

4.7   Discussion

Verba, Schlozman and Brady demonstrate that one of the primary reasons people participate is because someone asks them. It is in the dynamics of who is asked and who is asking that partied, candidates and special interests compete for control over elections (Brady, Verba and Schlozman, 1995). The people doing the asking intend to influence the behavior of other actors. Though any vote is unlikely to change the outcome of an election (Downs, 1957), mobilizers try to turn one vote into one thousand. And a thousand mobilizers can change an election's outcome. (Gerber, Green and Larimer, 2008) demonstrate it matters who is doing the asking. Neighbors are more effective than strangers because neighbors can exert greater pressure to conform to social norms about participation. But are some neighbors more capable of exiting that influence than others and why?

In an unusual setting, this study set out to investigate the role of social influence has on political participation. This experimental design tested three falsifiable hypotheses. First, if asking individuals to participate matters, then individuals randomly assigned to a mobilization treatment condition should have participated in our political activity at greater rates then those subjects not assigned to the mobilization treatment. Indeed, they did. The results demonstrated that those directly asked to participate were more than 30% more likely to participate than those who were not asked.

Second, if there is a social pathway for information diffusion, subjects in the non-mobilizer treatments should have been more likely to participate in the political activity the closer they were located to the mobilizer within the social network. They were. An individual one degree separated from a mobilizer was 40% more likely to have participated than an individual six degrees separated. Furthermore, degree separation produced significant

differences in likelihood to attend a meeting a degree-separations of (0,1); (1,2); and (2,3). Perturbing a network with information and incentives at one node had measurable effects that rippled three-degrees of separation through the network.

Third, if there is a social component to the ability to influence individuals, mobilizers who possess a greater amount of this influence should have been more successful in mobilizing subjects to attend the meeting. They were. Using a non-linear regression equation, I demonstrated that individuals one standard deviation above the mean authority level of the mobilizers were 35% more successful in mobilizing subjects to participate than individuals one standard deviation below the mean.

Taken together, these results begin to answer the aforementioned question. Yes, some neighbors are more influential than others. The reason for those differences in influence is more muddled, but in assessing the influence of a mobilizer on a citizen, this study demonstrates that social distance matters and so too does eigenvector centrality. Both of these findings indicate that a persons ability to influence another depends on the respective positions that both actors occupy within a larger social structure.
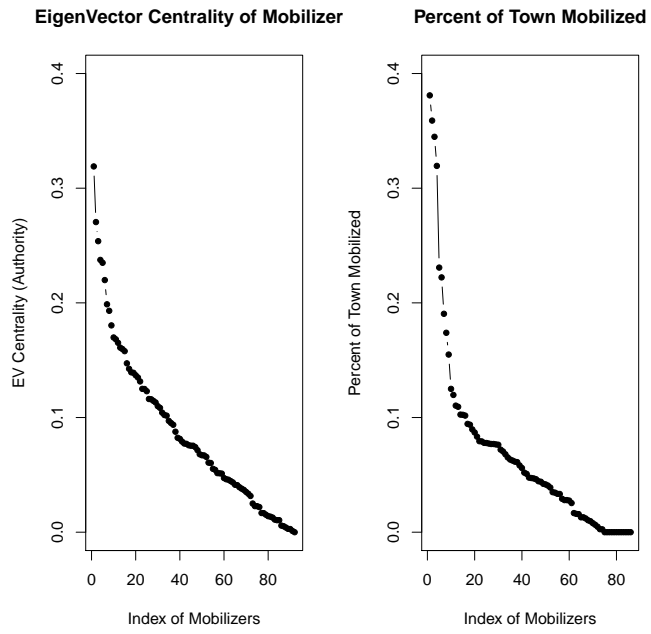
Figure 4.4: Non-linear variable distributions
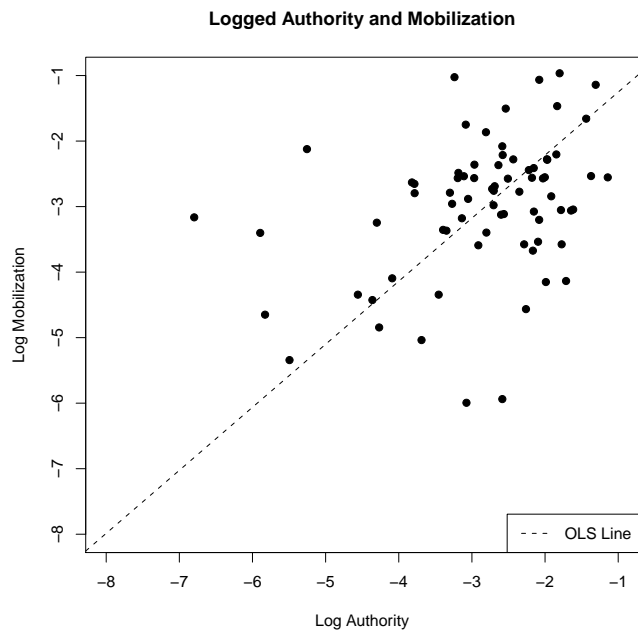
Figure 4.5: Logged Values of Mobilization Percentage plotted against Logged Mobilizer Authority.

Table 4.2: Block-Random Treatment Group Summary Stats

Variable	All	$X_{k,0}$	$X_{k,1}$	$X_{k,2}$	$X_{k,3}$	$X_{k,4}$	$X_{k,5}$
Age	37.826	40.648	39.469	38.225	37.835	35.793	34.327
	(15.735)	(15.628)	(14.522)	(14.793)	(16.228)	(16.028)	(18.105)
Female?	0.531	0.486	0.46	0.532	0.533	0.615	0.514
	(0.499)	(0.502)	(0.499)	(0.499)	(0.499)	(0.487)	(0.502)
Married?	0.447	0.560	0.492	0.462	0.438	0.413	0.324
	(0.497)	(0.499)	(0.5)	(0.499)	(0.496)	(0.493)	(0.47)
Years Edu.	4.019	4.848	3.903	3.86	3.938	4.036	4.42
	(2.273)	(3.365)	(2.418)	(2.161)	(2.059)	(2.181)	(2.397)
Parents Raised?	0.662	0.651	0.705	0.677	0.677	0.623	0.586
	(0.473)	(0.479)	(0.456)	(0.468)	(0.468)	(0.485)	(0.495)
Monthly Income	1647.59	2693.818	1466.183	1641.454	1497.879	1884.057	1495.429
	(3059.818)	(3192.446)	(1267.159)	(2354.19)	(1970.116)	(7179.055)	(912.541)
Party ID	1.938	1.954	1.897	1.905	1.902	1.943	2.027
	(0.758)	(0.75)	(0.706)	(0.737)	(0.767)	(0.786)	(0.78)
Pol. Complicated	2.475	2.56	2.499	2.545	2.448	2.509	2.225
	(1.752)	(1.729)	(1.752)	(1.724)	(1.761)	(1.721)	(1.818)
Vote Efficacy	2.337	2.514	2.303	2.295	2.419	2.354	2.297
	(1.731)	(1.783)	(1.792)	(1.731)	(1.694)	(1.731)	(1.73)
No Say in Gov't	2.566	2.679	2.684	2.551	2.573	2.625	2.55
	(1.705)	(1.66)	(1.657)	(1.69)	(1.718)	(1.696)	(1.683)
Trust Gov. Official	2.356	2.706	2.415	2.391	2.314	2.31	2.523
	(1.798)	(1.771)	(1.829)	(1.76)	(1.803)	(1.802)	(1.715)
Trust Others	2.399	2.624	2.312	2.451	2.471	2.328	2.288
	(1.592)	(1.556)	(1.683)	(1.581)	(1.556)	(1.59)	(1.62)
Other are Fair	2.507	2.532	2.637	2.491	2.515	2.486	2.631
	(1.592)	(1.659)	(1.623)	(1.584)	(1.58)	(1.592)	(1.513)
Others Help	2.483	2.67	2.43	2.503	2.537	2.432	2.441
	(1.517)	(1.522)	(1.581)	(1.529)	(1.471)	(1.497)	(1.541)
Trust Strangers	2.723	2.679	2.716	2.744	2.732	2.832	2.694
	(1.647)	(1.638)	(1.661)	(1.62)	(1.645)	(1.608)	(1.715)
Trustworthy	2.43	2.339	2.368	2.428	2.504	2.612	2.568
	(1.952)	(2.029)	(2.001)	(1.954)	(1.919)	(1.91)	(1.91)
Vote?	0.622	0.706	0.714	0.661	0.631	0.53	0.468
	(0.485)	(0.458)	(0.452)	(0.474)	(0.483)	(0.5)	(0.501)
$\text{Vote}_{(t-1)}$?	0.615	0.716	0.703	0.67	0.604	0.55	0.441
	(0.487)	(0.453)	(0.457)	(0.471)	(0.489)	(0.498)	(0.499)
N. Obs: $\forall$, Income	3035, 1100	105,44	461,186	895,337	851,313	382,122	110,35

Note: A full description of the variables is available in the appendix.

Table 4.3: t-test of Meeting Attendance – Mobilizers and Non-Mobilizers

H_0: $P(\text{Attend}_{Mob}) = P(\text{Attend}_{Attend})$

	Attendance	sd	N
Mobilizers	0.695	0.47	95
Non-Mobilizers	0.32	0.46	3372
	t = 7.84		

			Degree Separation from Randomly Assigned Mobilizer						
Degree	**Attendance**	**N**	**0**	**1**	**2**	**3**	**4**	**5**	**6**
0	0.78	105	*(0.78)*						
1	0.48	464	6.42***	*(0.48)*					
2	0.40	902	8.66***	2.75***	*(0.40)*				
3	0.27	852	11.89***	7.72***	6.10***	*(0.27)*			
4	0.23	385	12.04***	7.97***	6.45***	1.44	*(0.23)*		
5	0.17	110	11.19***	7.15***	5.78***	2.38**	1.32	*(0.17)*	
6	0.18	11	4.66***	2.40***	1.79	0.68	0.38	-0.07	*(0.18)*

Table 4.4: Difference of proportion t-test statistics are reported. In parentheses are reports of attendance percentages.

Table 4.5: Fixed Effect Logit, Meeting Attendance

Variable	Coefficient	(Std. Err.)
Mobilizer?	1.485**	(0.378)
Age	0.001	(0.002)
Female?	0.308[†]	(0.162)
Married?	0.123	(0.143)
Years of Edu	0.001	(0.001)
Parents Raised?	-0.422**	(0.154)
Monthly Income	0.000	(0.000)
Party_ID	0.081	(0.095)
Vote?	0.347*	(0.153)
Intercept	-1.123**	(0.287)

Significance levels : † : 10%   ∗ : 5%   ∗∗ : 1%

Table 4.6: Fixed Effect Logit, Meeting Attendance

| | Model | |
Variable	No FE	Fixed Effects
Dist. to Mob.	-0.512 ***	-0.506 ***
	(0.364)	(0.072)
Age	0.0004	0.0004
	(0.002)	(0.0017)
Female?	0.385 *	0.347 *
	(0.174)	(0.176)
Married?	0.045	0.0373
	(0.151)	(0.155)
Years of Edu	0.001	0.0010
	(0.000)	(0.0008)
Parents Raised?	-0.545 ***	-0.524 ***
	(0.165)	(0.167)
Monthly Income	0.000	0.000
	(0.000)	(0.000)
Party_ID	0.02	0.039
	(0.010)	(0.104)
Vote?	0.100	0.171
	(0.168)	(0.168)
Intercept	-1.123	0.430
	(0.364)	(0.371)
	AIC: 1149	AIC: 1114

Significance levels : $*: 5\%$ $**: 1\%$ $***: 0.1\%$

Table 4.7: Simulated First Differences of Geodesic Distance

Degree Separation	Marginal Effect	Cumulative Effect
0	–	–
1	12.3%	12.3%
2	12.1%	24.4%
3	10.4%	34.8%
4	8.0%	42.8%
5	5.7%	48.5%
6	3.8%	52.3%

Table 4.8: OLS Regression, Log Transformed Town Mobilization

Variable	Model (1)	(2)
Logged Authority	0.479 ***	0.309 *
	(0.116)	(0.151)
Age	0.001	0.002
	(0.008)	(0.008)
Female?	-0.141	-0.106
	(0.251)	(0.221)
Married?	-0.211	0.768
	(0.232)	(0.620)
Parents Raised?	-0.434 †	-0.489 *
	(0.165)	(0.224)
Trust Index	-0.127	-0.093
	(0.127)	(0.093)
Vote?	0.026	0.146
	(0.262)	(0.252)
(Logged Authority *	–	0.359
Married)	–	(0.216)
Intercept	-0.835	-1.418 *
	(0.548)	(0.371)
	AIC: -11	AIC: -15
	N: 51	N: 51
	adj. R^2: 0.26	adj. R^2: 0.30

Sig. levels :   † : 10%   ∗ : 5%   ∗∗ : 1%   ∗ ∗ ∗: 0.1%

CHAPTER 5

Conclusion

Since the preceding chapters are stand-alone papers and therefore already contain summaries of the findings and implications, I do not repeat those conclusions again. Instead, I comment upon the complexity of studying political phenomena like participation and cooperation, and how this complexity should drive scholars to think of data that is more systems-oriented. I also focus on the relationships between the chapters and the concepts with a more expansive view.

5.1 Social Data for Social Dynamics

5.1.1 The Limitations of Conventional Data

As this study has shown, and many others have demonstrated or speculated, people do not make decisions in social isolation. Individuals live in a rich immersive social, political and economic environment. This environment shapes and influences the decisions that individuals make. This is particularly true of the decisions about participation, mobilization and cooperation which are inherently social acts. Political science has unearthed many of the dynamics that govern these concepts but too few of these studies do not explicitly capture the social nature of participation, mobilization and cooperation. Without data that more explicitly takes into account the social dynamics behind these concepts, there may be an ommitted variable bias that prevents a more wholistic understanding of these political behaviors and calls into question the internal validity of such studies.

Social network analysis is one means of incorporating explicit social dynamics into models of participation, mobilization, and cooperation. As I have demonstrated herein, data on social networks has something to say about incorporating this larger environment into the political and economic decisions that people make. However, as I have also demonstrated herein, social network data also comes at significant cost, most notably in terms of

external validity. Although this study endeavored at great cost to seek out social systems that could be analyzed as a whole and where nearly everyone could be a part of the study, the question remains about just how emblematic the findings are to life in more complex, larger, social systems like the United States? Also, while the social network data included strong affective relationships between residents of these social systems, what about other relationships that influence actors' decision making that were not included?

5.1.2 The Rural Social Networks Study

This study drew exclusively fromThe Rural Social Networks Study provide analysis about the interrelationship between cooperation, participation, mobilization and social networks. The findings are discussed extensively within, but one of one of the largest strengths of this study has not been mentioned, the data itself. The RSNS went beyond previous data collection methods and technology and created a path for others to follow for the more accurate and cost-effective collection of data. This dissertation, especially the technical appendix, can serve as a roadmap for other scholars who would like to try and better understand the social dynamics of political phenomena.

5.2 The Bonds between Cooperation, Social Networks and Participation

5.2.1 Social Side-Payments

Much of the literature reviewed in this study and other works on participation and cooperation open by discussing the self-interested models that under estimate the presence of cooperation and participation in the real world (Riker and Ordeshook, 1968; Olson, 1971). I will not rehash those models here again, but one of the reasons these models do not perform well empirically may be a result of social factors(Fehr and List, 2004), which focus almost exclusively on social sanctions. But perhaps there are social rewards for cooperation as well.

That cooperators and participators are more likely to be popular then those agents could have learned that over time the rewards that come from being popular outweigh the costs of cooperation and participation. These rewards could include greater employment options, reproductive benefits, and general emotional satisfaction among many other things. Improved social position would act in a sense as a type of side payment for cooperation and participation.

With the data from this study, it is not currently possible to distinguish between which factors cause the others, and therefore I cannot say popularity is a result of cooperative and/or participatory behavior. It is more likely that these behaviors coevolve together rather than one being responsible for another. Regardless, I can say cooperators and participators tend to be more popular.

5.2.2 System Dynamics

I have had the pleasure of traveling the world as a curious observer of various social systems. Once inside a community, it becomes apparent quickly that some social systems are more friendly while others are rude and distrustful; some govern themselves efficiently while others are infested with corruption and other forms of rent-seeking, some actively participate in the process of improving their communities while others neglect the system and focus on the individual, and some work together to solve common problems while others compete in a manner that can tear a community apart. Adequately explaining this variation is beyond the bounds of this study; nonetheless, these are the questions that motivated the research herein and I do believe this work on the relationship between social networks, participation and cooperation provides some clues about where and how to look for answers in the future.

These issues share at least four dynamics: first, these are social dilemmas and by definition manifest through interpersonal interactions. Second, these are not small-n problems that develop in groups of two, three or four people. The lower bound for the number of people necessary to constitute a large-n is a bit unclear but it is clear that there is no upper bound. These issues are rampant through the world's largest social systems. Third, these systems are difficult to replicate in a laboratory because these systems grow naturally over long periods of time and the agents in those systems learn through a variety of mechanisms including trial and error how to navigate others in those systems. Finally, each of the aforementioned issues also involves tradeoffs between real costs and benefits regardless of whether the currency is time, reputation, money or popularity.

These four factors are not necessarily an exhaustive list of the commonalities between cooperation, friendship dynamics and participation, but I believe there is scientific value in continuing to pursue a better of understanding of these concepts by studying large-n social systems in which actors have natural and not laboratory created relationships, and then placing those actors in situations where real invectives are at stake.

5.2.3 Future Directions for Study

As is often the case, this study generates more many more questions for future research than it has answered. These section briefly discusses a few of those questions that are of particular interest.

5.2.3.1 Context

The RSNS was conducted in rural Honduras. I believe further study in different contexts, while repeating the same procedures, might add to the study's external validity. For instance, do these results hold in across other rural cultures around the world? What about in more urban developed settings? Although social network data often requires complete social systems making more urban and developed systems more difficult, this does not mean these studies could not be repeated in urban settings where there is a defined population like schools, or fraternal organizations, or offices.

This study worked under the assumption that real social networks are different than artificially created social networks in laboratories. This assumption should be tested. I believe the assumption would hold but illuminating the differences between the laboratory and real social networks would be interesting.

5.2.3.2 Relationships

This study focused exclusively on strong affective relationships. I would like to see further study on how different types of relationships affect political participation, mobilization and cooperation. For instance, do weak ties affect these behaviors as well? How? Is there a difference between the effects of weak and strong ties? Finally, there are a dearth of studies that look at these behaviors in the context of negative ties. How does animosity affect the decisions people make?

5.2.3.3 Different Games

Although the RSNS used he public goods game and the mobilization game to measure a political behaviors, I believe social networks may affect many other political and social phenomena that can be measured in a similar manner. I would like to see this analysis applied to games in coordination, altruism, and perhaps other concepts that could be measured in a similar manner.

CHAPTER 6

Technical Chapter

6.1   The Rural Social Networks Study: A Social Systems Laboratory

In the summer months of 2009, I collected data from for the mountainous regions of a Central American country for Rural Social Networks Study part I (RSNS1).[1] To complete the project, I directed and trained a team of 25 American research assistants and another 25 Honduran surveyors. The data includes a nonrandom sample of 32 rural villages of varying sizes totaling about 5000 persons. The population is Poisson distributed with the median town containing about 120 residents. From each of the satellite towns, the project gathered five types of data: standard respondent attribute information and relational data obtained from surveys, geographic maps, GPS coordinates for all edifices in the communities, records of subject behavior under incentivized experimental conditions, and historical community-level data regarding collective action problems like road quality and mobilization for public health activities. The purpose of RSNS1 is to explore the relationship between social networks and collective economic behavior.

The RSNS1 is fairly unique and definitely atypical. This uniqueness contributes to its strengths and weaknesses. I used procedures that differ from other scholars in the sampling and data collection process; and thus, I should need to describe in great detail how these differences affect the study's external and internal validity. Therefore to increase transparency, this section will highlight the differences in our methods and discuss the implications of these new procedures.

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[1]The RSNS1 was a joint project with Alex Hughes.

6.1.1 An Introduction to La Union

Honduras contains 18 federal departments, which are further subdivided into municipalities. For a point of comparison to the United States, federal departments are like states and municipal regions are similar to counties. In the La Union municipal region of Honduras's Lempira department, approximately 32 small towns surround a central city, which has a population of about 5,000 people. These adjacent 32 smaller towns have an aggregate population of about 5,000 as well, bringing the total population to about 10,000. I did not collect any data from the center city because our research team lived in this town and I did not want our presence and business relationships to influence survey or experimental outcomes.

The farming of coffee, beans and corn is the dominant form of employment and the average household earns about two dollars a day. The beans and corn are the primary source of subsistence for people in these communities and the coffee is exported for profit. The number of purchasers is limited, which gives these intermediaries tremendous bargaining power and reduces the purchase price the farmers receive. Furthermore, the wealthier processors of coffee offer loans to the farmers who cannot afford agricultural inputs that are both usurious and contractually obligate the farmers to sell to the given processor at below market values when the loan cannot be repaid in full. Of course, the loans are seldom completely repaid, which creates a vicious cycle of dependence that is reminiscent of sharecropping in the American South. To try and supplement nutritional intake, many people also grow a few additional fruits or vegetables like plantains and bananas. The mountainous climate, while ideal for coffee production, limits other possible crops. Although chickens regularly run through the makeshift roads and paths, the chickens are rarely eaten because they supply the families with eggs.

There is little diversification of labor. People in La Union are predominately coffee farmers though some of wealthier land owners do traffic in cattle. Every town has at least one store but these merchants run this business out of their homes for supplemental income. The stores may carry a few dozen items but the only products sold regularly are lard and Coca Cola.[3] The primary income of the people who own these shops is still coffee farming. The crops are often carved into the sides of mountains and the farming is grueling and dangerous. This rugged land may appear plentiful, but the largest portions of it are owned by a few families who are the remnants of an old aristocratic regime. These wealthy few have for the most part left La Union for the nation's cities. More than half of the farmers tend

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[2]A abbreviated version of this subsection appears in the introduction to this dissertation.

[3]Pepsi and a few other soft drinks are sold as well, but in much smaller volumes unless priced under Coke.

their own small portions of land, while those without land work for the larger landholders for slightly over a dollar a day. The agricultural tools and techniques used by the people can best be described as archaic. On average, agriculture engineers estimate a given farmer only yields 15-20% of the land's production capacity.

This mountainous region of Honduras is geographically isolated from the rest of the country. The network of rocky roads that connect these towns are rugged in fair weather and treacherous during the rain. The roads were not built nor maintained by the government. Local coffee farmers pool resources and coordinate road repair to maintain the capacity to export their commodity.[4] During the rainy season there are weeks when passage in and out of any given town is infeasible. The vast majority people have never visited towns only a few miles up the mountain because of the harsh conditions of these roads.

The roads are not the only basic governmental service that the Honduran national and local governments have deserted and left to the people. The police are occasionally a presence in the center town, but officers are rarely if ever seen in the villages. Without police courts or prisons, the system of justice is also informal. The preponderance of formal laws has no relevance to or mechanism of enforcement for the people in La Union. There are of course the most basic codes of conduct against murder or theft, which are enforced sporadically albeit brutally by people from the victim's family and/or the community. For instance, if a member of the community drinks too much of a local hallucinogenic moonshine and walks through the village firing a gun at houses that "jump out" at the person, the rest of the community stays away from the windows to avoid the line of fire, and the next morning a group of males find the offending person and beat him severely. Though I lack data to confirm the following statement, I have been told these shootings have decreased in recent years since the institution of this policy.

The center town has two health clinics, one of which is private. For the people from the peripheral villages, the journey to the center town is arduous and expensive, and thus, rarely taken. If someone is seriously injured like through a farming accident with a machete, the likelihood of surviving the trip to the center town is low. The doctors at the two clinics do not have the training or equipment to try anything more than minor surgery. So if the injured party needs more complicated aid, the person must survive a second journey to a "hospital" in a town an hour and twenty minutes from La Union. The people from the villages[5] also built irrigation systems into some portion of their homes, which the government did not

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[4]In the section on the Commons, I will discuss many of the collective action problems the people of these communities, and how networks relate to the variation in how the villages address these problems.

[5]One village, San Augustin, is too far the mountain from the nearest stream to have irrigation. The people get water every day by carrying buckets to and from the stream, which is about a half mile down the side of a mountain.

finance. The water comes out of faucets and is undrinkable because of pollution from nearby crops and other villages. The water can be used in cooking or once purified.

This combination of extreme poverty and rugged geographical landscape also limits the communications of the people in these villages to people outside of their respective community. Occasionally, someone's child migrates to a large city and is seldom if ever seen again. The families tend to memorialize the son or daughter with a faded photograph on n a wall in the home. A significant minority of the people own cell phones however, all of which are prepaid but few people have the money to make calls. Televisions are almost nonsexist. Across the 32 villages and thousands of homes, I may have seen four. Radios are significantly more plentiful, but only one radio station is audible, a local church broadcast from the center town. Printed media is also unavailable, but even if it were, literacy rates are low. People from these communities do learn of external events in Honduras. Information somehow travels through their social networks, probably "weak ties" and connects them with the rest of the world.

There are some signs that a government exists. For instance, most of the villages have electricity and all of the villages have a school. In order to be classified as community and treated as a separate unit of analysis, the village had to have at least one distinct school and church. The provision of electricity to different communities is apparently based on the number of votes for a given party that a community can turn out. The villages participate in national and local elections but no elected official is actually from these communities. The mayor from La Union lives and works in the center town and has so for decades. Nonetheless, people in the towns do have strong partisan affiliations. People also feel quite strongly about religion in La Union. Catholicism and a local form of Protestantism[6] are available in the communities. Except for the center town, which is not part of our study, there is only one Christian denomination in any single town, and church services are attended regularly by almost everyone in the towns.

The origins of the different villages are fairly uniform. From several oral histories gathered to understand this process, I learned that normally a family would settle on a piece of land. If the government did not actively enforce the legal boundaries of their land, then that family eventually took over ownership of the land. As the family grew and found profit through cultivating the land, others would marry into the family and additional families may move to the land to share in the labor and revenues. The groupings would then grow in a similar manner over the past several generations. Eventually, 32 of these

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[6]The local form of Protestantism is a church called Vida Abundante (Abundant Life) and the founding pastor, Evelio Reyes is a national political and religious icon. He subscribes to many of the faith healing teachings of Benny Hinn and the services are somewhat similar to those in Pentecostal faiths. The pastor is also the owner of the aforementioned private health clinic and a bilingual school in the center town.

would be communities survived and an unknown number of other social systems did not.

6.2 Network Analysis and Survey Design

The standard bearer for quantitative analysis in the social sciences, the multivariate regression model, determines the conditional expectations of the dependent variables given a set of independent variables. While this model assumes observational independence, network analysis scholars assume the opposite: that the behaviors of agents change or impact the actions of each other. In short, social scientists care about networks because interpersonal influence and matters. This assumption is merely one of many differences between these two methodologies as even their core theoretical foundations differ. While matrix algebra is the mathematical base for the MVR, graph theory is the source of network analysis (Brandes and Erleback, 2005). These stark distinctions highlight the need to treat these methodologies differently when performing analysis as well as data collection. As a methodological tool the traditional multivariate regression model is a jackhammer, capable of breaking through the flaws and imperfections in the data gathering process to identify the significant relationships between variables. Network analysis is more of a chisel and the consequences of small population response rates and measurement error are poorly understood. While minimizing measurement error in data collection efforts should be of paramount concern regardless of the form of methodology, measurement error in procuring relational data is particularly damaging to hypothesis testing in relational data.

Aggregating these relationships and generating a network produces a graph theoretical representation of the community's social structure(Friedkin, 1998). These structures are complex webs of interactions between actors that exhibit tremendous variation between agent position within a network and between different networks. Network analysis statistics explore this variation to provide information on overall network organization and the structural position of agents. Many of these measures depend on the structure of the entire network. These global network statistics present several problems for researchers who analyze empirical social network data with measurement error because there are simultaneously multiple types of error: (A) The distribution of bias is nonlinear; (B) The error varies substantially in the choice of statistic; and, (C) The error is recursively defined by network characteristics like density and degree distribution, which are themselves influenced by measurement error.

Accordingly, there is no scholarly consensus on the proportion of a population sufficient for analysis, nor is there consensus on the form of standard errors and confidence intervals to evaluate the validity of inference drawn from analysis of data with measure-

ment error. I do not attempt in this paper to resolve this dilemma, but rather discuss the literature from the scholars who examine the consequences of data imprecision. my aim in using these authors' conclusions is to motivate the development of better survey instruments and procedures that reduce the most detrimental forms of error and thereby permit meaningful inference. I discuss the solution to the measurement error problem, a relational survey program, Netriks, which uses pictures for interpersonal cross-identification and our field tested procedures implemented in gathering social network data on 32 rural towns in Honduras. The final section of this article explores the substantial reduction in cost from the developed procedures. In short, Netriks is better and cheaper.

6.2.1 A Primer on Network Survey Designs

The first step for a whole-network based study is the proper identification of the population of actors capable of influencing other actors in the population. The construction of a population list can be a rather daunting task depending upon the population and the variables of interest (Laumann, Marsden and Prensky, 1989). An extensive literature already exists that discusses the development of this list including event-based expansion (Krackhardt, 1990) expanding selection (Doreian and Woodard, 1992), k-core sampling (Seidman, 1983). These population lists depend uniquely on the study and are also not the focus of this paper and survey administration program.

Not unlike the procedures employed to develop the population list, the type of instrument used to gather the relational ties that compose the network of interest depends heavily on the researcher's conceptualization of the network. For instance, if a researcher wanted to gather information for a network analysis of a fifth grade classroom of 30 children to study popularity and academic performance, asking the question, "*Please list all to students who you know by sight or name.*" would presumably elicit an 30 x 30 adjacency matrix of completely filled with 1s. This fully connected network would not inform the researcher about any meaningful element of social structure within the network the descriptive network statistics of any student would be identical to any other respondent. However, instead asking the students "*Who are your best friends?*" could paint a more informative picture. While the type of question asked varies significantly between studies, name generators, which are not without controversy or limitations, have become the standard in large interpersonal network studies because of ease and relatively low cost.

In the 32 villages of the La Union municipality, more than likely everyone knows or could recognize almost everyone else who lives in their community. This situation is similar to example of the classroom. Everyone is connected to everyone else but some connections

are unequal. my theory of social authority assumes that these unequal or "strong" ties are the relevant relationships for structuring social hierarchies.

6.2.1.1   Name Generators

Name generators are questions designed to facilitate the identifications of alters by an ego. Examples of name generators are questions such as "*Who are your parents?*" "*With whom do you discuss important matters?*" and "*Who are your best friends?*" These questions are generally not used to identify all of a respondent's connections, but rather some meaningful subset of the most important connections along the relevant relational dimension. The variation in type and method of name-generator varies substantially, such that citing a canonical version at this time is impossible. There are nevertheless numerous studies of how the type of name generator employed affects or biases the subsequent network graph.

Name generators are generally better for identifying some core group of ties between actors but struggle when asking a respondent to name naming of all of their contacts. Additionally, the wording of the question greatly affects the network graph as name generators that ask for more intimate ties decrease the number of mentioned contacts and thus change network density (Campbell and Lee, 1991; Milandro, 1992) Researchers have employed name generators through a variety of methods including the writing of responses with a paper and pencil (Burt, 1997) and computerized questionnaires (Bernard et al., 1990). Also, generators that impose higher burdens on the respondent by asking for large numbers of alters are less effective than a larger number of relational question with fewer responses allowed per question (Van der Poel, 1993).

In terms of response inconsistency, Brewer (2000) demonstrates that name generators and other similar survey instruments exhibit significant response variation, and that depending on generator context, ego's often forget alters. Brewer devised a survey technique to address problems with recall difficulty by using name generator questions followed immediately by asking the respondent to scan a previously collected population list before providing a name. While addressing the recall problem, this method quickly becomes unwieldy and functionally expensive when the networks increase beyond a certain size. Indeed, at some point the names called at the beginning of a list may be forgotten by the time the respondent reaches the end of the list. If undertaken in this fashion, the cost of conducting a network survey in a thousand person community would be prohibitive.

As the list expands, so does the likelihood of name similarity, which is a particularly large problem in cultures where name variation is small. In these communities, to avoid measurement error, researchers must ask qualifying question to differentiate between two different "John Smiths" so that in the whole-network structure, the ego and alter are cor-

rectly specified connected to the correctly connected by their unique identifiers in the adjacency matrix. These qualifying questions allow for the respondent to differentiate between the name similar alters. Yet, this process is further confused by the alter needing to accurately answer the qualifying question. For instance, the respondent must first identify "John Smith" as an alter, then correctly categorize "John Smith" along another dimension. If the qualifying question is too broad, like "*Is John Smith a male or female?*" it will fail to disqualify one of the alters because, as this example suggests, both "John Smiths" are male. Conversely, if the qualifying question is too specific, then the ego may not be able to answer correctly about her alter. The Honduran case presents a particular challenge, because using combinations of first and last names does not provide the researcher with much meaningful differentiation among potential alters. In one village from La Union, a particular combination of first and last names "uniquely" identified fifteen distinct people!

The developments in survey design have significantly advanced the reliability and validity of networks studies and Brewer's procedures are particularly noteworthy. Unfortunately, although the Brewer method for employing name generators helps relational data to be considerably more accurate in recall, in large-*n* network studies the name generator and subsequent scanning of the list may generate other forms of information and certainly increases the time for administering a relational question and consequently the costs of network surveys. Of course, for researchers accuracy and not cost *should* be the chief concern, but if the technology and procedures exist to both decrease measurement error in relational questions *and* lower the cost of administering the survey, then applying this new programme would represent a strict Pareto-improvement. However, before comparing relative precision of different procedures, it is necessary to define accuracy in terms of the consequences of specific types of measurement errors on the relevant network statistics used in hypotheses testing.

6.3   Data Gathering Procedures and Netriks

In this section I introduce the program `Netriks`, an interactive, fully *customizable*, survey interface designed to minimize measurement error while maintaining ability for dynamic surveying and rapid deployment. This section proceeds as follows: First, I explain in broad strokes the procedures I implemented in the creation of our data. Second, I introduce `Netriks'` mechanism for minimizing network relationship error. Third, I discuss the range of potential mechanisms upon which `Netriks` can meet the requirements for reduction in network error. Fourth, I discuss `Netriks'` output for analysis, and finally I provide a brief introduction to the `Netriks` interface.

6.3.0.1 Reducing Network Measurement Error

As demonstrated earlier in this paper, it is of critical importance to properly identify each node within the network. In a best case scenario, mis-specifying a node generates a network with misleading periphery statistics, but in the case that a central node is misspecified, the entire structure of the network can be erroneously generated. The difference between network analysis and traditional survey research lay in the anonymity afforded to respondents in traditional surveys; once a respondent has completed her survey, her identity is not necessary for any consequent aspect of the research program. In traditional survey research individual identities are subsumed with the probability sampling frame – the identify of the respondent is unnecessary, even unwanted, specifically because their identity is defined by their *ex post* survey responses. The individual is fully identified by their membership within the probably sample frame of the study – the respondent was in the 20% oversample of minority population, or within the desirable range on demographic covariates, & cetera. In network analysis, and specifically in recall questioning, however, the identity of the individual is critical to the further completion of the research program.

Reference to an individual as a member of the minority group oversampled in the study is of little import when the unit of analysis is at the subgroup, individual level. Given the degree of specificity required in 'calling' others' names in field research, it is necessary to generate a unique identification of individual respondents.[7] In some cases naive name pattern matching may be sufficient to capture the range of respondent identities, however, it is my belief that in most cases this will be an insufficient specification. Even in small heterogeneous populations, the probability of multiple respondents carrying the same name identification is non-zero. In societies where there are naming norms which perpetuate father-son naming dyads. In societies where there are norms of surname repitition, specifically Central and South American and northern European, there likelihood of entire groups of respondents are likely to have very similar names.[8] The main point here, is that name identification often under specifies the identify of a respondent.

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[7]Human research protection standards demand this unique ID be distinct from the individuals real-world identity. For the purposes of analysis, it is important to link this unique identification to the individuals' survey response data, but in a way that is compliant with human protection standards.

[8]Gonzalez, Hernanzed, Suyapa, & Clarke, O'Malley, O'Brien, & cetera. Note that this is more than a anecdotal assertion, the researchers intend to show in following sections the results of this bias in their current research.

6.3.1 Procedures

6.3.1.1 Overview

In our procedures, tasks were broken roughly into three sections. First I specified the geographic boundaries of a town by creating detailed maps of the physical structures of each village. Second, I recorded who within the whole network slept in each of the structures and captured photographs of each respondent that keyed the respondent to a unique ID specified in the architecture of `Netrix` for the administration of the survey. Finally, the third section was the actual administration of the survey using `Netriks`. At the beginning of the summer research period, each section corresponded to a single town-day, but as our research assistants honed their skills, these sections required less time, and multiple sections could be completed in a single day or the same section could be completed in multiple towns in a single day. Before more fully explicating our procedures, I pause to establish a concept I will refer to as *researcher uniqueness* throughout the remainder of this article.

6.3.1.2 Operationalizing Photograph Taking

Operationalizing picture taking is a straightforward task once the researcher identifies the unique component of each picture. At a given household, and therefore a given picture taking session, regardless of the individual taking the picture or of the individual in the picture, there remain two common, fixed and therefore unique components: (A) The *setting* or house where the picture is taken, and (B) The physical camera with which the picture is taken. Regardless of the idiosyncratic issues presented by the subject of the picture, or for that matter of the undergraduate taking the picture, at a given locale the locale and the camera will be invariant. These then present the two fixed components in creating our unique identification, the third component was allowed to vary, and varied specifically according to the rule that each person who I were told lived in a given domicile was assigned a specific number from the sequence from 1 to the number of people living the home.

The Layout of our Code Board   Labeling the digital negatives of our photographs proved to be time consuming, and inaccurate, and because I were above all else motivated by accuracy, I forwent that process for a more straightforward, albeit *anachronistic* approach: I asked the respondents to hold a white board in the photograph that I were to use to key them into the database, that way, no matter the coding issue that could be brought to us later, I retained specific, accurate information about the photographic identity of the respondent.

Observe, the following to photographs. In each photograph, the first character, in this case a letter, represents the camera with which the photograph was taken. However, more

specifically, this represents the SD card loaded into a camera, because this was the storage location for the photograph. Each time the camera changed hands, I required our research assistants to check the identification on the memory card to ensure proper coding. By creating a leading identifier that is specifically coded to a camera/SD card, a team of three cameras is capable of working in parallel through a single small neighborhood. Imagine instead the case where the smallest delineation of uniqueness was at the three-camera group level. The team would then be limited to working as a unit without the possibility of specialization or comparative advantages[9]

Figure 6.1: Photograph illustrating inclusion of a unique database ID and unique photographic ID. Camera C, House 5, Person 1, A Relative.

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[9]Alex thinks that this looks somewhat like Coases' description of a firm when there is no within group distinction. Furthermore, assigning individual codes allows the Researcher to hold accountable for production the individual assigned a camera/SD combination. When groups are assigned in undifferentiated groups of three, Agency theory suggests that the incentive for shirking, as a function of decreased ability to monitor, will increase.

The second character is the house number taken with *that specific camera.* That is, the first house that camera A approached would be coded as "1", the second house as "2", etc. This is an easily observable and countable measure to maintain, and when taken together with a map, presents multiple levels of redundancy: (1) The previous house number is recorded on the memory card, and (2) The lieutenant tasked with maintaining the map can easily query his notes.

The third character is the person number within the house (on the camera). The first person with whom I spoke, and who took the picture first, would be coded as "1", the second as "2", etc. In the case that individuals resided at a house (i.e. house "A"), but were not present to take a picture, I included an "X" in the person code, and asked his closest of kin to stand in for him. It was frequently the case that when I canvassed a town the women were at the family's home and the men were at the *campos* working. In this case, I asked the woman to take a picture (coded as A.1.1 - Maria), and then asked the woman to take a picture in the stead of her husband (coded as A.1.2x - Tito).

6.3.1.3 Operationalizing Map Making

Returning presently to the issue of researcher uniqueness, geography proves to be exceedingly relevant because even without addresses or house numbers, if members of a community sleep in a commonly known, fixed location, researchers may easily develop ordinal maps of communities. Such an ordinal map, when fully completed for the entire community, constitutes an effectively cardinal map. This map, when fully specifying a community's domiciles, creates a single factor with the number of homes in the community as the number levels of the factor. Furthermore, such a map allows the researcher to meaningfully index her progress through the town. The utility of these two assets will be further established in subsequent paper sections.

As important as is the link from respondent to unique ID to picture to database, so important is the specification of that respondent within her locale and specifying the boundaries of that locale. This is the boundary specification issue discussed earlier in this paper. The house each respondent lives in is a key static input into her unique ID.[10] As such, it is critical that the topology of each *town* be created with equal precision as is the photograph. Indeed, the two are reasonably closely co-determined; an incorrectly specified map will generate an incorrectly specified unique ID. Conversely, an incorrectly specified unique ID could lead the researcher to the incorrect part of the town when searching for a respondent.

Many of the same precautions required of the picture are also required of map mak-

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[10]Specifically, the second entry.

ing: (A) The unique identification of *each map* is necessary to ensure comparability, (B) The unique identification of each house is necessary to fully specify residences. However, additional demands are placed on the lieutenants tasked with maintaining and recording the group's map. This individual is responsible for communicating with residents to identify hidden-away homes, and is further responsible for ensuring that his team of research assistants does not duplicate the work of another groups of researchers.[11]

Upon arriving at the edge of town, with the help of our guide, I inquired about the location of the church; nearly without exception I found that the church was located near the population center of each village, and typically community leaders' homes were also located in the area. From this central location, I sent out one of our researchers with a translator to speak with the village mayor, to explain our project and to ask for his assent to speak with the individuals in the town. Following the mayors' approval, I broke-down into 4 teams of 4 researchers and 3 translators. In each group three of the researchers were paired with a translator, while the fourth, and more senior researcher, was charged with mapping the movement of her team through the village.

While the three research teams identified residents and took photographs of each home, the fourth researcher catalogued the other teams' movements through the village.

Following the completion of the mapping by each of the four groups of four-researchers, the partial maps were complied into a single map containing the whole of the population of the village. In this manner, starting from rudimentary building block of the villages,

6.3.1.4 Administering Survey

Administering the survey is the final of the three stages, and when the researcher has been fastidious in her performance of the previous two stages, is a straightforward, perhaps even simple task. As the researcher approached a house, she was able to search for all of the respondents who live in the house by searching the leading characters in the unique ID – recall that the *house ID*, was a factor in creating the unique ID for each individual. Armed with a list of the residents of each house, the researcher was able to ask if specific people were home, and could immediately begin surveying a targeted respondent.

The mechanics of giving a survey were also straight forward. Once a respondent is identified within Netriks, her record can be opened with a single click, and the survey began. Realistically, questions about respondents' attributes proceeded in much the same way that a *very* well designed online survey would proceed.

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[11]Assuming that there are multiple teams of researchers working in parallel throughout the township or village.
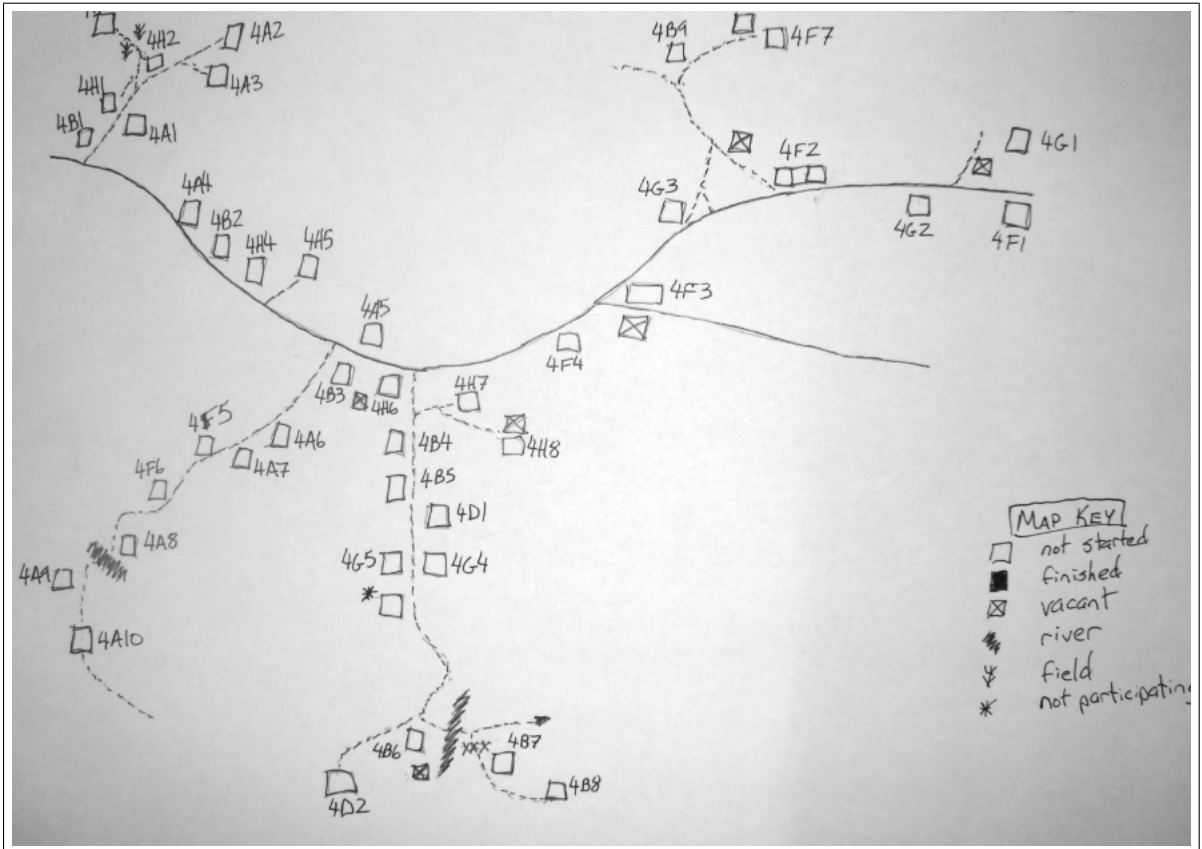
Figure 6.2: Example Map with Unique House ID

6.3.2 Response Rates

Population response rates (PRRs) are not ordinarily reported in social network analysis. Table 1 presents the response rated from RSNS1. Across the 32 villages, the average PRRs for this study are 86.7%.[12] I would have liked to approach 100% in every village, cost limitations made this objective infeasible. Nevertheless, I believe these PRR's and the geographic and cultural isolation of the research sight represent the hurdling of whatever previous standard there may have been for network completion. In summary, the previous section demonstrated that that the level of societal complexity of La Union provides for the ability isolate the interpersonal relationships that are the foundation for social authority. This section demonstrated the consequences of using incomplete or inaccurate data in

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[12]The removals from the calculation of the Population Response Rates were reserved for when a person's name was mistakenly added to the population list. These mistakes generally occurred when respondents mentioned persons who had formerly lived in the town but at the time of the study had either moved elsewhere or were deceased. It did not seem appropriate to include these people in our PRRs. One town has a particularly high removal rate, because a particular line of work disappeared in that town a few years earlier and a large number of people left the village. I have included the number of removals to be as transparent as possible.

network analysis and proposed a series of procedures for minimizing the effects of these errors. The following section introduces behavioral economics as a means for studying incentivized behavior, and discusses the importance of studying that behavior in La Union with social networks before concluding with a review of the internal and external validity of the RSNS1.

6.4 Behavioral Economics

Behavioral economics is relatively new field of study that integrates the literatures from psychology and neoclassical economics to try and make more accurate predictions about how people behave. Behavioral economists theorize that social, cognitive and emotional factors can affect economic decisions and have introduced concepts like prospect theory bounded rationality and conditional cooperation to the literature on rationality (Kahneman and Tversky, 1979; Simon, 1955, 1986; Fehr and Fischbacher, 2004; Fehr, 2004). The primary method for behavioral economists is placing subjects in experimental settings that structure incentives for their choices. Predictably, traditional economists have been critical of the methods and theories of people who have tried to bridge the gap between the literatures in psychology and economics. Traditional economists tend to believe that agents reveal their preferences over time and once aggregated rather than state these preferences in surveys (Rabin, 1988). Moreover traditional economists are particularly critical of the experimental process. Some of these critiques have led to stricter guidelines in methods for experimental economics (Friedman and Sunder, 1994; Davis and Holt, 1993; Camerer, Ho and Chong, 2003). For instance, it is now standard practice to incentive subjects with real monetary payoffs. Because the incentivized payoffs are relative to each subject, the experimenter should scale the payoffs in terms of the average daily salary of the subject pool (Henrich et al., 2006). The researcher should also publish the full instructions from any experiment to make any cues that may have influenced the subject more transparent. Finally, although the researcher should avoid deceiving the subject, the experimenter should also limit the amount of contextual information provided to the subject, which may encourage behavior that does not reveal the subject's true preferences.

Behavioral economists have learned that a number of possible factors influence the results including the seating arrangements in the laboratory. Varying the people in the subject pool produces some of the more interesting results. For instance, students majoring in economics differ significantly from other students, leading to the conclusion that an undergraduate degree in economics teaches students to defect. Results also vary cross nationally and cross culturally Yamagishi (1986); Henrich et al. (2006). In *The Foundations of Human*

Population Response Rates

Town Name	Missed Population	Total Responses	Completion Rate	Removals	Population Response Rate
Valley of the Deer	4	65	93.8%	2	96.8%
El Naranjo	20	143	86.0%	11	93.2%
Los Planes de la Zona	11	64	82.8%	7	93.0%
Los Camoteres	4	40	90.0%	1	92.3%
El Rio Frio	12	87	86.2%	5	91.5%
Los Ramos	4	36	88.9%	1	91.4%
La Cuesta	21	111	81.1%	12	90.9%
Pina Betal	22	226	90.3%		90.3%
Agua Zarca	23	128	82.0%	11	89.7%
San Bartolo	75	419	82.1%	35	89.6%
Gualciras	58	380	84.7%	17	88.7%
Quiscamote	22	155	85.8%	2	86.9%
Los Pazes	25	104	76.0%	13	86.8%
La Ceibita	99	407	75.7%	51	86.5%
Los Barrientos	26	119	78.2%	11	86.1%
El Filo	26	118	78.0%	11	86.0%
Los Hoyos	9	39	76.9%	4	85.7%
Las Playas	30	181	83.4%	4	85.3%
Las Penas	56	376	85.1%		85.1%
El Sitio	46	251	81.7%	10	85.1%
San Carlos	11	73	84.9%		84.9%
Lepagual	18	78	76.9%	7	84.5%
Chimisal	23	146	84.2%		84.2%
Cedrales	38	191	80.1%	8	83.6%
Los Planes	21	97	78.4%	6	83.5%
La Zona Alto	18	93	80.6%	3	83.3%
San Augustin	12	66	81.8%	1	83.1%
El Aguila	9	47	80.9%		80.9%
Los Perdomos	5	21	76.2%	1	80.0%
Nueva Paz	106	437	75.7%	21	79.6%
Malcincal	75	320	76.6%	12	79.5%
Totals/Averages	**929**	**5018**	**82.1%**	**267**	**86.7%**

Table 6.1: Response rates to the core survey instrument.

Sociality, a group of diverse scholars commissioned experimental economics experiments in several rural communities throughout the world to better understand how culture affects economic behavior. Underlying their hypotheses was the assumption that people who are from the same community and have been socialized in the same way, will behave differently than people who do not have these connections and shared experience. Accordingly, the Rural Social Networks Study is an attempt to directly explore the relationships that are the foundation for those assumptions in as organic a setting as possible.

6.4.1   Games and Procedures

We placed respondents in three incentivized situations: the mobilization game, the election game, and the public goods game. The first two "games[13]" are not designed to understand the subjects' preferences, but also their abilities to demonstrate influence of some over others. The following section describes the procedures and incentive structures for the mobilization, election and public goods games. The data from these incentivized situations and the social network data serve as the foundation for subsequent hypothesis testing.

6.4.2   Mobilization Game Procedure

The procedures for the mobilization and election games overlap and accordingly will be discussed in unison. I administered the public goods game before each of these two games because I did not want a meeting on microfinance to influence cooperative behavior. After surveying a given village, between five and ten people, depending on the size of the town I would vary the numbers of people selected to be mobilizers, were selected non-randomly or participation in the mobilization game. By definition, leaders should be rarer than non-leaders. Accordingly, I oversampled more central actors for participation in the mobilization game to provide enough data points for subsequent analysis. Our sampling procedures were as follows: households were randomly selected for participation and then one home in the geographic center of each town was then also selected. It was our assumption, because I did not yet have access to the network data, that homes in the center of town

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[13]Normally, these experiments are closely tied to game theory, a means of mathematically expressing strategic interactions. This work will focus on three situations in which I placed subjects in incentivized situations. Two of those situations, the mobilization game and the election game, are not from series of games previously developed. The games do involve strategic interaction, but I are not sure the word "game" is the appropriate terminology because I are not studying their utility functions or trying to analyze equilibrium states. Nevertheless, I refer to these incentivized situations as games because the term seemed more appropriate than any other idiom. The third incentivized situation, the aforementioned public goods game, is of course from game theory.

were more likely to have people who were also more central in the social networks. Then, adult from each home was randomly selected to participate in the game.

The selected subjects were read the following script. The actual script was in Spanish and was tested extensively with people in the center town to ensure the meaning was similar across languages and cultures.

> "You have been selected for a special role in our study this week. On **[Insert Date**[14]**]** at **[Insert Time**[15]**]** there will be a town meeting at **[Insert Location**[16]**]** building. In this meeting I will be discussing with your community the future of microfinance[17] in this region. At this meeting you and your community will be electing representatives to the microfinance company. It is important that I have as many people as possible at this meeting so that your community is well represented. I don't have the time to convince everybody in the town to go to this meeting, so I are selecting certain individuals to inform the community. You have been selected as one of these people for your community. This means that I want you to get as many people as you can to come to the meeting. Because I want as many people as possible at this meeting, each person selected for this role will be rewarded with a change to win **[Insert Quantity**[18]**]** Lempira in a lottery. Everybody who comes to the meeting will be asked who got him or her to attend. For each person that names you as the person who got them to come, you will receive a lottery ticket for the [Insert Quantity] Lempira. Therefore, the greater the number of people you get to come to the meeting and identify you as the person who influenced them to come, the greater chance you have at winning the money. Your goal should then be to get as many people you can to come to the meeting. It is important not only that they come to the meeting, but also that they must identify you as the reason that they came so that I can put your name on the raffle ticket. You may convince them to come by explaining that at the meeting I will be discussing the future of microfinance in your region, or however else you would like."

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[14]The meeting date was selected so it would be no more than 72 hours after the mobilization game was initiated to ensure that memory lapses did not affect the game data.

[15]The time for the meeting was based on initial information collected in each village as to when was the most appropriate time for a meeting that everyone could attend.

[16]Although I thought the location for the town meeting could vary in different towns, I quickly learned that the school house was an ideal location for the meeting, and all meetings were held in the school house of each town.

[17]Six months after the completion of the study, I started Union Microfinanza to apply this research on collective action to the 32 communities from this research site. Selecting microfinance as the reason for the meeting was helpful.

[18]The number used for these game was the per person amount of money expected for to aggregate to 3 days salary. The expected value of that money was 100 Limpira or just over 6 dollars. Although 3 days salary is quite high for a behavioral economics experiment, I increased the payment because of skewed income distributions.

Therefore, there are two types of subjects in this game: the mobilizer and the attendee. The mobilizer's incentives are fairly straightforward; the more attendees to the town meeting, the greater the chance of winning the money. The attendee's incentives are slightly more complicated. Because of the incentives provided, I expected that in towns that are as small as the 32 villages from our study's sample that people would be mobilized by more than one person and that mobilization efforts may be competitive. Accordingly, receiving the information regarding the community meeting is only half the game. The person having been mobilized must also be willing to identify a single person who is responsible for the respondent's attendance and thus able to receive an additional share of the money allocated for that town[19].

6.4.3 Public Goods Game Procedure

Before administering the ballot and before holding the meeting on microfinance,[20] I selected ten people from every town to play the public goods games.[21] These people were asked if they would like an opportunity to earn some money by helping us learn about how people behave in different situations. I then isolated the subjects in a classroom and assured that no one outside or inside of the classroom could see the choices that the actors were making to ensure the process was completely blind so fear of reprisals from the community would not be a factor.[22] Upon entering the room, the subjects were asked to sit down in the ten available chairs and listen while I explained how I were going to distribute money. At

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[19]This incentivize structure for the attendee parallels the distributional situations discussed by Knight and North regarding power-asymmetries.

[20]It is important to play the public goods game before holding the meeting on microfinance because the discussion on microfinance which includes themes about cooperation could prime people to alter their behavior in the public goods game.

[21]We also oversampled more central people for the public goods game as well.

[22]This process was not always easy. Everywhere our team went, there seemed to be an omnipresent group of children whose curiosity fueled creative efforts to find out what was happening, including climbing onto roofs to peer through elevated windows. Although the children provided occasional distractions, I am confident that no privacy was successfully violated.

this time, the *banker*[23] would remove a clear plastic bag filled with stacks of money from a backpack and begin organizing it on a table in the front of the classroom. Making the money visible and being able to allocate it after each iteration are important components of experimental economics Friedman and Sunder (1994). The presence of the money makes the incentives more tangible and focuses the attention of the people in the room. Then scaling the rewards by the average daily salary ensures that the subjects will take the game seriously. In a third-world environment, people may also distrust formal authorities and not believe that the rewards are real. Having the opportunity to see and hold the money, changes the atmosphere in the room. Our team often remarked how quiet the room became. The game leader then read the following script:

> "Thank you for participating in this study. I would like to learn a little bit more about how people in general, not just your town or you specifically, behave when money is involved. I are going to play a game, in this game I are going to be giving you real money which you will be able to leave here with. I repeat, the money that I give you is your money and you can do whatever you would like with it.[24] Also, it is not my money, it is money that has been given to me to use for the purpose of this study.[25] Again, the purpose of this study is to understand more about when people do things to help themselves and when people do things to help everybody.
>
> The game is pretty complicated so please pay close attention. You have two envelops on your desk. One of them is your personal envelop and the other is the group envelop. You can tell the difference between them because your envelop has one person on it and the group envelop has several people on it.[26] Can you hold up your envelop? Please check to make sure everyone is holding up the correct envelop. Thank you. Now, can everyone hold up the group envelop. Please check to make sure everyone is holding up the correct envelop. Thank you.[27]

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[23]The banker was the name given to the person from our team that was responsible for collecting and distributing the money before and after each round of the public goods game.

[24]Repeating this sentence is important because the subjects need to be certain the money is not a placeholder.

[25]This sentence is also crucial because I did not want the subjects to believe that their decision took money out of our personal funds. The subjects needed to be free to behave in ways that reflected their incentives.

[26]The group and personal envelops were labeled as such, but to deal with any literacy problems, the individual envelop had one stick-figure drawn on it, and the group envelop had five stick-figures drawn on it.

[27]Using the envelops was particularly important for the accuracy, efficiency and privacy study. As already discussed, the drawing on the envelops helped alleviate problems with literacy, but each envelop also contained the unique identifier of each subject so the data from the public goods game could easily sync with

There will be an unknown number rounds,[28] and I will give you **[Insert Quantity**[29]**]** Lempira in each round. Every time you are given this money you will need to make a choice. You have the option to place the **[Insert Quantity]** Lempira in your envelop or you may choose to place the **[Insert Quantity]** Lempira into the group envelop. This must be a personal decision and you may not discuss it with anyone. I will not tell anyone else in the game or outside of the game what your decision was. After everyone has chosen either to keep their money or contribute it to the group, I will collect and redistribute the money according to the amount of people that have contributed. For each **[Insert Quantity]** Lempira that is put in the group pot, I will add **[Insert Previous Quantity Multiplied by 0.5]** Lempira to the total amount. Therefore the total amount in the group pot will be multiplied by 1.5. *Ask for questions.*

This money will then be distributed evenly to each and every one of you, not just the people who chose to put their **[Insert Quantity]** Lempira in the group envelop originally. The more people that choose to put their original **[Insert Quantity]** Lempira in the group envelop, the more money I will multiply by 1.5 and the more total money each of you will receive. However, if other people give their money and you do not, you will end up with extra money because your original **[Insert Quantity]** Lempira was not distributed among the entire group. If everybody chooses to keep their money in this manner, the entire group will suffer because no money will be in the group pot and therefore no money will be multiplied by 1.5. For example, if everybody gives 10 Lempira to the group, you will all get 15 Lempira back. But if only half of the people give their money to the group, the people who gave to the group will get 7.5 Lempira back, and the people who didn't give to the group will get 7.5 Lempira plus the 10 Lempira that they kept, for a total of 17.5 Lempira. Proceed with the series of hypotheticals until you feel the group is ready for the quiz.[30] *Ask for questions.*

If you would like to keep your money and not share it with the group, put it into the personal envelope when asked. If you would like to contribute your money to the group, rather than keeping it for yourself, put it into the group envelope when asked. As I mentioned before, I will be repeating this activity many times. At the end of each round, you will add the money given back to you to the total amount of money that you have collected in the personal envelope. This money is yours to keep and will not be used for the rest of the game.

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the data from the survey and other games. Since I would collect the "group" envelops from each subject regardless of their decision to cooperate or defect, the envelops also ensured privacy. Finally, the envelops streamlined the money collection, data recording and money allocation processes.

[28]Every town played 20 iterations of the public goods game, but I did not inform the subjects of the number of rounds because a finite number of rounds affects the incentives of the actors (Axelrod and Hamilton, 1981).

[29]The per-iteration quantity was determined by the number was determined by the expected aggregate quantity that a subject would earn. On average, the subject would earn about 120 Lempira, about six dollars or 3 days of work for a farmhand.

[30]The study leader would then present several other hypothetical examples to the subjects, while pausing to ask individuals about how much money different players would get.

Then I will start a new round by giving each of you **[Insert Quantity]** more Lempira. You will have to decide again if you want to contribute this money to the group pot or if you want to keep it to yourself. Each round you have a new decision to make and it doesn't matter what you did in the previous round. I will not tell anyone about your individual decisions, but at the end of every round I will announce how many people put the money in the personal envelop and how many people put the money in the group envelop, then say how much money the people made who kept their money in the personal envelop and how much money the people made who put the money in the group envelop. I will not tell anyone about your individual decisions. The rules stay the same for each round. *Ask for questions.* I are going to stop for a minute and ask each of you a few questions about the game to make sure everyone understands. *Administer the quiz.*[31]

After completing the quiz, the group of experimenters would then rearrange the seating to prevent communication in any form and further maintain the subjects' privacy. Diagram 1 demonstrates the seating arrangements. Finally, the group commenced playing the game by the stated rules. After completing twenty iterations, I thanked everyone for their participation, reminded people to put their money in a safe place and informed them that they were free to attend the community meeting on microfinance.

6.5 `Netriks` Appendix

6.5.1 `Netriks'` Malleability

The `Netriks` environment is capable of capturing any of a number of these potential identification tools easily. After the researcher asks an preliminary identification question, "*Who is your best friend?*" the `Netriks` environment can generate a respondent list that matches all individuals within the population sample frame that meet the `Name` criteria. Netriks then prompts the research to ask increasingly specific identifications of the respondents that meet the preliminary criteria. "*Is your friend John who is a painter, or is he John*

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[31]To further ensure that the subjects understood the games dynamics, I administered a five question quiz to each person. The questions probed the subject's general comprehension of trends like the fact that no matter what anyone else does, the subject makes more money by defecting, but if everyone acts that way, then the group will make less money than they could otherwise.
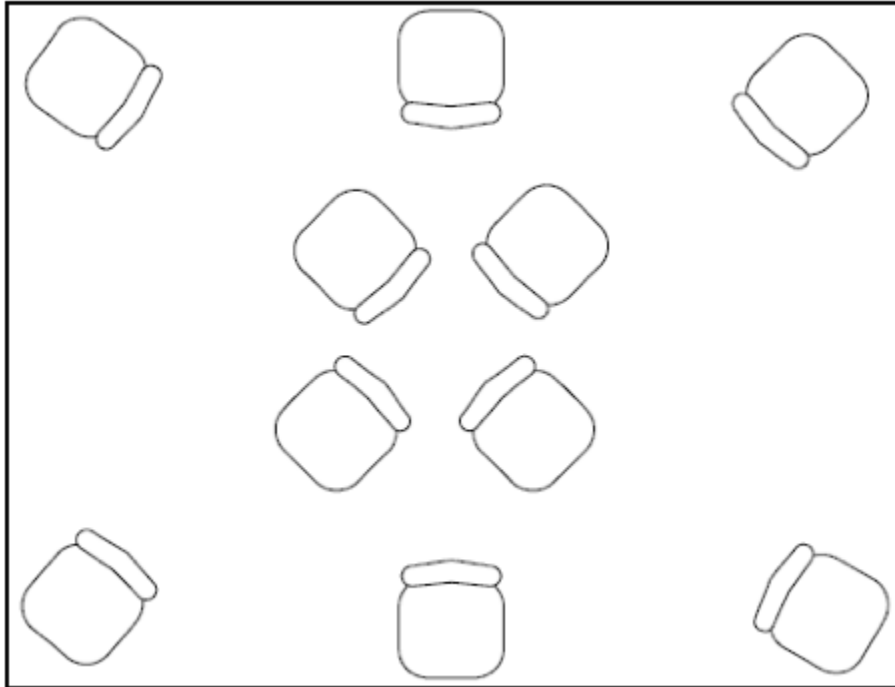
Figure 6.3: The layout of our chairs to ensure no communication.

who is an accountant?" "*Good, John who is an accountant, does he work a Ernst & Young, or Deloitte?*" When `Netriks` is properly populated with the population identifiers, this method is capable of correctly specifying individuals with even the most common names.

As most analysts know, one of the most frustrating parts of network analysis is the re-coding of non-network data into a format their analysis package will read. With this in mind `Netriks` is optimized to output network data directly in ajacency matrix format. Furthermore, the analyst may specify the package she wishes to use. `Netriks` will generate output in Pajek, netlogo, and Networks for R. format. `Netriks` includes network covariate data in a separate .csv datasheet for reading into **R**. This way, analysis is straight forward, and in a single step the analyst can move from survey response to analysis.

6.5.2 The `Netriks` Interface

Netriks is designed hierarchically, with the intention that the researcher familiar with basic object-oriented programming can set and maintain subclasses. This effectively allows a researcher to run multiple studies, with multiple surveys, in multiple locales. The next part of this paper will introduce the layout and process of creating a new study in `Netriks`.

6.5.2.1 Creating a New Study

`Netriks`, as currently implemented, runs natively on each target computer. It is hosted on a local, internal, internet connection to utilize the the html and .php infrastructure that is built into Mozilla's Firefox. As a result of this, although the setup is initially slightly more time intensive, the program is capable of running on underpowered netbooks, which both increases the portability of the end user, and reduces sunk hardware costs when rolling out a study.

For this explanation, it is important that the reader understand a distinction that I have made in developing `Netriks` between a study and a survey. For the sake of our explication of the program, a study is a logically super-ordered object, and a survey a logically sub-ordered object. That is to say, any characteristics or information that a study has, a survey located within that study will also have. However, the relationship does not flow in the opposite direction. A study can have further specified information or characteristics that do not flow back to the study. To the reader minimally familiar with object-oriented programming, this distinction should be clear, but it is important for clarify that all readers are familiar with this distinction.

For the purposes of this demonstration, I intend to create a Study with the target population of political science professors at the University of California, San Diego. Within this Study, I will create two distinct surveys, one to determine the nature of each professors involvement in departmental affairs and educational background, and another to identify each professors' relationships with other professors in the department.

The first step is to create and name a new study. Figure 1, below, is the page the user is presented with when `Netriks` is loaded. The first column is a column that presents Study names, and the second column the active Survey within each Study. To begin adding a new study, the user selects New Study from the screen and follows the successive prompts.
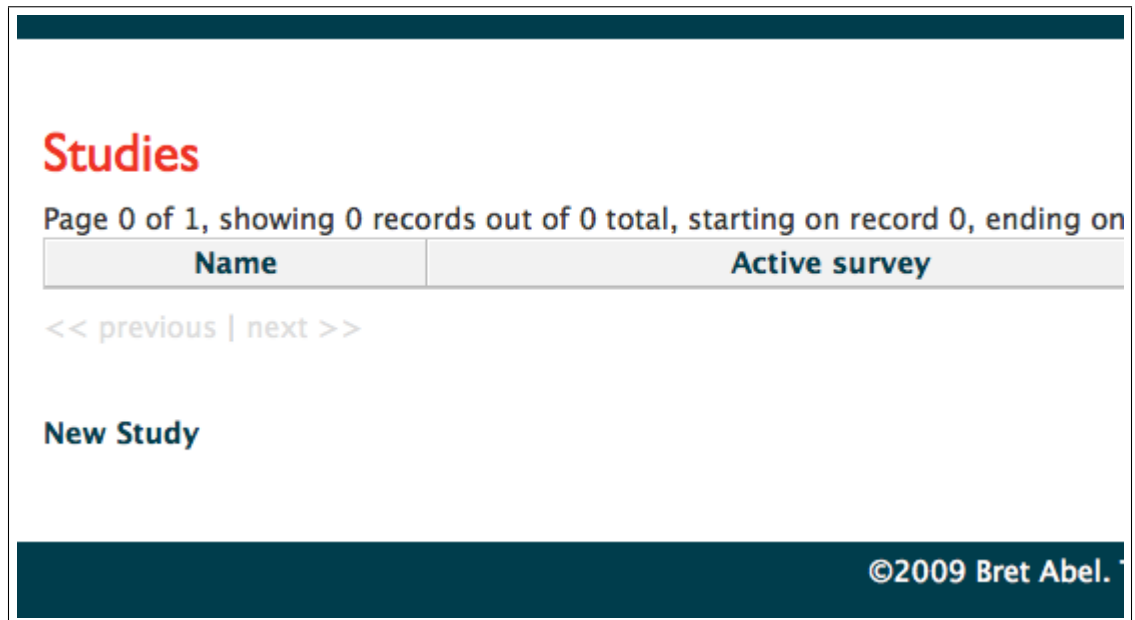

Figure 6.4: Create a Record for a New Study

The next screen, shown in figure 2, prompts the user to create a target name for the Study, and add it to the database. For our example, I will call the Study "UCSD."

Having created a Study called "UCSD," the user is now returned to the main screen, or homepage of the Study. This is the page that reachers will be presented with most frequently, so it bears explanation in some detail. At this point, however, I will focus on the Add a new survey... link at the bottom of the page and the Edit demographic fields half way down the page. These links begin the process of creating a survey, the actual unit of analysis in the research programme, and a sub-class of the Study "UCSD."

The first open link, Edit Study Name, allows the researcher to change the highest-level reference to the study, meaning that a constituent survey within the Study will also have its highest level reference altered. The next available link, Edit demographic fields,
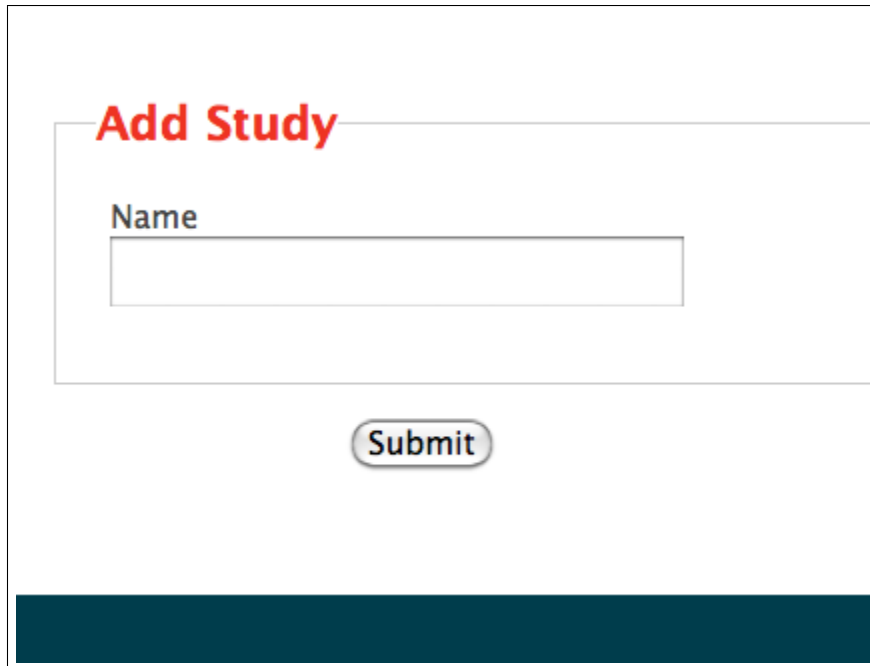
Figure 6.5: Create a Study Name

allows the researcher to edit those fields which she will use to identify respondents. I will explicate this in detail in the next section. The third link, Advance to respondent entry mode, is a one way link.

To create demographic fields, which are fields that the program will use to search for respondents, follow the Edit demographic fields link. Creating these demographic fields is necessary prior to loading the database with the study population. There are several options that can be chosen from within the demographic fields category. For my toy example I will use a combination of *First Name, Last Name,* and *Photograph*. Figure 4, below, illustrates the process for generating a demographic field *First Name*, which Netriks will index to search upon for respondents. Once the field has been created, Submit the field to return to the Add Demographic Field page. Once all demographic fields have been included, return to the study homepage.
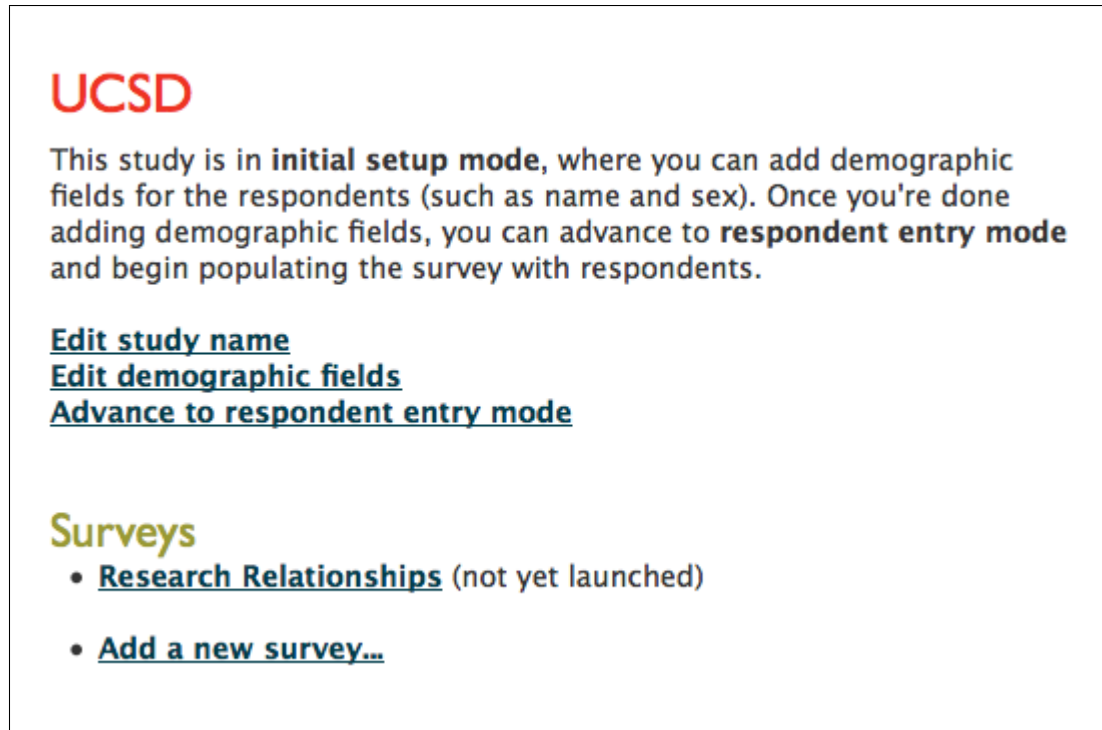
Figure 6.6: The Study Homepage

6.5.2.2 Generate Survey

At this point, the researcher has generated a study and generated demographic fields within that study. I am now ready to begin inputting my survey into the study.

There are four types of questions that `Netriks` uses: (1) Text Fields, or free response questions; (2) Integer fields; (3) Multiple Choice Questions; and (4) Person Select, or relational questions. To include a question, first select the type of question from one of the four choices. Once the type of question is selected, `Netriks` will flow forward to prompt the researcher to complete the text of the question, as well as to specify the set of responses from which the respondent can choose.

Figure 6.7: Creating a Demographic field *First Name*

6.5.2.3 Generate Population List

The population list is the core of the name generating instrument in `Netriks`. It requires a significant investment of resources prior to beginning the application of the survey, but given the research on population list studies compared to ego-centric snowballs as currently conducted,[32] I believe it to be the more appropriate method for this type of work. Once a complete population list has been created, the task begins of entering the population list into `Netriks`. There exist currently two ways to enter the population list, through the `Netriks` GUI, or if properly formatted, through the back-end .php and SQL architecture. It is my intent to include front end database operability, but as of yet this has not been developed.

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[32]See: Campbell and Lee (1991), Milardo (1992), Van der Poel (1993), and Carrington, Scott and Wasserman (2005) for a more complete discussion of the validity of population list versus snowball sampling.
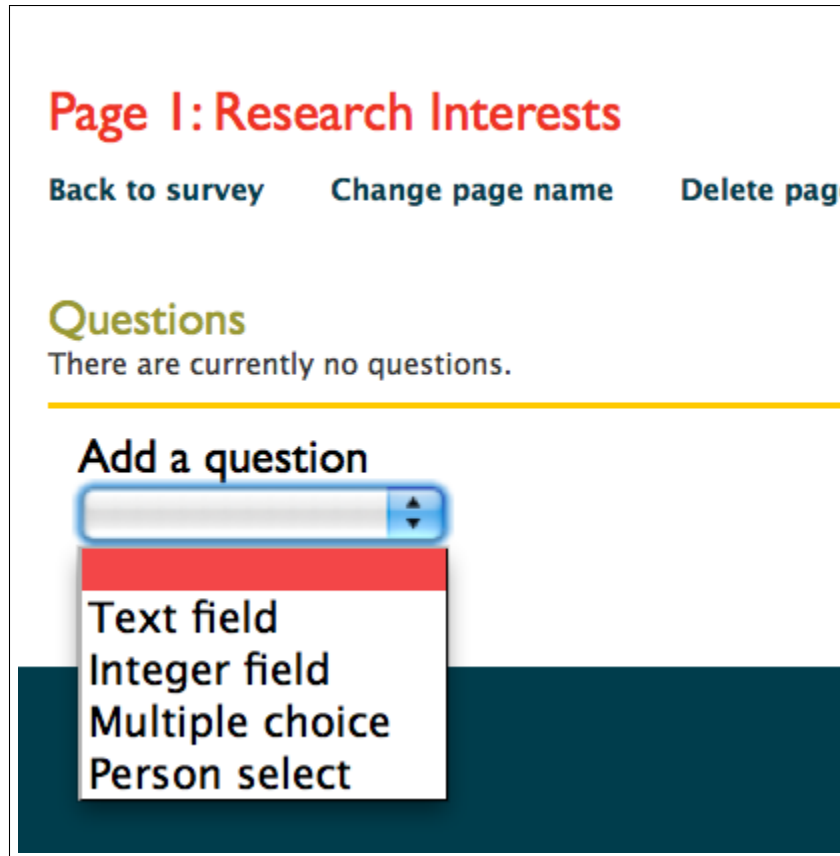
Figure 6.8: The Four Question Types in a drop-down menu

To add a respondent, the research selects Advance to respondent entry mode shown in Figure 3: The Study Homepage. By advancing to respondent entry mode, the user is locking in demographic fields. This is a one way move; to maintain the structure of the internal data-frame, once Netriks has moved into the respondent entry mode, demographic fields cannot be altered.

To add a respondent, the user selects the Add a Respondent link from the screen, and inputs the demographic fields she specified in the prior screen. For my example, recall I specified three demographic fields: (1) First Name; (2) Last Name; and (3) Photograph. To include a picture with the respondent card, Netriks reads pictures stored in a local directory of the computer into the working directory Netriks reads and writes from; this essentially functions in the same way as loading a song into iTunes, or uploading a picture
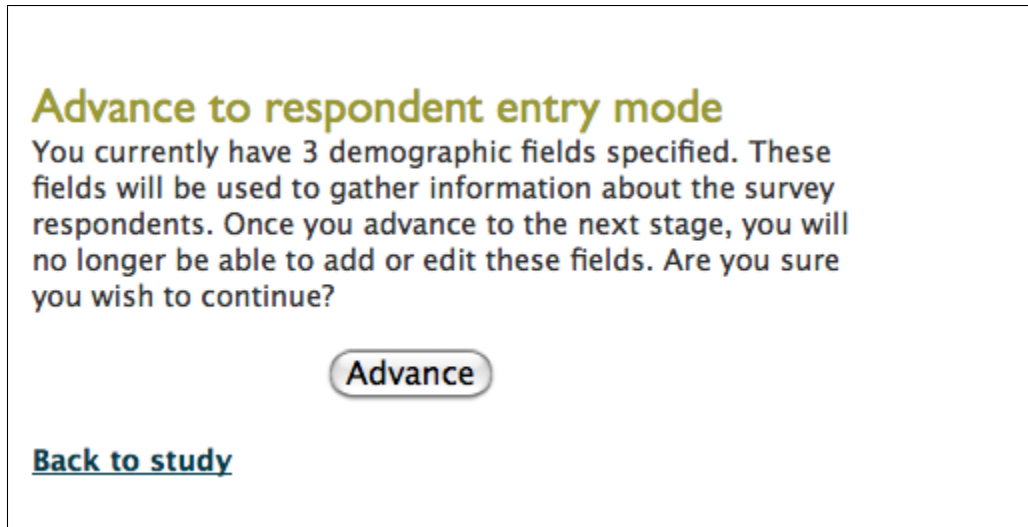
Figure 6.9: Warning about moving to Respondent Entry Mode

to facebook, with the exception that once the picture is loaded into `Netriks` it need not continue to be stored in the local directory on the computer.

Once this process has been repeated for the sample population, the researcher is ready to proceed to the nuts and bolts application of administering the survey.

6.6   Microfinance as a Common-Pool Resource

Microfinance may seem like a strange starting point for an examination of common-pool resources and cooperation, but the incentives of that solidarity groups established by microfinance firms do match the dynamics present with common-pool resources (Gerrity and Ostrom, 2002). In fact, several scholars developed a game theoretical representation of the moral hazard present in the solidarity lending groups (Gine et al. 2006).[33] This section will give a brief description of the procedures of the microfinance organizations that employ solidarity lending groups to increase repayment rates to illustrate how this dynamic can be considered a common-pool resource with the proper procedures.

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[33] We do not contend that this particular game is a representation of the process inherent in microfinance. I believe this game has serious flaws in that representation, but this game does nevertheless represent a scholarly acknowledgement of the collective action dilemmas present in solidarity lending groups.

Figure 6.10: Cropping the Respondent's Picture

Microfinance firms provide small financial services like the access to credit or banking to impoverished people who have been denied access in the past because these individuals lack the collateral to sufficiently reduce the risk of borrowing. Although the loan models vary by firm, traditional microfinance firms reduce this risk through increased interest rates and or group lending. By lending to a group rather than a person, the firm simultaneously spreads the liability for all loans across a number of people and increases the social pressure on any individual person to repay their share of the loan.[34] Without collateral, even in solidarity groups, the rational behavior is for the individual and the efficient behavior for group is default. In a non-iterated game with this incentive structure, repayment can be attributed to social norms. Microfinance firms however advertise these financial services as an indefinitely repeated game. If the accountability group repays the current loan, more loans will be available in the future. To control for discount rates, organizations also state

[34]There is a third benefit as well, which is not applicable to the current study: when the microfinance organization permits the groups to self-select into solidarity groups, the firm also harnesses local information about trustworthiness. Firms assume that people will not form solidarity groups with people who are likely to default.

Figure 6.11: Cropping the Picture, and the Completed Respondent Card.

that subsequent rounds of loans will increase the line credit in subsequent iterations.[35]

In the aforementioned model of microfinance, a solidarity group loan default could be analogous to over consumption in of a common-pool resource. If any individual defects, the remaining members of the accountability group can probably repay the loan and maintain the availability of future credit. If however enough people default, and the group cannot or chooses not to repay the loan then all persons lose the access to loans, which makes the microloan process rivalrous. Additionally, once in a solidarity group, the loans are non-excludable; and thus, the access credit becomes the common good. If loggers cut down enough trees, the forest will not provide any lumber the following year.

The true benefit to studying microfinance as a common-pool resource is that most common-pool resources occur endogenously and organically, which means that studying the development of institutions for appropriation is a matter of identification and timing, but a researcher can artificially and strategically introduce microfinance. I can control the timing, the placement, the information, the incentives, and the procedures. The firm can specify the number of players in the game, whether loans amounts increase to account for the discount rate and any number of alternative variables. In small communities, micro-

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[35]This study did wanted the incentives of the microfinance firm to closely mirror a common-pool resource, so I did not advertise this expanding line of credit.

finance firm can also indicate that there is a limited number of loans and if enough loans default on first credit round, then the company must look to other communities in future years which in effect makes the entire community the subjects in an n-player game. Essentially, microfinance presents an opportunity to engineer a real world collective action problem.[36]

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[36]This statement obviously raises many ethical questions. In the subsequent description of the actual study, I believe that you will see no harm was done. I did not allocate loans or form solidarity groups to people as an experiment. Although other scholars are currently doing such research, I were concerned about the ethical consequences of such an experiment and refrained from doing so. Moreover, this is not a study on microfinance repayment rates. This is a study on institutional development. Accordingly, I introduced microfinance to several communities in a manner that allows us to study structured responses to the introduction of this common-pool resource. When subsequently providing microfinance to all 32 communities I tried to provide loans through industry best practices. The microfinance is not a part of my study, but the final chapter will in part discuss the success of these efforts. Not only am I confident that I did no harm, I am certain the net effect of my study and the subsequent distribution of microfinance loans is positive.

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