THREE ESSAYS ON DECISION-MAKING IN NATURAL RESOURCE ECONOMICS

DISSERTATION

Presented in Partial Fulfillment of the Requirements for the Degree Doctor of Philosophy in the Graduate School of The Ohio State University

By

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This essay explores different aspects of how people make economic decisions with a focus on applications to the use of natural resource. The first two essays use laboratory experiments to provide a controlled setting to understand how the process of group decision-making integrates the preferences of constituent individuals for non-self-interested behavior. The third essay takes a global perspective to look at how technological change in agriculture influences producers land-use decisions.

The first essay, *Group Preferences for Other-Regarding Behavior and the Role of Procedure in a Laboratory Experiment*, compares other-regarding behavior exhibited by groups under three different procedural arrangements to individuals in a laboratory experiment using the gift-exchange game. I find that levels of other-regarding behavior of groups do differ from that of individuals, but the direction and magnitude of the deviation depends on the procedures governing group decision-making. This leads to the conclusion that rules governing how individuals can exert their preferences in the formation of group decisions is critical, and a hypothesis that groups are more self-regarding because of greater weight being put on group members is rejected in a baseline case.
The second essay, *The Dynamics of Group Decision-Making: Preference Strength or Reciprocal Preferences?*, examines a possible explanation for recent findings that groups act with greater self-interest than individuals which posits self-interested types exert more influence over the group decision-making process, and are less willing to deviate from a group choice that is different from their individual preference. This explanation is tested using results from a laboratory gift-exchange game where the dynamics of group decisions are revealed through the use of a novel limited communication mechanism. The preference strength argument is found to have some explanatory power, although it is argued that it may be more advantageous to model group decisions using reciprocal preferences in terms of explaining observed behavior as simply as possible using pre-existing theory.

The third essay, *Technological Change and Agricultural Land-Use Decisions: A Global Perspective*, takes advantage of recent developments in measuring total factor productivity in output specific directions to examine the influence of technological change on land-use decisions in a large cross-section of countries over the last 30 years of the 20th century. Theoretical models show that the sign of this relationship depends on important assumptions about political, economic, and demographic factors that are most prescient in different societies. Therefore, the empirical analysis seeks to maximize the variation in these factors across countries to understand which relationship are most important in general. While growth in productivity is most often associated with an expansion of agricultural land the opposite is shown across some sub-sectors. Also, population appears to be the most dominant factor, although this may
become less important in the future given falling population growth rates in many parts of the world.
Dedicated to my family past, present, and future
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CHAPTER 1

PREFERENCES FOR OTHER-REGARDING BEHAVIOR AND THE ROLE OF PROCEDURE IN A LABORATORY EXPERIMENT

1.1. Abstract

This study compares other-regarding behavior exhibited by groups under three different procedural arrangements to individuals in a laboratory experiment using the gift-exchange game. I find that levels of other-regarding behavior of groups do differ from that of individuals, but the direction and magnitude of the deviation depends on the procedures governing group decision-making. This leads to the conclusion that rules governing how individuals can exert their preferences in the formation of group decisions is critical, and a hypothesis that groups are more self-regarding because of greater weight being put on group members is rejected in a baseline case.
1.2. Introduction

This study compares other-regarding behavior exhibited by groups under three different procedural arrangements to individuals in a laboratory experiment using the gift-exchange game. While research on the cognitive performance of groups has convincingly demonstrated that they outperform individuals, an adequate understanding of how group preferences differ from individuals has been more elusive. There has been a recent boom in research on groups in economics. It has largely been spurred on by the argument that individuals making collective decisions are pervasive in many markets, and that the group decision making dynamic does not simply average individual preferences, invalidating a representative individual assumption. Whether laboratory experiments provide a reliable base upon which to make conjecture about behavior in real world markets is one of the most important questions facing the field at the moment (Levitt and List, 2007). As a result, considerable focus is being placed on how to improve the design and implementation of experiments to address this issue. This research seeks to add to our understanding of how to design laboratory experiments to more accurately predict behavior in actual markets where groups make decisions. This has many potential applications within the field of natural resource economics given the preponderance of family and community based decisions where individuals both actively make collective decisions, and also make decisions on behalf of others. Through the use of three different group treatments that isolate the effect of
varying the concentration of decision-making power I seek to add clarity to previous studies that have found groups to be both more and less self-regarding than individuals. I find that levels of other-regarding behavior of groups do differ from that of individuals, but the direction and magnitude of the deviation depends on the procedures governing group decision-making. This leads to the conclusion that rules governing how individuals can exert their preferences in the formation of group decisions is critical, and a hypothesis that groups are more self-regarding because of greater weight being put on group members is rejected in a baseline case.

Two or more individuals come together to make representative decisions in most aspects of economic life. Common examples include married couples, business management teams, corporate boards, and congressional committees. Cognitive experiments looking at subjects’ ability to solve problems with universally ‘correct’ answers have convincingly shown that groups outperform individuals. Cooper and Kagel (2005) found that teams transferred learning better than individuals in the context of a signaling entry-limit game. Sutter (2004) found that four-person teams outperformed two-person teams and individuals in a beauty contest game. Blinder and Morgan (2005) found experimentally that groups outperform individuals in a game framed around developing an optimal monetary policy.

How group preferences, decisions where there is no correct answer, differ from individuals has been less clear. While social psychologists have generated a significant amount of research on group decision-making in the last forty years, their methods used and the behaviors of interest do not inform significant economic environments. Their primary finding though that group decisions tend toward extremes relative to individual
decisions, a phenomenon referred to as group polarization first discovered by Stoner (1961), was clearly of potential interest to economists\(^1\). The first economic study of group preferences was Cason and Mui (1997), which focused on integrating concepts from social psychology into economics, and to test two competing theories of group decision-making, Social Comparison Theory (SCT) and Persuasive Argumentation Theory (PAT), using the dictator game. They find that other-regarding behavior is accentuated in groups as individuals seek to represent their preferences as being less self-regarding\(^2\). According to Social Comparison Theory (SCT) people seek to display their preferences as being more extreme than average in the direction deemed preferable according to social norms. For example, among business students risk taking is considered to be an attractive trait, so a contest develops to present oneself as more of a risk taker than others. The result is that the group decision is less risk averse than would have resulted from each individual anonymously making decisions alone.

The results in Cason and Mui (1996) have been contradicted by more recent studies that have found that groups seem to act more strategically with less concern for the payoff of others; in other words, groups act in a manner more consistent with narrow self-interest. In ultimatum games groups play closer to game theoretic predictions by offering and accepting less equal splits (Bornstein and Yaniv, 1998). Cox (2002) found groups returning less money in trust games (another continuous form of response game) than individuals. In the study most related to this one, Kocher and

\(^1\) A number of summary articles have been written in the social psychology literature on group polarization including Isenberg ( ).

\(^2\) Cason and Mui (1997) base their argument that other-regarding preferences are more socially acceptable on the standard finding that a large percentage of the population sacrifices to improve the pay of others in experimental designs such as the dictator and ultimatum games.
Sutter (2007) also compare individual and group play in the gift exchange game.\(^3\) While they do find groups acting in greater accordance with narrow self-interest in a treatment where individuals in three person groups vote, this finding is less strong in a face-to-face treatment. No significant difference between individuals and groups is found in terms of reciprocity. It has also been shown that groups differ from individuals in their level of trust in experiments with non-enforceable exchange. Kugler et al. (2006) find that groups transfer less money in the first stage of a trust game and expect less in return, although they return just as much money as individuals in the responding role. While many trends have been revealed through this line of research questions remain. What is clear though is that group decisions do differ from that of individuals, but the magnitude and direction of the deviation is highly sensitive to procedures defining how the group decision is made.

One explanation for group behavior that has come out of field experiments is the importance of group identity. These studies look at how imagining oneself as part of a defined group may impact behavior as a result of focusing more on those within one’s group relative to those outside. The logic is that a person that is willing to sacrifice their own pay to improve that of another person is unwilling to do so when this sacrifice also applies to someone inside their group to the betterment of an outsider. Goette et al. (2006) examined other-regarding behavior among soldiers for those in their temporarily formed platoon relative to soldiers outside their platoon. Even though the groups were temporary with no future, soldiers quickly formed a group identity and showed strong

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\(^3\) While they also have one treatment that employs computerized interaction to track group decision-making dynamics, it is based on a discrete proposal and voting scheme that differs from the continuous time dynamic format used in this study.
preferences for those inside their group relative to those outside. Solow and Kirkwood (2002) found that in some cases being part of a pre-existing group could increase contributions to public goods, results varied depending on a number of factors. In particular, in most settings group formation is endogenous meaning that certain types of groups are likely to attract particular types of individuals. The impact of this type of selection is likely just as critical as to group decisions as general group processes are, and it has received limited study to date. The strength of group identity in contexts including sports teams, military units, corporate identity, or branding is likely to be the subject of many future studies. In this study I test whether a group identity forms in even the weakest of circumstances where the subject has no prior relationship with their pair member and do not interact with them in the decision-making process.

Purely theoretical work has also started to incorporate the concept of group polarization. Eliaz et al. (2006) show that group polarization can be seen as a violation of expected utility theory similar to that found to underlie the Allais paradox. Specifically these authors show how choice shifts relating to risk can arise if the independence axiom is violated. Sobel (2006) provides an explanation for group polarization through aspects of information pooling between group members. Specifically, when a true state of the world exists and each person receives an independent signal, there are situations where a group’s optimal decision may be constrained by individual’s signal-based recommendations. Results focus on how to design institutions to avoid systematic biases in group choices.

Before moving on to an analysis of the results of this study it is worth reviewing research that led towards our understanding of social preferences of individual decision-
makers. Evidence has led many economists to suggest that people derive a benefit from the improvement in the well-being others receive, however, even if it comes at their own expense. It has also been shown that most individuals would sacrifice their own well-being to enforce perceived societal norms of cooperation and fairness. Common examples of other-regarding behavior include observations that people anonymously contribute to public television (Brunner, 1998), monopolists do not fully exploit pricing power due to consumers’ belief that there exists a ‘fair’ price (Kahneman et al., 1986), firms rarely lower wages in downturns because of employees’ expectations of the presence of implicit agreements based on previous years’ pay (Campbell and Kamlani, 1997), and workers lower effort in order not to harm co-workers pitted against them for a common pool of incentives (Bandiera et al., 2005). The presence of other-regarding behavior is important to economists because this type of behavior can impact market functioning and outcomes.

Economists’ understanding of other-regarding behavior has been refined through extensive laboratory experimentation, which has resulted in a suite of simple fundamental games that have undergone extensive testing. Games such as the ultimatum game, the dictator game, the trust game, and the centipede game, among others, have revealed consistent trends for social preferences.

In the ultimatum game it was shown that players would reject offers they deemed unfair even if this meant receiving no payoff (Guth et al., 1982). Players were also often willing to absorb personal financial costs to punish other players with no benefit to themselves (Fehr and Gachter, 2000). The evidence accumulated so far suggest that many people have predictable expectations about fairness and cooperation,
and take the well-being of other players into consideration. Camerer (2003) provides an extensive review. Data generated from these experiments have resulted in the creation of several models of social preferences (SP).

In the dictator game individuals choose between splits of pay for themselves and another person. They have the attractive characteristic of isolating distributional preferences from strategic considerations that exist in the ultimatum game. Kahneman et al. (1986) found that 75% of subjects when choosing between a split of $18 for themselves and $2 for the other person or $10 and $10 chose the prior. Forsythe et al. (1994) found subjects to be less altruistic when they were allowed to split an amount of money any way they wanted. The mean choice was an 80/20 split. Any number of games would have provided potentially fruitful results in looking at differences in SP between groups and individuals.

Since Rabin’s (1993) seminal paper, models attempting to incorporate systematic results of other-regarding behavior have relied on one of three premises; aversion to inequity (Bolton and Ockenfels, 1997; Fehr and Schmidt, 1999), social welfare maximization, or reciprocity (Rabin, 1993). The first two social preference forms assume that people may have preferences over distributions of payoffs. Thus, individual utility is determined by own wealth, the wealth of others, and the distance between the two.

Inequity aversion postulates that people are motivated to minimize the distance between the payoffs of agents. Fehr and Schmidt evaluate inequity aversion as the basis of other-regarding behavior by using the ultimatum game and simple market games with competition over an indivisible good.
Social welfare maximization focuses on the desire to increase a function of all individual’s payoffs, either in the form of the simple utilitarian sum of payoffs, a Rawlsian ‘maximin’ form, or some convex combination of the two (Charness and Rabin, 2002; Engelmann and Strobel, 2004).

Reciprocity is a response-based motivation that says willingness to help others depends on the level of cooperation previously provided (Rabin, 1993) with helpful or harmful actions leading to like responses. More recent theories of reciprocity allow for the strength of the response to be tempered by the type of institutional barriers that may restrict the first mover’s actions (Falk and Fishbacher, 2006).

Charness and Rabin (2002) argued that confounds existed in these previous experiments making it impossible to delineate the extent to which people were motivated by inequity aversion or welfare maximization. In response, they developed a set of simple games (CR games) to allow for the isolation of preference motivations. The non-response games, when coupled with randomly re-matched partnerships, eliminate reciprocal behavior as a possible motive. By varying the pay to A and B in each choice it is possible to test the strength of different preferences. The choice cast in each game will often be consistent with more than one type of social preference. Incorporating the correct set of games allows for testing preferences against others.

The primary result from Charness and Rabin was that the earlier models that relied on only one other-regarding preference type were oversimplified. It was likely researchers need to account for more types of preferences. Seven preference motivations are typically identified as explaining most behavior in games in subsequent studies (Engelmann and Strobel, 2004; Charness and Rabin, 2002); efficiency
(maximize the sum of group payments), maximin (maximize the minimum of individual payments), selfishness, competitiveness (maximize positive distance between own payoff and others’), concern withdraw (withdraw of willingness to sacrifice for a fair allocation if others show they are not willing to do so), difference aversion, and reciprocity. Collectively, this description of other-regarding behavior constitutes the concept of social preferences.

Another important experimental design, which is the focus of this paper, combines reciprocal and distributional preferences and is based on the fair wage-effort hypothesis put forth theoretically in Akerlof (1982), Akerlof (1984), and Akerlof and Yellen (1990). It was theorized that due to social norms, a worker’s effort could be increased by firms if they pay an amount greater than the perceived ‘fair’ wage, or more precisely the market clearing wage. This came to be known as gift-exchange, which was put forth as an explanation for involuntary unemployment and the division of labor markets. The critical aspect of the theory is that the workers provide additional effort without any expectation of receiving a promotion or any other benefit in the future, which goes against the neoclassical model of the economic agent.

The fair wage-effort hypothesis was tested experimentally by Fehr (1998) and Fehr et al. (1998) who found that second movers who were given a higher wage (or price depending on the context) reciprocated with a ‘gift’ to the first-mover even in a one-shot (non-repeated) game. As a result, more efficient terms of trade were achieved because positive sentiment prevented the market from moving towards competitive minimum wage and minimum effort levels.
In another study, Charness and Haruvy (2002) design a gift-exchange experiment to delineate between altruistic, distributional, and reciprocal preferences by assigning wages to employees randomly, by self-interested managers, and by the experimenter in different treatments. Further tests for the presence of gift exchange have questioned somewhat the robustness of early gift-exchange results. Hannan et al. (2002) find that previous work experience of subjects may impact other-regarding behavior where MBA students, who presumably have professional work experience, returned higher levels of effort than did undergraduates. Charness et al. (2004) found that by simply giving a payout table to subjects, gift-exchange was eliminated. In a field experiment, Gneezy and List (2006) show that subjects who were paid more did initially provide a higher effort level, but they approached the effort of lower paid workers as the day proceeded, and exerted the same effort level when brought back for a second day.

The variance in results found in the gift-exchange should perhaps not be surprising. Just as is the case with laboratory simulations of public goods games, it is a slightly more complex game framed within a more realistic economic setting. Results appear to be more sensitive to variations on the game than is the case with the more abstract simple games that were reviewed in the previous section. This is of little concern in this study since the exact same version of the game is played in the individual and group treatments, and relative decisions between treatments is of interest.
1.3. Research Design

Subjects play a form of the gift-exchange game that follows Charness and Haruvy (2004), which has two important design elements relative to other forms of the game. The first is that workers (second-movers) cannot reject their wage offer. In other designs of the game, a continuous time market is created where firms offer wages that are accepted by a pool of workers. It was not possible to implement this design here because of the group communication structure used where groups can only communicate by proposing choices to their group member that either can accept. This system was chosen because it provides a rich amount of data on the dynamics of group decision-making, but it does not permit groups to collectively decide on which wage offers to accept in a dynamic continuous time market.

A second design element is that there is no public posting of all wages and effort, so workers only know their wage. This was done because of the importance of perception within the theory on the fair wage-effort hypothesis, which proposes that workers will provide extra effort if they receive a wage above what they perceive as a fair amount. Subjects have no experience playing this game so their perception of a fair wage is likely to be determined by two things. For one, they may believe that the wage \( w^* \) that is part of the pair \((w^*, e^*)\) that results in the largest total surplus is the fair wage. This could be calculated since there is complete information on income for both parties, but would require a significant cognitive effort.

Perception of fairness may also be based on their knowledge of wages in this game based on both levels they have received in previous rounds, and wages offered to
other workers, if there is public reporting. In this case they evaluate their wage relative to a reference wage. By not using public reporting, there is much greater confidence of what wage is being used by the subject as the reference wage, which motivates only using private reporting here. Also, as mentioned in Charness and Haruvy (2004), a review of gift-exchange experiments shows that public posting does not seem to impact results.

Specifics of the game follow the standard format in other gift exchange games. Subjects are assigned as managers or employees throughout the entire game. There are 12 subjects in each session, and the game is limited to five rounds so that the six managers and employees are never paired with the same group member twice. This is done to eliminate the possibility of subjects developing a dynamic strategy as a result of possibly being rematched with the same person in subsequent rounds. If one believes willingness to sacrifice is lowered after having received less in previous rounds, a subject will want to be less selfish if there is a possibility they will come across the same person more than once.

Managers are given 100 points and they choose to give a wage (w) to the employees between 0 and 100. After being informed of their wage, employees decide on a quantity of work (q) between 0.1 and 1.0, which has an associated cost (c(q)) schedule as shown below.
The managers income for the period is calculated as \( MI = (100-w) \times q \). Income for the employees is \( EI = w-c(q) \). The Nash equilibrium reached through backward induction is \( w = 0 \) and \( q = 0.1 \), which results in income for the manager and employee of 10 and 0, respectively. The largest possible total surplus is 100 points, which is achieved with \( q = .1 \) and \( w = 100 \). This result is unlikely since it requires a manager that is purely motivated by social efficiency preferences given that they know with certainty that they will get nothing.

To examine the effect of group decision-making on social preferences of constituent individuals four different treatments were used that provide a spectrum of group interactions. These treatments are individual (IN), bilateral group (BG), asymmetric group with communication (AC), and asymmetric group without communication (AN). By slightly altering the decision-making power between the constituent individuals in the group it is possible to assess whether social preferences are attenuated in groups, and how sensitive this is to different group decision-making procedures. Specifically, it allows for testing the hypothesis that group decisions are attenuated because concern for those inside the group are weighted more heavily than those outside the group.

All treatments were run with 12 subjects over networked computers. Individuals are randomly assigned to be managers or employees and they keep the same role
throughout. The experiment was limited to five rounds to eliminate any strategic considerations resulting from repeated interaction between employees and managers\textsuperscript{4}. The gift-exchange game measures social preferences by measuring whether the decisions of subjects are different than the Nash equilibrium strategy of zero wage and minimum effort. If interactions are repeated this is not necessarily the optimal strategy if employees believe that managers can be coerced to provide higher wages with higher effort. In all the group treatments a managing pair is grouped with an employee pair, so there are three of each.

Treatment 1: Individual (IN)

The individual treatment closely follows the gift-exchange game employed in other studies. The most important difference is that there is no market for labor contracts where employees voluntarily agree to a wage/effort combination. They must accept the wage they are given by their manager. Again, managers are paired with different employees in every round and no pairings are repeated.

Treatment 2: Bilateral Group (BG)

In the BG treatment both manager and employee groups of two communicate by negotiating over the computer. They are limited to offering a wage or an effort to provide to either the manager or employee pair they are grouped with. It is not possible

\textsuperscript{4} The experiment was limited to 12 subjects because of the computer lab being used.
to provide any explanation or reasoning for their offer either over the computer or by speaking to the other person. Negotiations are completely endogenous in that both group members can suggest a choice as often as desired and either person can make the first offer during the group-communication phase. The group-communication phase ends either when one of the offers is accepted or after 180 seconds. If there is no concurrence after 180 seconds, both subjects receive a payout of zero for that game. If this happens for the managers a wage of 0 is assigned to the employee team, while minimum effort is supplied for employees if no decision is reached. There is no limit on the number of offers that can be made during the group-communication phase. Each person sees all the previous offers they have made and all the offers their partner has made.

This form of group interaction has a number of important advantages. First, it eliminates a number of confounds that are created by face-to-face interaction. Factors including gender, race, physical stature, force of personality, and fluency with English could all confound the negotiation process. While each may play a key role in real-world scenarios, these factors are not the focus of the proposed research. The communication system isolates, as much as possible, the nature and intensity of each subject’s preferences. The only way for players to express preference intensity for a choice is either to repeatedly make the offer or simply wait and refuse to accept a partner’s offer.

A second advantage of the communication format is that it allows for a detailed analysis of the group negotiation process. Analyses can thus be made about who made an offer, who accepted an offer, how many offers were made, and when they were
made. Face to face interactions makes encoding these facets much more difficult. Conversations could be recorded, but knowing they were being recorded could change what people say. A text communication system could be used but this may allow people who are more comfortable in written argumentation to dominate negotiations.

Treatment 3: Asymmetric Groups with Communication (AC)

The asymmetric group treatments were designed to reveal group decision-making while eliminating any tendencies specific to back and forth negotiations. This is done by giving one person in the group ultimate control over wage and effort decisions. The AC treatment assigns half the managers and half the employees as decision-makers, while the other managers and employees can not directly control decisions. In the instructions read to the subjects the language used is ‘Decider’ and ‘Suggestor’. The non-dominant group members first inform the dominant member of the wage or effort decision that they prefer. The dominant pair member then decides the actual wage or effort. In the case of the employees, both employees are informed of the wage they have been assigned and then non-dominant member suggests an effort, and then the dominant member decides the actual effort to make on behalf of their group.

Due to the limitation of possible permutations of group pairings it was necessary to have repeated interaction between dominant and non-dominant subjects. Repeated interactions could have been avoided by allowing subjects to change roles in the course of the experiment, but previous studies have found this to significantly change behavior.
Also, a manager will be grouped more than once with a particular employee, but they will not face the same pair of managers or employees. While this does introduce some possibility of decisions being driven by repeated interaction they are minimized by not allowing subjects to identify the individuals through any type of ID number.

Treatment 4: Asymmetric Groups without Communication (AN)

The AN treatment is the same as the AC treatment except that the non-dominant pair member has no communication with the dominant team member. The dominant team member is simply told that they are making a decision on behalf of themselves and a pair member. They also know that managing teams and employee teams have the same arrangement. This treatment provides the cleanest baseline for estimating whether a group effect is aroused in even the most minimal group settings. Namely, someone making a decision on behalf of themselves and another person. Once again, it was necessary to sacrifice either role changing or repeated interaction due to a limit of permutations. Therefore, dominant managers are paired with two of the three dominant employees twice and one once. Again, they have no way of identifying which person they are interacting with in each round. The non-dominant pair members are asked what they would do if they were the dominant pair member.

The entire protocol has been approved by the local Institutional Review Board.
The four treatments are used to test the following nested hypotheses.

1. *Is gift-exchange in the group treatments different than in the individual treatment as would be predicted by previous studies?*

2. *Second, does the level of gift-exchange in groups differ from that found in the individual treatment in a consistent direction?* Evidence supporting this finding would throw weight behind a model of group decision-making that focuses on the concept of group identity if groups are more self-regarding. If groups are consistently more other-regarding then the finding in Cason and Mui based on SCT is supported.

3. *Third, if group other-regarding preferences differ from individuals but not in a consistent direction what is the impact of concentrating decision-making power group interaction particularly in relation to the predictions of SCT?* Differences in trust between groups and individuals is also examined using expected effort from managers.

1.4. Results

I begin by presenting descriptive statistics to identify trends in wage and effort across treatments and periods. This is followed by regression analysis used to directly test for the effect of group decision-making dynamics on other-regarding behavior.
Summary Statistics

Sessions were run between October, 2006 and July, 2007. Twelve subjects took part in each session, and a total of 13 sessions were run. By treatment, there were three sessions of IN, four of BG, three of AC, and three of AN. Since there are five rounds, a total of 30 wage and effort choices are made in each session for IN, while there are 15 for all the group treatments. For the total sample there are 237 unique wage/effort contracts.

Trends in average wage and effort across treatments and periods are shown in Figure 1. Wages were higher in BG (41) and AC (42) than in AN (33) and IN (38). IN, BG, and AN were all similar in distribution around the mean with a standard deviation of about 23, as opposed to the more tightly grouped wages in AC where the standard deviation was 15.

Mean effort was similar for IN and BG at 0.23 and 0.22, respectively. Mean effort was slightly higher in the AN treatment at 0.26. The most notable deviation in either variable was in the effort choice of the AC treatment at 0.36. Minimum effort was more than twice as frequent in BG (60%) than in AC (26%). IN was a slightly lower than BG at 56%, and lower yet in AN at 31%. Figure 4 breaks down average effort at different points in the wage schedule to provide some insight into mean effort across the treatments conditional on wage. A notable exception in AC compared to the other treatments is that no managers ever assigned a wage of less than 10. AC also
stands out with higher effort in each wage range greater than 10, while effort was notably lower at high wages in BG.

A basic test for the presence of other-regarding behavior is to check whether effort and wage are different than the game theoretic solution. Given that this is a one-shot game, the Nash equilibrium strategy by the manager is to assign a wage of 0 since they would predict that the employee will maximize their own pay by choosing minimal effort no matter what the wage. Effort and wage are different than 0.1 and 0 at a 99% confidence level in all treatments.

While the location of the distribution of observed wages are only moderately different across treatments, the variance is greater in IN and BG than in AC and AN. In fact, according to a variance ratio test there is no difference between IN and BG (p-value = 0.46). On the other hand, the variance in wages in IN and BG are both significantly different than AC at a 99% confidence level.

Looking at the frequency of low wages, 23% percent of wages in the IN treatment were 10 or below. In the BG treatment 19% were in this range. This percentage drops to 4% (2 out of 45) in the AC treatment where it was equal to 10 in both cases. Slightly more similarity is present in the frequency of high wages across treatments. In the IN treatment 32% of wage offers were above 50, while just under half were in BG (47%). AC was in between IN and BG at 36%, while AN was the lowest at 25%. Clearly, managers in the BG treatment are much more likely to offer high wages than are those in the other treatments. It is also apparent that the AC and AN treatments differ significantly to IN and BG in the lack of variance in wage offers.
Very few observations are particularly low or high in the group treatments with asymmetric power.

Earnings and Surplus

A central question when analyzing any market is whether social surplus is greater under certain regimes than in others. In the gift exchange game, where the managers income is $MI = (100 \text{- wage}) \times \text{effort}$ and the employees income is $EI = \text{wage} - \text{cost}$, either actor has significant leverage to affect surplus. If all subjects employed the Nash equilibrium strategy where wage is 0 and effort is 0.1, income is 10 for managers and 0 for employees. The average points per round for managers over all the treatments was 14, while it was 36.3 for employees. Broken down by treatment it was 13.1 for IN, 11.5 for BG, 18.5 for AC, and 15.5 for AN. The mean point total for employees was 33.2 for IN, 40.5 for BG, 38.2 for AC, and 33.9 for AN. So, managers do only marginally better in the BG treatment than they would have if the Nash strategy had been used. On the other hand, the employees in the BG treatment earn the most points of either role in any treatment. This is an indication that employees in BG are returning the lowest effort relative to the wages they are receiving.

The average total surplus per contract per round is the highest in the AC treatment at 56 points. It is followed by BG at 52, AN at 49.4, and IN at 46.3. It would appear that managers maintained higher levels of gift exchange by avoiding the very low wages that were common in IN and BG. Employees in AC also contributed to this by not deviating to minimum effort in round 1 and 2. Employees did earn fewer points
on average in AC as a result of this, although the increase in managers points more than made up for it from a social surplus standpoint.

It is typical in laboratory experiments examining other-regarding preferences for decisions to vary over periods as subjects gain more information on what the population they are interacting with tend to do. This experiment was limited to 5 rounds to avoid repeated interactions and reputation effects. Pooling all the treatments, there is clearly a downward trend in effort. The mean effort levels for periods 1 through 5 of the pooled sample was 0.35, 0.25, 0.26, 0.22, and 0.20. The mean wage for the entire sample for periods 1 through 5 was 45, 42, 41, 32, and 30. Figures 5 and 6 show the trend in mean wage and effort broken down by treatment and period. There is a clear downward trend in the pooled sample.

Regression Analysis

The nature of the effort and wage decisions requires moving beyond a basic ordinary least squares regression framework. Both variables are restricted to a range. As was shown above, a large percentage of effort choices were at the minimum of 0.1, while a small number were at the top end limit of 1. Wage is also restricted with a minimum of 0 and maximum of 100. Again, a significant minority of wage decisions were 0. Given that some observations of both variables were at the limits, it is necessary to account for censoring when either is the dependent variable. Interpretation of the effort variable as censored can be viewed as parallel to the Tobit model of durable goods purchases where a number of subjects reported no purchases, as opposed
to the interpretation of truly censored variables such as top coded income data where measurement limits observing the true value above or below a certain level.

Employees are also required to consider effort choices in discrete increments, so the effort decision is not truly continuous. As is often the case with economic data, while the variable is not truly continuous, the increments are small enough so that the variable can be modeled as continuous. This avoids problems related to using a model such as an ordered probit when there are few observations for some realizations of the dependent variable.

The data also contains repeated observations from the same individuals. Thus, the assumption of independent errors is violated. In the IN, AC, and AN treatment this simply requires accounting for unobserved individual specific effects through a panel data model. Given that regressors, as will be discussed shortly, are exogenous to the individual it is prudent to increase efficiency without threat of biasing estimates by using a random effects framework. Representing individual specific effects in the BG treatment is slightly more complicated. In BG there are two individuals actively making one choice as opposed to AC and AN where the decision is made by one person. Since the pairs change every round it is not possible to have group specific effects. Using individual specific effects requires including each wage and effort decision twice in BG. This is the approach taken in modeling the BG treatment here.

The determinants of effort are examined using a random effects censored regression, which is used throughout the following analysis. Explanatory variables include wage, period, period squared, dummies for treatment, and wage and treatment interaction terms. The effect of treatment on effort and wage decisions is identified by
pooling relevant treatments and including a dummy variable identifying the treatment with IN dropped to avoid collinearity, and an interactive term between wage and the relevant treatment dummy. This specification makes it possible to identify both level and slope effects of group decision-making dynamics on other-regarding preferences. Considering a comparison IN to BG, with IN being the dropped categorical variable identifying treatment, the coefficient on wage in the regression equation identifies the total effect of wage on effort in the IN treatment. The total effect of wage on effort in BG is calculated using the linear combination of the coefficient on wage with the interaction term with wage for each treatment. A difference in the slope of the relationship of wage on effort between treatments is identified by statistical significant of the coefficient on the interaction term. While bias of estimates of coefficients is typically a concern in random effects models resulting from correlation between unobserved individual specific effects and regressors, it is not a concern here since all regressors are exogenous to any individual characteristics or choices. For all regressions with effort as the dependent variable in treatment AN one observation where wage is 0 and effort is 0.5 is dropped due to the sensitivity of regression results to it’s presence. While there is nothing illegitimate about this effort choice by one employee there are no similar observations anywhere in the entire sample.

Model specification is as follows. Let $e^*$ be a normally distributed variable where $e^* = e$ if $e > c$, else $e^* = c$ where $c$ is a constant (Hsiao, 2004).

$$e^*_i = \alpha_i + \beta_x x_{it}$$

$i = 1, \ldots, N$

$t = 1, \ldots, T$
As stated above, the error term is assumed to be independent of \( x_i \) and is i.i.d. over time and across individuals. Assuming the error \( \alpha_i \) is randomly distributed with density function \( g(\alpha) \), the likelihood function is

\[
\prod_{i=1}^{n} \left[ \prod_{t \in c_i} F(-\beta x_i - \alpha_i) \prod_{t \in c_i} f(e_i - \alpha_i - \beta x_i) \right] g(\alpha_i) d\alpha_i
\]

The estimated coefficients resulting from the above model can be interpreted directly as marginal effects since it is of interest here to make statements about effect of wage on effort for the general population, as opposed to only those supplying non-minimal effort.

General descriptive statistics of effort and wage hinted at supporting the finding in previous studies that groups do exhibit different preferences for other-regarding behavior, but the direction and magnitude depends on the group procedure. Table 2 provides a comparison of gift-exchange in all the group treatments compared to IN. The slope effect of wage on effort is statistically different in BG compared to IN at a 10% confidence level. Employee pairs returned less to managers for a given increase in wage than did individual employees. The difference is non-trivial from the perspective of managers seeking to generate higher effort. The total effect of wage on effort was 0.011 for individuals compared to 0.0067 for groups in BG. In other words, gift-exchange in BG was only 67% what it was in IN.

The difference becomes more pronounced when considering only wages of 10 or greater, which is a useful benchmark since an employee is guaranteed to make less than a manager if the wage is less than 10. Thus, it provides a point where negative
reciprocity is likely to be aroused. Regressing effort on wage, period, and period square for IN and BG as separate samples results in a striking difference in both the magnitude and significance of gift-exchange between treatments. The wage coefficient is significant at less than 1% with a value of 0.011, while it is only significant at 10% for BG with a value of 0.004. A useful way to interpret this difference that may shed light on group behavior in other experiments is that individual second-movers in the gift-exchange game can be motivated to continually increase effort throughout the wage schedule, while groups can be motivated to give non-minimal effort with higher wages but do not continue to increase effort. One possible explanation is that individuals exhibit both negative and positive reciprocal preferences whereas groups only exhibit negative reciprocity in the form of lowering effort from an unfairly low wage.

Switching the group procedure towards dominant and non-dominant decision-makers clearly has an impact on other-regarding preferences. Hierarchy in the group decision-making process is an important characteristic to be modeled, and one that this experimental design isolates. While BG had the lowest level of other-regarding behavior, AC had the highest. Results from the regression analysis of show that the estimated slope of the relationship between wage and effort is different in AC than in IN at a 5% confidence level. The difference with AC compared to BG is that gift-exchange is greater relative to that in individuals. Again, the difference is not only statistical but is also meaningful. The total effect of wage on effort is 50% higher for AC (0.015) than (0.01) IN. What is common between AC and IN is that little changes when restricting wage to be greater than or equal to 10, so the relationship between wage and effort appears fairly constant over the wage range.
AN provides an important comparison to IN because it isolates the effect of merely telling someone they are paired with someone else. This is important for testing the power of a model of group decision-making based on a group identity effect. While the complete lack of interaction between the pair members may seem artificial it serves two important purposes. For one, it completely eliminates any group effect that may result from negotiations with equal or hierarchical group structure. This is necessary to understand whether individuals weigh those inside their group more than those outside even in the weakest definition of the term ‘group’. The AN treatment in this experiment reveals whether a group effect, identified as less gift-exchange than in IN, arises when there is some interaction in the form of a suggestion but this also introduces other possible explanation, such as SCT. An argument can also be made that the procedure in AN is not as artificial as it may seem. There are many instances in the business world where managers make decisions that effect those inside their organization that they know exist but do not know personally in addition to those outside their organization. Results from the regression comparing AN to IN does not show that a group effect is formed in this treatment. There is no statistically significantly different relationship between wage and effort. Restricting wages to be greater than 9 does not change results in any way. Therefore, if group identity is causing a reduction in other-regarding preferences in some instances it would seem to require some experience greater than what is used here to initiated.

Analysis of the non-dominant group members in treatments AC and AN shows how dominant pair members respond to their non-dominant partner revealing how a hierarchical group procedure changes other-regarding behavior. To review, in these
two treatments there are three types of effort variables. There is suggested effort made by the non-dominant member in AC that is reported to the dominant partner, hypothetical effort made by the non-dominant partner in AC that is not reported to the non-dominant partner, and the delivered effort made by the dominant partners in both AC and AN. This procedure leads to an important question. Does the privilege, or burden depending on one’s perspective, of having the ultimate say lead to a different reported preference? Also, does the fact that the stated preference made by the non-dominant partner is reported to the other group member affect the choice? A scatter plot of all suggested (AC) and hypothetical effort (AN) with the corresponding wage are shown in Figures 8 and 9. While non-dominant employees have a clear preference for increasing effort in response to higher wages there is a greater tendency for minimum effort at higher wages to be suggested in AC than hypothetically reported in AN. The highest wage with a minimum effort in AN is 25, while there are a number of non-dominant employees in AC suggesting minimum effort at wages between 30 and 60. The impact of reporting to the dominant partner on the non-dominant partner’s choice is evident when regressing both variables in separate samples on wage, period, and period square. Results, displayed in Table 3, show the coefficient on wage to be significant at greater than 99% in both treatments, but the magnitude of the effect of wage on hypothetical effort is twice as large in AN (0.015) than suggested effort in AC (0.0077). In fact, all employee effort decisions represent a similar level of gift-exchange in treatments AC and AN other than that from non-dominant employees in AC who are clearly the most self-regarding at levels similar to that found in BG.
Another finding from group preferences studies has been that in games involving trust group first-movers are less trusting than individuals. The wage variable in the gift-exchange provides some measure of trust, but it is confounded with distributional preferences. It is not correct to assume that a high wage is a direct measure of high trust since it could also correspond to a person with strong other-regarding preferences that is seeking to minimize income inequality between themselves and the employees. To provide some control for this confound the managers are asked what effort they expect to receive after having assigned a wage. Thus, trust in this context is interpreted as the expectation of high effort in response to a high wage. Expected Effort and corresponding wage observations for all treatments are shown in Figures 10 to 13.

Using the same regression modeling approach employed to analyze the employee effort decisions, Table 4 shows that trust does not differ statistically between IN, BG, and AN. Trust is higher in AC compared to the individual treatment. This increased trust likely had a role in the high wages assigned in AC, which stood out from the other three treatments for having no wage decisions less than 10. Given the finding in the analysis of employees that the act of reporting had an effect on non-dominant employees it is worth investigating whether trust differs between the two roles in AC and AN. Results provided in Table 4 show that the coefficient on the dummy for non-dominant interacted with wage is insignificant for AC, so there is no difference in trust. Results of the same regression for AN are curious given that expected effort is not related to wage for dominant players. This result is largely driven though by the few observations for non-dominant managers in AN that expected near maximum effort.
despite their group having assigned a wage of or near zero. Restricting wage to be greater than 9 results in trust estimates that are similar to other estimates, and there is no difference between the dominant and non-dominant roles. In general, results here do not unambiguously support the finding in Bornstein et al. (forthcoming) that groups are less trusting. The only group treatment that differed from individuals was AC where trust was higher.

1.5. Conclusion

Other-regarding behavior in groups compared to individuals was examined in a laboratory gift-exchange game. By gradually shifting decision-making power towards one group member over another this research sought to clarify previous studies on the social preferences of groups that have been equivocal. A hypothesis is put forth based on research in field experiments that groups tend to be more self-regarding because individuals weigh the pay of those inside their group more heavily than those not in their group. This is compared to a theory of group decision-making called Social Comparison Theory that was originally developed in the social psychology literature that predicts groups will be less self-regarding because social norms dictate that strong social preferences are considered desirable.

It was not found that the level of gift-exchange in group treatments consistently differed from that in the individual treatment. While the group treatment that assigned equal bargaining power resulted in less gift-exchange than with individuals, the group treatment that assigned decision-making power to one person while allowing the other
to make suggestions resulted in more gift-exchange. This reinforced previous studies that have found the level of other-regarding preferences in groups to be very sensitive to the procedure of group decision-making.

The hypothesis put forth that group identity causes group decisions to be more self-regarding was rejected as gift-exchange in the group treatment with asymmetric power and no communication did not differ from that found with individuals. This result does not fundamentally reject the group identity explanation as a potentially important one. Treatment AN was designed to investigate whether the group identity hypothesis had any explanatory power even when the concept of a group was very weak. This is important for providing a baseline. It is the subject of future research to increase interaction between group members to understand what is required for a group identity to form, and whether it attenuates social preferences.

The high level of gift-exchange in treatment AC leaves open Social Comparison Theory as potential explanation for increased other-regarding preferences in groups. In a companion paper to this an explanation of group decision-making based on the strength of preference of some individuals put forth by Luhan et al. (Working Paper) is empirically tested, and is compared to the explanatory power of SCT. While it is clear that when individuals come together to make a collective decision the group decision-making process does not simply aggregate their individual preferences, the deviation is highly reliant on the procedure that defines how the decision is made. Further empirical research that continues to test and build theoretical models of group decision-making is needed.
1.6. References


Kugler, T., G. Bornstein, M.G. Kocher, and M. Sutter. Trust Between Individuals and Groups: Groups are Less Trusting than Individuals but Just as Trustworthy. Forthcoming in *Journal of Economic Psychology* (Forthcoming).


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<th>Wage</th>
<th>Effort</th>
<th>Wage</th>
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Table 1.1 Average Wage by Period and Treatment.
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<td>-0.286</td>
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<td>(0.13)</td>
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<td>(0.122)</td>
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<td>0.011***</td>
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<td>(0.0018)</td>
<td>(0.0014)</td>
<td>(0.001)</td>
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<td>(0.0023)</td>
<td>(0.0024)</td>
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<td>-0.172**</td>
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<td>0.015***</td>
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<td>(0.0026)</td>
<td>(0.002)</td>
<td>(0.0023)</td>
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Notes: *, **, and *** denote significance at the 90%, 95%, and 99% confidence levels. Standard errors are in parentheses. Treatment abbreviations are IN=Individual, BG=Bilateral Groups, AC=Asymmetric Communication, and AN=Asymmetric No Communication. TD represents the treatment dummy.

Table 1.2 Random Effects Censored Regression Comparing Gift-Exchange in Each Group Treatment to the Individual Treatment.
### Table 1.3 Suggested, Hypothetical, and Actual Gift-Exchange in Treatments AC and AN.

<table>
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Notes: *, **, and *** denote significance at the 90%, 95%, and 99% confidence levels. n=45 for all samples.
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<th>AN Dom vs. Non-Dom</th>
<th>AN Dom vs. Non-Dom Wage&gt;9</th>
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Sum of Wage and Wage*AC: 0.011***

Notes: *, **, and *** denote significance at the 90%, 95%, and 99% confidence levels. Sum of wage and interaction term only provided for cases where coefficient on interaction term is significant. Dum is a dummy for the relevant treatment for the first 3 columns, and represents the non-Dominant role in the last three columns.

**Table 1.4 Regression Analysis of Expected Effort as a Measure of Trust.**
Figure 1.1 Treatment IN Effort/Wage Contracts.
Figure 1.2 Treatment BG Effort/Wage Contracts.
Figure 1.3 Treatment AC Effort/Wage Contracts.
Figure 1.4 Treatment AN Effort/Wage Contracts.
Figure 1.5 Mean Effort by Treatment at Low, Medium, and High Wages.
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2.1. Abstract

This study examines an explanation for the empirical finding that collective decisions made by groups of individuals tend to correspond more with pure self-interest than those made by individuals acting alone. Based on results from a group dictator game Luhan et al. (2007) contend that there is a difference in ‘strength’ of preferences between other and self-regarding types where the latter exert more influence over the group decision-making process, and are less willing to deviate from a group choice that is different from their individual preference. This causes other-regarding preferences to be attenuated in groups. This study considers this explanation using results from a laboratory gift-exchange game that compares individuals to group decisions made in three different hierarchical arrangements. Results partially, but not completely, correspond with the strength of preference concept. This leads to a consideration of whether group decision-making should be modeled as an application of reciprocal preferences.
2.2. Introduction

This research studies the dynamics of group decision-making in a laboratory gift-exchange game to develop understanding of why group social preferences tend to differ from that of individuals, which has been well established empirically. Dynamics specifically refers to how individuals in a group act and interact in the process of reaching a collective decision. Analysis of the process of how groups arrive at decisions is made possible by a novel group decision communication methodology that provides many advantages over methods used in other studies by allowing for endogenous timing of offers, while eliminating confounds that exist in procedures with greater interaction. Two other treatments allocate decision-making power to one group member, and vary whether there is communication with the non-dominant partner. This isolates negotiation related phenomenon from group consideration effects. The group treatment with negotiation is abbreviated as treatment BG. The asymmetric groups with communication are treatment AC, and those without are treatment AN. Details of the treatments are provided in Section 1.3.

Results from this experiment provide an ideal data set to test an explanation for why group decisions deviate from those of individuals proposed in Luhan et. al (2007) based on the dictator game. In the dictator game an individual is asked to split a set amount of money between themselves and another person. Based on analysis of text communication between group members they contend that group decisions tend to deviate from those of individuals because people with self-regarding preferences are
more influential in the decision-making process, and are able to orient the group decision closer to their individual preference. This is referred to as strength of preference (SOP). Developing theory with reference to group decisions is an important question since the most common model to date called Social Comparison Theory (SCT) concludes that the process of group decision-making will result in more other-regarding preferences, which is counter to a majority of empirical findings. While results of this study partially agree with the SOP explanation I find that there may be an additional group of other-regarding types that have relatively strong preferences. An argument is put forth that a better explanation for group decision-making may be provided by the concept of reciprocity. It is shown that this approach can explain a great deal of results in this study and in Luhan et al.. Also, developing a group model on reciprocity has the advantage of being rooted in social preferences theories that have received significant attention and treatment over recent years, thereby avoiding the need to build theory from scratch.

Most studies on the social preferences of groups have found that they act with greater self-interest than individuals. These include Bornstein and Yaniv (1998), Cox (2002), Kocher and Sutter (2007), and Kugler et al. (2006). It is important to note that these studies focus on small group decisions, which is different from the literature looking at how individual preferences are aggregated into social preferences asking questions such as will different voting schemes produce different decisions (Harsanyi (1955) for instance.

The first study comparing social preferences displayed by groups to individuals was Cason and Mui (1997), CM from here on, where they found the opposite result. In
an experimental design that alternated subjects playing a dictator game individually and in pairs, group choices were more other-regarding than those of individuals. The groups discussed face-to-face how to split the money between themselves and the other team. The experiment was designed to test two theories of group decision-making that came out of social psychology research on groups. They are Social Comparison Theory (SCT) and Persuasive Argumentation Theory (PAT). CM contend that other-regarding preferences are deemed more favorable in society than are self-regarding preferences. As the individuals discussed what choice to make with their pair member they sought to be looked upon favorably suggesting a more other-regarding choice than they would have chosen alone. As a result, group decisions tend to be more other-regarding on average.

Within social psychology this phenomenon is more generally referred to as group polarization, and was put forth after it was found that group decisions in contexts with risk could be shown to be either more or less risky than individuals on average, but most importantly were consistently more extreme than the preferences of the most extreme individuals. The original study is Stoner (1961). Meta-analyses include Isenberg (1986) and Pruitt (1971). The critical assumption of SCT in terms of group social preferences is the assumption that social norms dictate that other-regarding preferences are held in higher regard, which motivates most people. There is justification for this. Few awards are given for an adherence to self-interest. On the other hand, recognition is routinely given for those who volunteer, give to charity, or generally sacrifice to help others. So, there is enough reason to believe that if social pressure exists to portray oneself in any particular light it is to tend towards that of
having a strong concern for the welfare of others. The basic problem with SCT as a model of group decision-making over economic choices has been that it has not provided an accurate prediction of behavior in a majority of empirical studies.

Luhan et al. (2007) perform a partial replication of CM due in large part to the fact that so many studies have not found the same result. They seek to discover whether results can be repeated with some alteration to the design. These are not inconsequential though. One change is to have group members discuss what choice to make by writing over computer rather than discussing face-to-face as was done in CM. They also form three person groups instead of two. Another change is that all subjects play the dictator game individually, then in teams, and again alone. Results do not replicate those from CM. Instead, they find that groups act with greater self-interest. They also show that individuals who decided on a more equal split in the first individual game are more selfish in the second individual game if the group decision, done between the two, provided a more unequal split. The opposite is not true though. If a self-interested type is part of a group choice that was more other-regarding their second individual choice does increase the share for the other person. They also show that analysis of the text communication between group members reveals that the self-interested individuals have the most control over the group decision.

This research also uses a more limited form of group interaction to reveal the dynamics of group decision-making to understand why individual preferences are not simply weighted equally. Instead of a simple distributional game, a response based design called the gift-exchange game is used. Originally designed by Fehr et al. (1998) to experimentally test a model of voluntary unemployment proposed by Akerlof (1982),
it tests whether subjects return money if more is transferred to them by someone in the first stage. The analysis is based on data made possible by a novel group communication mechanism designed to provide a rich environment for negotiation while eliminating confounds that are likely to result from higher forms of communication such as typing, talking, or negotiating face-to-face. In both the first and second stages of the gift-exchange game subjects in groups of two are asked to come to an agreement with their partner. Once time starts either person can make offers. An agreement is made only when one person accepts an offer from their partner. Otherwise, either person can make as many offers as they want. It has favorable characteristics relative to group communication procedures from other studies. For example, Kocher and Sutter (2007) use a three person multi-round voting procedure that eliminates complications that arrive from increased interaction. Characteristics such as height, gender, weight, race, language ability, typing ability, and many other variables could dictate the final group decision. The method used in this study also eliminates those confounds, but allows for subjects to display their preferred choice to their partner in a more nuanced manner. Someone who feels more strongly about a choice can make an earlier offer, make more offers, or they can harden their position by making a more extreme offer in the opposite direction of an offer they disapprove of. Other studies provide more realism by allowing face-to-face interaction, spoken, or written communication for group discussions, but introduce the confounds discussed above.

The negotiation data consists specifically of all offers made, who made the offer, when each offer was made, and who accepted the agreed upon choice. This is used to
test the explanatory power of the concept of strength of preference as described by Luhan et al. Results from treatment AC are analyzed to test how dominant decision-makers were influenced by suggestions made by their non-dominant partners. This provides a test of whether certain types are more likely to be influenced. Also, the influence of effort choices made by the dominant partner on the suggested and hypothetical effort choice of the non-dominant types are considered to examine whether observing trends in the preferences of others affects preferences.

2.3. Experimental Design

The exact design of the gift-exchange game is the same as in Chapter 1, but is repeated here for convenience. Managers are given 100 points and they choose to give a wage \( w \) to the employees between 0 and 100. After being informed of their wage, employees decide on a quantity of work \( q \) between 0.1 and 1.0, which has an associated cost \( c(q) \) schedule as shown below.

<table>
<thead>
<tr>
<th>( q )</th>
<th>0.1</th>
<th>0.2</th>
<th>0.3</th>
<th>0.4</th>
<th>0.5</th>
<th>0.6</th>
<th>0.7</th>
<th>0.8</th>
<th>0.9</th>
<th>1.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>( c(q) )</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>4</td>
<td>6</td>
<td>8</td>
<td>10</td>
<td>12</td>
<td>15</td>
<td>18</td>
</tr>
</tbody>
</table>

The managers income for the period is calculated as \( MI = (100-w)q \). Income for the employees is \( EI = w - c(q) \). The Nash equilibrium reached through backward induction
is \( w = 0 \) and \( q = 0.1 \), which results in income for the manager and employee of 10 and 0, respectively. The largest possible total surplus is 100 points, which is achieved with \( q = 0.1 \) and \( w = 100 \).

There are 12 subjects in each session with 6 managers and 6 employees. There are 5 periods, which was chosen to completely eliminate repeated interaction in the individual treatment. There is some rematching between pair members in the group treatments, although subjects are not given any way to identify who they are paired with.

In treatment BG both the management and employee pairs have 3 minutes to arrive at a decision. Once the time starts they can make as many offers as they want whenever they want. Offers cannot be rescinded, so once an offer is made it can always be accepted. This provides greater significance to each offer made. If a group does not make a decision within the 3 minute time limit they earn 0 points for that period. If this happens for management teams a wage of 0 is assigned, and for employees an effort level of 0.1 would be used to calculate the management teams points. Figure 2.1 shows an example of an employee group negotiation. The circular symbol denotes when the offer that was accepted was made.

This design allows testing the following specific hypotheses that are posed to examine the explanatory power of the proposition that self-regarding types have stronger preferences.

1. *In treatment BG do group negotiations that require greater effort in terms of time and number of offers result in lower gift-exchange?* If self-regarding types
have stronger preferences than they should be willing to wait longer to reach an agreement or make more offers reinforcing their preference during negotiations. As negotiations progress other-regarding types will hold less firm resulting in an agreed upon choice that is more self-regarding.

2. *Do subjects that initially display other-regarding preferences through actual, suggested, or hypothetical gift-exchange migrate towards choices that conform more with self-interest if they observe other subjects displaying self-regarding preferences?* Both the non-dominant and dominant subjects in treatment AC and the non-dominant subjects in AN have the preferences of other subjects revealed to them in a controlled manner that makes it possible to examine the influence of the preferences of others.

### 2.4. Results

**Gift-Exchange for Groups vs. Individuals**

Regression results providing a comparison of gift-exchange between treatments is given in Table 1.2. To briefly review, the term gift-exchange is interpreted as the return of higher costly effort on the part of the second-mover, or employee, in response to receiving a higher wage. Gift-exchange in groups, as measured by the coefficient for the linear combination of wage and the interaction term between wage and the group treatment dummy variable. To provide some perspective it was necessary for managers in treatment BG to increase wages by 15 points to induce a one level increase in effort
compared to IN managers that only need to increase wages by 10 points. Consider an individual manager that is choosing between paying a wage of either 40 or 60 points. If they pay 40 and delivered effort is 0.2 their point total for that period is 12. If they increase the wage from 40 to 60 inducing a 2 level increase in effort to 0.4 their point total is now 16, or a 4 point improvement. A BG manager on the other hand would have to increase the wage from 40 to 70 to induce a two effort level increase, although they would be indifferent because they would earn 12 points either way.

As described earlier, the advantage of the BG group communication mechanism used in this study is that it provides a detailed description of how individuals arrived at their final decision. Allowing either pair member to make as many offers whenever they want within the 3 minute time limit provides an ideal dataset to test whether individuals of certain preference types act differently from other types.

Before proceeding to an analysis of the negotiation it is informative to review by subject the effort choices made between the group and individual treatment. Eighteen subjects played the employee role in the IN treatment. For treatment BG there were 24 employees consisting of 12 groups. For IN 28% chose minimum effort in all periods, while 21% did in BG. Somewhat unexpected given the higher effort levels in treatment AC no subjects chose minimum effort in all periods, while 22% did in AN. One explanation for this is that certain subjects were unlucky and received low wages and reciprocated with low effort. Comparing the average wage of minimum effort types to the rest of the sample does not show this to be the case though. In the individual treatment the average wage for minimum effort types was 38 compared to 34 for non-minimum effort types. They are nearly equal for BG with a value right around 42. The
minimum effort employees in AN did receive wages that were about 7 points below the average. This provides some indication that a significant minority, around 20%, of subjects select minimum effort no matter what the wage is.

The important question in the context of group decision-making and preference strength is what influence individuals with strong self-regarding preferences, in terms of not engaging in gift-exchange, have when placed in a group decision-making environment. The focus of the remaining analysis is to provide some insight to this question using the employee negotiation data.

Group Negotiations

The communication structure used in treatment BG was designed to create a rich data set revealing how individuals in a group arrive at decisions while imposing as little structure as possible. Most importantly, it achieves this aim while eliminating confounds resulting from more intimate interaction. The timing of offers is endogenous where either pair member can make the first offer, and either can make as many offers as they want, whenever they want, within the three minute time limit. While it does sacrifice some real world context where face-to-face or spoken interaction is common the elimination of confounds presents these results as a valuable baseline scenario. The approach used in this treatment represents an attractive compromise between realism and control relative to other group studies.

Compared to the management pairs the employees required fewer offers before arriving at an agreement. This is probably due to the fact that managers have a wider
range of values over which to decide. Also, most employees are likely to agree on a
low effort level when they have been assigned a very low wage reducing the number of
offers for a large set of pairs. Out of 57 groups, 36 made one or two offers before
reaching an agreement. The largest number of offers made or an employee group was
14.

Total offers and time to decision are used to test the hypothesis that self-
regarding types have stronger preferences. The mean time to decision for employees
was 37 seconds with a standard deviation of 46 seconds. The minimum time was 2
seconds, while the maximum was 178 seconds. As shown in Figure 2.2, when wages
were below 35 relatively little time was required to reach an agreement. The groups
that required more time typically received a wage between 35 and 60. What is striking
in Figure 2.3 is that all but two of the minimum effort choices were agreed upon in
under 40 seconds. That means that more contentious negotiations generally did not
result in minimum effort. For the entire group sample the average effort choice was
0.22. All effort choices were equal to 0.1 when the wage was 20 or below. An average
of only 10 seconds and 1.5 offers was required to arrive at a decision, while
negotiations took an average of 43 seconds and 3.7 offers when the wage was greater
than 20.

Regression analysis is used to more precisely test the hypothesis that longer
negotiations result in lower effort. The sample is restricted to observations where the
wage is greater than 20 since the data provides convincing evidence that even other-
regarding subjects will supply minimum effort when the wage is below this point. The
question then is are individuals with self-regarding preferences willing to undergo
greater effort to reach a consensus in the group to provide minimum effort? If effort choices resulting from more difficult negotiations are not lower then there is an indication that self-regarding types may not have stronger preferences than other-regarding types.

The wage was greater than 20 in 46 out of the 57 BG contracts. Minimum effort was chosen 48% of the time in this sample. In contrast to the idea of strong self-regarding preferences, the minimum effort decisions were agreed upon in less time and with fewer offers. In fact, it is the negotiations that resulted in non-minimal effort that appear more contentious. In the sample where wage>20 there is a significant difference in time and offers when minimum effort was chosen compared to non-minimal effort. Only 17 seconds and 2.5 offers were required to arrive at the minimum effort decisions. In contrast, the non-minimum effort decisions were arrived at after 67 seconds and 4.8 offers on average. Could it be that the minimum effort decisions were at the lower end of the 21 to 100 point wage range? This does not appear to be the case. The mean wage for the minimum effort choices in this sample was 51.1 compared to 50.1 for non-minimum effort choices. In other words, the minimum effort choices were evenly distributed along the wage range relative to non-minimum effort when wage>20.

Dividing the sample of effort choices into minimum and non-minimum provides useful information, but does eliminate a great deal of information derived from the effort decision. Therefore, a regression framework is specified to capture the relationship between time, offer count, and effort. Table 2.1 provides results from a censored regression of effort choice on wage, time, number of offers, period, and period squared. Before focusing on time and offers it is important to note that the coefficient
on wage is insignificant meaning that there is no gift-exchange, no positive statistical relationship between increasing wage and increasing effort, in this sample. There is also no measurable relationship between the number of offers and the effort choice. There is a positive and significant relationship between time and effort. The coefficient on time equates to an increase in one effort level for an additional 33 seconds taken to reach an agreement.

These results provide evidence that partially agrees with a concept of SOP, but with a caveat. The interpretation of SOP used to explain the increase in self-regarding preferences of groups is that individuals with strong self-regarding preferences are less willing to compromise than those with other-regarding preferences. As a result, groups tend toward self-regarding choices relative to individuals. This model would seem to predict that groups that take longer to arrive at a decision would make a more self-interested choice than groups that agree quickly. This occurs when an individual with self-regarding preferences is paired with an other-regarding type, and the prior makes more offers or waits longer until the latter agrees to a lower effort level.

Before turning to whether this is supported it is worth considering the focus of the strength of preferences concept. One could alternatively say that individuals with other-regarding preferences have weaker preferences. This would seem to agree with the data. In the individual treatment subjects continued to increase effort throughout the wage range, while they did not in the group treatment. Considering observations where wages are greater than 20 shows that minimum effort choices were reached quickly, and this occurred even as wages increased significantly. So, one can conclude that some individuals who would have increased effort at higher wages agreed to minimum effort
with very little provocation. In this sense, the proposition that self-regarding preferences are held more strongly, or alternatively other-regarding preferences are held more weakly, has some ability to explain results here. On the other hand, negotiations that take more time result in higher effort levels throughout observed wages from 20 to 100. Using the same reasoning this would mean that some portion of subjects with other-regarding preferences hold them more strongly than self-regarding subjects. This additional element does start to complicate a SOP concept somewhat in terms of future attempts modeling and prediction. In the discussion that follows it is shown how viewing group decisions through reciprocal preferences provides an alternative perspective to explain these results within a pre-existing theoretical framework.

Table 2.2 shows results from a regression estimating gift-exchange with observations from treatments IN and BG pooled and restricted to cases where wage>20. The coefficient on wage, the marginal effect of wage on effort for treatment IN, is significant at greater than 99%. The linear combination of wage and the wage interacted with the dummy for treatment BG, the marginal effect of wage on effort for treatment BG, is only significant at a 90% confidence level. Also, the magnitude of gift-exchange is 188% lower than for individuals. The difference in gift-exchange becomes significantly lower in BG than for IN as the sample is restricted to higher wages.\(^5\) It seems as if a number of subjects that would have chosen a higher effort level individually were quick to accept or propose minimum effort offers when in a group setting given the trends revealed in treatment BG negotiations. Also, this would have to

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\(^5\) Subjects for these treatments were recruited from the same list of students enrolled in introductory economics courses, and all sessions were run in the same academic quarter.
account for a majority of individual other-regarding types given the general reduction in gift-exchange in treatment BG. At the same time, it was shown that the longer negotiations took, the more likely it was that non-minimum effort was chosen, which was independent of wage as long was wage>20.

Social Influence in Treatments AN and AC

Luhan et al. found that other-regarding types became more self-interested after being involved in a group that made a self-regarding choice, which can alternatively be interpreted as meaning that they learned that others have self-regarding preferences. They interpret this as further evidence that self-regarding preferences are in some way stronger. While a between subject design was used here, as opposed to a within-subject design as in Luhan et. al, the controlled nature with which the population preferences are revealed to subjects in treatments AC and AN provides an ideal data set to test this proposition. In this analysis the term ‘proposed effort’ is used to refer to the effort choice of the non-dominant partner when discussing treatments AC and AN together.

The non-dominant role in treatments AC and AN have no information on population preferences when they make their first choice. In the second period they have observed the choice made by their first dominant partner, and thus have one observation. By the time they make their final choice in the fifth period they have four observations. Dominant subjects in treatment AC have one observation when they make their first choice, and so on. Dominant subjects in treatment AN never gain any information, while non-dominant subjects observe the choice of their dominant partners.
If subjects with other-regarding preferences are prone to conforming with self-interest when observing such behavior displayed by others while self-regarding types do not change then results from treatment AC should show that effort tended to be lower than suggested effort. While there is some evidence in support of this conjecture results are weak. Dominant employees more often than not supplied less gift-exchange than what was suggested to them by their partner. Nineteen out of 45 effort choices were lower than the suggestion, while 12 were below. Fourteen were the same. The dominant partner agreed with the suggestion primarily when wages were low and they were choosing minimum effort, as was the case 75% of the time. While the average wage was 36 in agreement it was 50 in the 12 occasions where effort was greater than suggested effort. This somewhat mirrors the finding in treatment BG that there is a minority of individuals who are motivated to resist abandoning other-regarding choices. The average wage when effort was less than suggested effort was 41.

Evidence in favor of the position that a strong tendency exists for effort to be lower than suggested effort is weakened considerably when looking at the average difference between the two. The mean value of effort minus suggested effort by observation is -0.017. This is not statistically significantly different from 0 based on either a one or two-tailed t-test. Therefore, there is not much evidence that other-regarding types lower effort in response to low effort suggestions while self-regarding types hold steady no matter what in a systematic manner.

The influence of revealing population preferences can also be shown by looking at decisions of the non-dominant subjects in both treatments AC and AN. Again, do subjects with other-regarding preferences remove their willingness to sacrifice and act
with self-interest when they observe self-interest displayed by others? This is examined by analyzing the effect of the effort choice of the dominant partner’s decision in the previous period on the suggested and hypothetical effort selections of the non-dominant subjects. The non-dominant subjects in both treatment AN and AC are pooled for a regression of suggested and hypothetical effort that controls for wage, period effects, whether the treatment was AC or AN, and two sets of dummy variables that identify whether the dominant manager chose an effort level in the previous period that was above or below the effort suggested by the subject. Results, shown in Table 2.3, where above (below) is a binary variable equal to 1 if the effort choice of the dominant partner is greater (less) than proposed effort, shows that non-dominant subjects do not suggest less gift-exchange after having observed their partner in the previous round display preferences more in accordance with self-interest. While dominant partners were more likely to go below suggested effort than above the trend was not strong enough to strongly support this as evidence of a difference in the way self-regarding types hold their preferences relative to other-regarding types. That said, given the strength of the finding in Luhan et al. this should be explored further.

2.5. Discussion

The above analysis evaluated the explanatory power of a conjecture put forth by Luhan et al., based on results from a group dictator game with text communication, that group preferences are more in accordance with self-interest because individuals with self-regarding preferences have ‘stronger’ preferences. Stronger preferences translates
into being more active and forceful in the group negotiation process thereby dampening other-regarding preferences. This finding was based on analyzing text communication, and also by the finding that subjects that display other-regarding preferences initially abandon them after being part of a group that made a self-regarding choice.

In treatment BG employee teams that arrived at decisions relatively quickly and with few offers tended to be more self-regarding. One interpretation of this is that individuals that would have been likely to supply higher effort in response to a high wage were quick to go along with providing lower effort when proposed to them. It could also be that they proposed lower effort as a result of being part of a group. A drawback to the between subject nature of the experimental design used here is that it is difficult to discern between these two scenarios. This result does provide some support for the idea of self-regarding types having stronger preferences. At the same time though, group decisions that took more time and offers tended to be more other-regarding when the wage was above a threshold. One interpretation of this is that there is a separate pool of other-regarding types that have stronger preferences than self-regarding types.

What was not revealed in this study that was found in Luhan et al. was subjects displaying other-regarding preferences initially and then moving towards self-interest after observing self-interest from others. This should not be taken as a resounding contradiction of their results though given the considerable difference in the experimental designs. Luhan et al. found this using a within subject experiment, while it was tested here by comparing observations over periods as subjects see other subjects make choices and make inferences about their preferences.
Strength of Preference or Concern Withdrawal?

The initial foray of economic research into group preferences has provided many interesting results but has been lacking a theoretical model with convincing explanatory power. Social Comparison Theory has been the most commonly cited candidate model but makes predictions counter to the majority of empirical studies showing groups to display stronger self-regarding preferences than individuals. Luhan et al. take advantage of text communication to reveal the dynamics of group decision-making and argue that different preference types may interact differently in groups. Their conjecture of preference strength does provide some appealing intuition in understanding results in this study, particularly in treatment BG. That said, results here tentatively point at the possibility of there being two pools of subjects with other-regarding preferences. While further research is needed to solidify this finding it has invoked an alternative view of group decision making that rests on pre-existing models and concepts within social preferences.

It is proposed here that an alternative way to view group decision-making that could possess attractive properties in terms of predictive power and hypothesis building is through the lens of reciprocity. Reciprocity is a general term for response based social preferences where some subjects will weight the welfare of others in their utility function differently after having had either a positive or negative interaction with the person. The seminal paper by Rabin (1993) was a first attempt to build response based preferences into traditional utility functions. The most commonly tested form is costly
negative reciprocity where some individuals act irrationally in that they are willing to undergo a cost to punish someone who they believe made an unfavorable action even if there is no chance that they could benefit from doing so in the future. It has been shown that if even a small number of subjects display such reciprocal preferences then markets with little institutional foundation can be maintained by social norms by the threat of punishment.

Another form of reciprocity called concern withdrawal (CW) in Charness and Rabin (2002) has received significantly less empirical testing but could be just as or more important than costly punishment in the operation of many types of markets. The basic idea behind CW is that some people withdraw their willingness to sacrifice in response to another person not being willing to sacrifice to improve social welfare. A possible reason why it has received less empirical attention is that it is much harder to cleanly identify as a motivation for behavior because it is strongly confounded with self-interest. When CW is invoked an individual acts according to rational self-interest. Given that this is the way in which a large percentage of subjects act most the time it is difficult to isolate. It is the irrationality of lowering one’s own pay that makes costly punishment easy to identify.

So, what does CW have to do with group decision-making? Group decision-making differs from many individual choices in that subjects learn what others prefer to do in making the same decision they are faced with. Reciprocal preferences are generally examined in terms of the response to the person that made the positive or negative action. The case made here would require the additional assumption that CW can be invoked by a third party, namely one’s group member. To invoke a charity
fundraising example, a person may withdraw their willingness to donate if they see that others are not willing to do so. Assume the charity is to help the homeless. Each person that does not donate further reduces homeless shelter capacity. This does not negatively affect the person that was observed to be unwilling to donate. Rather, the negative repercussion is on the homeless.

Viewing group decision-making as being driven by CW has many attractive features. First, many functional forms have been proposed for utility that incorporate distributional and reciprocal social preferences, which allows for much cleaner hypothesis testing and prediction. Charness and Rabin (2002) propose the following utility function

\[ U_B(\pi_A, \pi_B) = (\rho \cdot r + \sigma \cdot s + \theta \cdot q) \cdot \pi_A + (1 - \rho \cdot r - \sigma \cdot s - \theta \cdot q) \cdot \pi_B \]

where

- \( \pi_A \) = person A’s pay
- \( \pi_B \) = person B’s pay
- \( r=1 \) if \( \pi_B > \pi_A \), and \( r=0 \) otherwise
- \( s=1 \) if \( \pi_B < \pi_A \), and \( s=0 \) otherwise, and
- \( q=-1 \) if A is unwilling to sacrifice, and \( q=0 \) otherwise
- \( \rho, \sigma, \theta \) are weights between 0 and 1

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\[ ^6 \text{It is important to recognize that this only applies to cases without a threshold. It is rational to not be the only person to donate towards research to cure a disease if the probability is 0 of finding a cure unless a minimum level of money is raised. In other words, the likelihood that sacrifice leads to an improvement in welfare for others is endogenous to the amount donated.} \]
The weights can be parametrically estimated econometrically by observing decisions that pose a tradeoff between one’s own pay and the pay of others, and also have subjects make distributional decisions after having observed others decisions. This can easily be generalized to reflect a group decision-making environment where reciprocal preferences can be triggered by a group member. This should additionally reflect the idea that part of what makes a group a group is that each person receives the same pay. This leads to the form

\[
U_B(\pi_A, \pi_B) = (\rho \cdot r + \sigma \cdot s + \theta \cdot q + \eta \cdot t) \cdot \pi_A + (1 - \rho \cdot r - \sigma \cdot s - \theta \cdot q - \eta \cdot t) \cdot \pi_i
\]

where

- \( t = -1 \) if group member displays self-regarding preferences
- if \( q = -1 \) then \( t = 0 \)
- \( 0 \leq \eta \leq 1 \)

This provides an additional mechanism by which the decision-maker’s weight on the outside subject A can be decreased. Also, if person A, the first-mover, has already triggered CW from person B then it does not matter whether the group member displays self-regarding preferences. This rules out the scenario where person B can have other-regarding preferences ‘reinvigorated’ by the preferences of the person they are making a collective decision with.

Viewing group decisions through reciprocity has a number of attractive features. First, it provides an explanation for why group decisions are more self-regarding by the
fact that CW can be triggered by the additional mechanism of the group member’s preferences that is not present in individual decision-making. This is aided by the additional assumption made above that person A not making an ‘unfair’ decision with respect to person B is a necessary condition for person B’s other-regarding preferences to not be withdrawn.

Second, it allows for two separate types of individuals with other-regarding preferences. The majority of other-regarding types demonstrate CW preferences in terms of both t and q. A second smaller pool of other-regarding types have CW preferences in terms of q but not t. Therefore, if person A has made a ‘fair’ decision then person B does not have their other-regarding preferences attenuated when their group member wants to be selfish. Charness and Rabin (2002) find that 48% of subjects sacrifice to increase the pay of someone who has sacrificed to help them. Only 7% are still willing to sacrifice when the other person is not. Then, it could be that most of the 40% that demonstrates CW in this case can also have CW triggered by the preferences of someone they are making a decision with.

Third, it provides some potential explanation for the finding in Luhan et al. that other-regarding types act with self-interest after being part of a group that did the same. This does require the assumption that CW triggered by a group interaction can carry over to a later decision. It would be unwise to push this contention too hard without further empirical analysis.

Lastly, viewing group decision-making through reciprocity takes advantage of pre-existing models, which potentially prevents the need to develop a completely new theoretical framework. It is also based on a concept with intuitive appeal that much of
what makes group decision-making different from individual decisions is that a person learns much more about what preferences other people have. Focusing on reciprocity then does not require make the leap that people have unstable preferences. Rather, it is the overlay of reciprocal preferences on top of distributional preferences that causes some subjects to behave selfishly at times but not at others.

Modeling group decisions through reciprocity does depend on a number of factors that would require further analysis. First and foremost is whether reciprocity is triggered by someone other than the person on the other end of the decision. This is a critical point that would require greater empirical justification. Also, evidence based on the analysis of treatments AC and AN in this study did not strongly concur with the idea of CW being triggered in one period being carried over to dampen other-regarding preferences in a later decision. This would be necessary to explain Luhan et al’s individual-group-individual result.

2.6. Conclusion

Laboratory experiments have convincingly demonstrated that group decisions differ from those of individuals. What has not yet been conceived of adequately is a theoretical model that both conforms with observed results and also provides a useful framework to be able to make predictions about how real economic environments are likely to be affected by the presence of group decision-makers. Social Comparison Theory has been examined in experiments but does not adequately predict results.
Luhan et al. find that self-regarding types are more forceful in group negotiations and contend that focusing on strength of preference could explain group decision-making.

I compare three different types of group environments to individual decisions in a laboratory gift-exchange game. One group treatment uses a limited communication design that allows for testing the concept of preference strength, while also eliminating confounds resulting from written or spoken communication. It is shown that there does seem to be a difference in the way individuals of certain preference types negotiate in groups that partially corresponds with self-regarding types having stronger preferences than other-regarding types. There appears to be a number of subjects that quickly agreed to a self-regarding choice in a group that would have returned more to managers if making the decision alone. This could be interpreted as meaning that self-regarding types have stronger preferences. At the same time, more difficult negotiations were associated with higher effort levels. This means that there is a separate portion of the other-regarding population with preferences that can be considered stronger than those of other-regarding types. This led to the proposition that a fruitful way to model group decisions could be through the use of reciprocal preferences. The attractive features of this approach along with its limitations given current findings were discussed.
2.7. References


Kugler, T., G. Bornstein, M.G. Kocher, and M. Sutter. Trust Between Individuals and Groups: Groups are Less Trusting than Individuals but Just as Trustworthy. *Journal of Economic Psychology* (Forthcoming).


|                | Coefficient | Std. Err. | z      | P>|z|  |
|----------------|-------------|-----------|--------|------|
| Constant       | 0.424       | 0.204     | 2.08   | 0.038|
| Wage           | 0.003       | 0.0024    | 1.25   | 0.213|
| Total Offers   | -0.028      | 0.021     | -1.32  | 0.187|
| Time           | 0.003       | 0.00135   | 2.27   | 0.023|
| Period         | -0.436      | 0.126     | -3.46  | <0.001|
| Periodsq       | 0.074       | 0.204     | 2.08   | 0.038|

Notes: Total offers is the combined number for both subjects in each group. Time counts from 0 up to 180 seconds.

Table 2.1 Censored Regression for Determinants of Effort on Wage and Negotiation Characteristics in Treatment BG.
|                  | Coefficient | Std. Err. | z     | P>|z| |
|------------------|-------------|-----------|-------|-----|
| Constant         | 0.066       | 0.16      | 0.42  | 0.677 |
| Wage             | 0.0092      | 0.0025    | 3.68  | <0.001 |
| BG               | 0.198       | 0.18      | 1.08  | 0.065 |
| Wage*BG          | -0.006      | 0.0032    | -1.84 | <0.001 |
| Period           | -0.271      | 0.077     | -3.53 | 0.001 |
| Periodsq         | 0.045       | 0.013     | 3.42  | 0.68  |

| Wage+Wage*BG     | 0.0033      | 0.002     | 1.64  | 0.1 |

Notes: BG is the dummy for treatment BG. The marginal effect of wage on effort in treatment BG is the linear combination of wage and wage*BG, which is a post-estimation calculation.

Table 2.2 Gift-Exchange in Treatment BG Compared to Treatment IN with Wage>20.
<table>
<thead>
<tr>
<th>Variable</th>
<th>Estimate</th>
<th>Std. Err.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>0.34</td>
<td>(0.39)</td>
</tr>
<tr>
<td>Wage</td>
<td>0.007***</td>
<td>(0.0028)</td>
</tr>
<tr>
<td>Period</td>
<td>-0.117</td>
<td>(0.22)</td>
</tr>
<tr>
<td>Periodsq</td>
<td>-0.002</td>
<td>(0.031)</td>
</tr>
<tr>
<td>AN</td>
<td>-0.3</td>
<td>(0.2)</td>
</tr>
<tr>
<td>WAN</td>
<td>0.0078*</td>
<td>(0.0041)</td>
</tr>
<tr>
<td>Below</td>
<td>0.087</td>
<td>(0.1)</td>
</tr>
<tr>
<td>Above</td>
<td>0.08</td>
<td>(0.11)</td>
</tr>
</tbody>
</table>

Notes: ***, **, and * denote significance at 99%, 95%, and 95% confidence levels. Below (Above) = 1 if dominant employee partner’s choice was below (above) proposed effort. The sample consists of 4 observations, periods 2 to 5, for 18 non-dominant employees.

Table 2.3 Regression Analyzing the Response of Non-Dominant Employees to Partner Choices.
Figure 2.1 An Observed Employee Group Negotiation.
Figure 2.2 Average Time to Decision by Wage for Employee Groups in Treatment BG.
Figure 2.3 Time to Decision for Each Effort Choice for Employee Groups in Treatment BG.
CHAPTER 3

Technological Change and Agricultural Land-Use Decisions: A Global Perspective
Using Output Specific Total Factor Productivity

3.1. Abstract

This study takes advantages of recent developments in measuring total factor productivity in output specific directions to examine the influence of technological change in different agricultural sectors on land-use decisions in a cross-section of countries from 1969 to 2001. Results demonstrate a positive relationship between productivity and land in agriculture in most cases. The ruminant sector is an exception where an increase in productivity was negatively associated with amount of pastureland. The analysis also includes variables that have been found to be important determinants in other studies of land-use change. Population is clearly the dominant factor over the time period analyzed, although it is argued that other factors are likely to become more important in upcoming years since population growth has slowed significantly in many countries.
3.2. Introduction

The primary cause of deforestation globally is agriculture (Barbier, 2001). The transformation of land for growing crops or raising livestock has drastic implications for issues related to the use of natural resources, and is directly tied to a number of the most pressing environmental issues. Therefore, a study of the causes and consequences of desertification, deforestation, loss of biodiversity, and climate change, to name a few, are intricately tied to changes in the methods of agricultural production. This study is the first to explore the relationship between the expansion and contraction of agricultural land and technological change in agricultural production using total factor productivity (TFP) measures that provide separate measures for different types of outputs. TFP measures are preferable to partial factor productivity (PFP) measures, such as yield, because they account for changes in the allocation of all inputs simultaneously. PFP measures often overestimate productivity change (Nin et al., 2003). Being able to isolate among specific outputs is important because technological change often occurs independently, and land is used very differently depending on the type of production. Results show a positive relationship between productivity and land in agriculture in most cases except for ruminants where increased productivity is associated with a decrease in pastureland. That said, population dominates in terms of explanatory power showing a positive relationship with most agricultural land variables. Results also demonstrate interesting cross-sector relationships between productivity and land-use.
The second half of the 20th century was witness to dramatic technological change in the agriculture sector leading to significant improvements in productivity, an acceleration in the pace of tropical deforestation, and population growth never before seen in human history. It come as no surprise then that this represented a new age in terms of the types and scale of use of natural resources. At the same time, some countries experienced dramatic improvements in material well-being while others remained stagnant, or even saw worsening living conditions. This variation in economic and demographic variables across countries provides an interesting scenario for empirical analysis of what factors are most important in determining how land is used. A country level approach is also prudent given the focus on agriculture since it is a sector that is defined by the level of interference of national governments.

While some developed countries have decreased agricultural land cover, and subsequently experienced afforestation, overall global forest cover continues to decrease. In the 1980’s approximately 1% of global forest cover was lost per year. The highest rate of deforestation occurred in Asia, although the largest area in terms of total area is being cleared in South America (FAO, 1993). In the last decade about 13 million hectares per year of forest land is brought into agriculture, although more each year has been regained thanks to replanting efforts and landscape restoration. Yet, over the period from 2000 to 2005 the world lost forest cover of approximately 7 million hectares (FRA, 2005), which is approximately the size of Panama. The fastest loss rates are occurring in South America, Africa, and Oceania. China and Western Europe have increased forest cover over the last five years.
Understanding the interplay between deforestation and agriculture is additionally important given the level of interference of government in the functioning of agricultural markets in most countries. Even countries with relatively free and open markets often heavily subsidize agricultural producers and construct significant trade distorting policies. These measures often produce incentives for overproduction, and the expansion of agriculture into marginally productive lands. While this variation across countries is attractive from an empirical estimation standpoint it does introduce significant complications in terms of predicting the direction of relationships. A review of theoretical models of agricultural expansion by Angelsen (1999) demonstrates that model assumptions based on the political and economic characteristics of countries dictate whether and how factors such a population change and agricultural productivity affect land-use. A somewhat detailed review of Angelsen’s exposition follows to provide a sound basis for understanding how results here can be viewed relative to theoretical predictions. After that a review of empirical studies on agricultural expansion and deforestation is provided.

Theoretical Models of Agricultural Expansion

As is true with any good economic model the direction of the relationship between productivity and the demand for land as a factor of production varies depending on model specifications. Angelsen classifies models according to assumptions that dictate the nature of the optimization problem of the agricultural producer. Categorizing models is most easily done by understanding the assumptions
they make about i) household preferences and objective functions ii) market assumptions, and iii) the property rights regime. These are varied to reflect the significant political and economic differences that exist across countries.

Household preferences focus primarily on the labor/leisure tradeoff. ‘Traditional’ societies display lexicographic preferences where they are not willing to trade leisure for labor once subsistence consumption requirements are met. This is largely a result of not being integrated into a larger economy. Models also vary the level of market integration primarily with respect to labor, which is critical in determining the relationship between productivity and land-use. Labor markets are assumed to take one of three forms. First, no off-farm employment options exist. Second, imperfect labor markets are present, but the household is quantity constrained. Third, labor markets are perfect for both buying and selling labor time.

Assumptions about property rights regimes are categorized as being a system of complete private or communal rights for both forest and cultivated land, pure open access, or partial open access. The last category applies to countries with land tenure laws where forests have no de facto ownership, but clearing and using land for agricultural production can lead to ownership. This is also referred to as homesteading, or ax rights.

The decision over how much land is used for agricultural production is modeled assuming agricultural land radiates outward from the population center. This can be viewed as either a local or a regional abstraction. The area is assumed to be a circle.

Also,

\[ X = xH \]
where

\( x = \text{output per hectare} \)

\( H = \text{total hectares} \)

\( X = \text{total output} \)

assuming that the elasticity of substitution with respect to land-use is one. Land in agriculture then is

\[
H_{total} = \pi (b_{\max}^2) = \int_0^{b_{\max}} 2\pi b \, db
\]

\( b = \text{distance to field} \)

\( b_{\max} = \text{distance to forestry frontier, or furthest field.} \) Land in cultivation for each producer, assuming each has the same area, is given by

\[
H = \frac{\pi}{mN} (b_{\max}^2) = \int_0^{b_{\max}} \frac{2\pi b}{mN} \, db
\]

where

\( m = \text{the inverse of the share of land under cultivation} \)

\( N = \text{number of households} \)

The intensity variable \( m \) is important for models that depend on income from agriculture. Labor assumptions also matter if it is concluded that migrants go to the frontier. This precludes focusing on a ‘general’ producer, and has implications for assumed costs. Variation in costs depend primarily on the distance to the field (\( b \)). Costs are either from on field labor that is normalized to 1 based on a fixed-yield
assumption, or are related to the distance to the field in terms of travel time (q). Total labor input per unit of land is
\[ l = 1 + qb \]
so total labor input is

\[ (3.3) \quad L = \int_0^{b_{\text{max}}} (1 + qb)h db \quad \text{where} \quad h = \frac{2\pi}{mN} \]

While it is clear how this type of distance cost would apply to production in a country like Brazil the placement of ethanol plants in the U.S. provides an interesting developed country context for such a specification.

This general form can be specified to apply to four types of models that differ primarily in their assumptions. Subsistence models, also called full belly models, make the assumption that no markets exist. Therefore, households consume their production and cannot sell surplus. The objective function is simply to meet subsistence requirements and then to cease all labor.

\[ (3.4) \quad Hx = c_{\text{min}} \]

where \( c_{\text{min}} \) is the subsistence requirement. Rearranging eq. 3.2 and substituting for H

\[ (3.5) \quad b_{\text{max}} = \sqrt{\frac{mNc_{\text{min}}}{\pi \chi}} = \sqrt{\frac{2c_{\text{min}}}{hx}} \]

This clearly predicts that as agricultural productivity (x) increases the agricultural frontier shrinks. At the same time, population growth will expand the frontier. Therefore, whether deforestation occurs comes down to the relative rates of growth between productivity and population.
So-called ‘Chayanovian’ models, Chayanov (1966), assume an imperfect integration into markets and focus on the trade-off between consumption and leisure once subsistence levels are met. Whether households increase land inputs as productivity increases depends on the marginal rate of substitution between labor and consumption, which can also be interpreted as the virtual price of labor or shadow wage rate. Angelsen assigns a general form

\[
\max_{b^\text{max}} U(C, T) = U \left( \int_0^{b^\text{max}} x h b db + wE, \int_0^{b^\text{max}} (1 + q b) h b db + E \right)
\]

where

- **C** = total consumption
- **T** = labor time
- **q** = labor time
- **E** = fixed amount of labor that can be sold in imperfect labor market at wage w

An additive utility function is assumed to derive less ambiguous comparative statics.

\[
U(C, T) = (C - c^{\text{min}})^a + v(T - T^{\text{max}})^\beta
\]

where

- **v > 0; a, \beta \in (0,1)**

While a full examination of the comparative statics of this model are not included here for the sake of space the basic intuition follows from recognizing the trade-off between consumption and leisure once minimum subsistence is met, and most importantly, results depend on the magnitude with which **C** is greater than **c^{\text{min}}**. **C** is much larger than **c^{\text{min}}** means a producer is wealthy and thus gains less utility from an additional unit
of labor because there is decreasing marginal utility from consumption and increasing marginal disutility from labor. If a producer is relatively poor and close to $c_{\text{min}}$ a productivity increase will expand the frontier and increase deforestation. If $C$ is much higher than $c_{\text{min}}$ a productivity increase will decrease the frontier.

Open economy private property models assume perfect labor markets and focus on profit maximization where all prices are assumed to be exogenous. The optimization problem then is to maximize land rents as

$$(3.8) \quad \max_{b^{\text{max}}} \, R = X - wL = x\int b^{\text{max}} \, hdb - w\int (1 + wb)hdb$$

First order conditions show the optimum to be

$$b_{\text{max}} = \frac{x - w}{qw} \quad \text{and} \quad db_{\text{max}} = \frac{1}{wq} = \frac{b_{\text{max}}}{x - w} > 0$$

Here an increase in productivity will increase deforestation along with any other variable that decreases costs and makes frontier farming more profitable. The critical difference in assumptions between the previous model and this one is that wages are assumed exogenous here as a result of perfect labor markets.

Open access open economy models assume profit maximization but stand apart from the other models by focusing on the role of property rights institutions. There are two versions of these models that lead to opposite predictions for the relationship between property rights and deforestation. In the first, where forest clearing cannot lead to permanent property rights, the open labor market assumption means that migration to
the frontier between agriculture and forest will occur as long as non-negative rents are feasible for the current period. Homesteading models that assume permanent property rights can be achieved by assuming that forest will be cleared for agriculture as long as the discounted future stream of rents is positive. This leads to potentially higher predictions for forest clearing if expectations are for productivity to increase in the future. Angelsen points out the critical fact that open access does not predict greater agricultural expansion and deforestation than private property environments necessarily. It depends on expectations that land rents will increase over time, and that property rights are assigned to homesteaders. If rents are not expected to increase then increased deforestation does not result. What does hold though is that higher productivity leads to more deforestation by increasing land rents.

To summarize, a population increase predicts an increase in deforestation in Subsistence and Chayanovian models, but has no effect in the last two. Increasing wages in alternative employment does not apply to Subsistence but predicts a reduction in deforestation in the other three. Increasing productivity predicts a reduction in deforestation in Subsistence models. In the Chayanovian model there is decreased deforestation with improved productivity when near poverty, but an increase at higher wealth levels. Increasing productivity leads to an increase in deforestation in both of the Open economy models. An increase in output prices follows productivity except for the Chayanovian model if the household is not in poverty where it predicts an increase in deforestation. This is a critical point given the data available to this study. It will be important in future research to incorporate output prices because an increase in prices predicts, in almost all cases, the same land-use decision as an increase in productivity.
This type of data was not available for this study for the cross-section of countries and years being analyzed.

Empirical Papers on Agriculture Land-Use and Deforestation

Studies seeking to empirically estimate the factors that play a role in deforestation began appearing in the mid 1980’s following the rise of social concerns surrounding the use of environmental resources in the 1960’s and 70’s. This was largely driven by concern over the loss of tropical forests. The first wave were primarily cross-sectional empirical studies, which developed a summary of the most important factors in tropical deforestation. Depending on whether a forestry or agriculture perspective is taken these factors include income, population growth and density, agricultural prices, agricultural productivity, exports, logging, road building, and institutional factors.

Barbier (2001) categorizes country cross-sectional land-use studies into four categories. Environmental Kuznets Curve (EKC) approaches hypothesize that the demand for forest related goods first decrease and then increase as wealth increases. Studies including Antle and Heidebrink (1995), Cropper and Griffiths (1994), Koop and Tole (1999), Panayatou (1995), and Shafik (1994), and Dietz and Adger (2003). The inverted U-relationship was not found to hold when temperate and tropical climates are combined. At best it holds for specific regions of tropical countries. Also, the per capita income where afforestation is estimated to occur in Africa and South America is often a multiple of 2 to 4 times current levels. Also, it was found that country specific
variables are important enough so that the critical points of the curve will vary significantly by country.

Studies such as Barbier and Burgess (1997) and Ehui and Hertel (1989) that focus on the pull between competing demands for land-use found that a reduction in forest cover was associated with increasing population density, whereas rising income per capita and increasing agricultural yields (PFP) led to an increase in forest cover. It is important to note that these studies rely on partial rather than total factor productivity measurements. Another set of papers looking households conclude that increasing agricultural output prices speed up the conversion of forest to agriculture, while rural wage rates are positively related to forest cover (eg. Barbier (2000), Barbier and Burgess (1996), and Lopez (1997)).

A number of other papers have focused on accounting for institutional characteristics to understand the role of property rights and security of tenure in deforestation (Deacon, 1994; Barbier, 2002; Southgate et al., 1991). These studies have generally found that institutional variables are important factors in land-use change where stronger property rights reduce deforestation by imposing additional costs. Data problems related to measure institutions in this type of study are discussed in the next section.

The focus of this study is to take advantage of recent developments in measuring productivity that allow isolating technological change in different sectors within agriculture to empirically examine the determinants of land-use change in agriculture. The use of output specific productivity measures makes it possible to determine separately how productivity changes in crops and livestock affect the allocation of land
towards different types of production. The discussion on theoretical models of agricultural land-use demonstrated the importance of political and economic factors that motivate different sets of assumptions. This makes it clear that no single model can be applied to all countries. More importantly, predictions of the direction of relationships depend on these assumptions. Rather than trying to sub-sample countries into the most relevant models this study seeks to maximize the variation in the explanatory variables across countries to estimate generally which are most important. A discussion is provided of how the results from this study could be used to educate further research by providing a guide for what factors are important in grouping classes of countries.

3.3. Empirical Model

Data

Countries in the Sample

The sample starts with 127 countries for which there are productivity estimates provided by Ludena et al. (2007). Actual sample sizes for different aspects of the analysis reduce the sample size depending on further data restrictions. Following Deacon (1994), very small countries in terms of population and agricultural land area are dropped. Analysis focusing on output specific measures of productivity have
reduced samples due to an inherent problem with this class of methods, which will be discussed in the section following on the productivity data set.

Agricultural Land Use

The two agricultural land categories examined are ‘arable land and permanent crops’ (ALPC) and ‘permanent pasture and meadow’ (PAST) (FAOSTAT, 2004). ALPC is land under temporary crops, temporary meadows for mowing or pasture, land under market or kitchen gardens, land temporarily fallow (less than 5 years), and land cultivated with permanent crops. PAST is hectares of land used permanently (more than 5 years) for herbaceous forage crops, either cultivated or growing wild. All summaries of ALPC and PAST are limited to countries that are included in the productivity data set.

Figure 3.1 and Figure 3.2 show the trend in the total allocation of land towards the two uses for the countries in the sample. There is a steady and significant increase in both from 1961 to 2001. There was a 10.7% increase in PAST, and a 15.2% increase in ALPC. The latter has appeared to flatten out over the last 10 years, while PAST dipped in the early 1990’s but has increased since. Figure 3.3 shows the percentage change in ALPC by country ranging from -93% (dark green) to over 100% (dark red). There is clearly a trend in the industrialized countries of North America and Western Europe to have decreased ALPC over this time period. The largest increases are in China, South America, and Western Africa. Shown in Figure 3.4, trends in PAST were fairly similar to ALPC. There were large decreases in India, Western Europe, and to a
lesser extend in Australia and the USA. The greatest expansion in PAST was in South America, Central America, and Asia. Australia, USA, China, Mongolia, and Brazil were among the countries with the most land in PAST in both 1961 and 2001. In terms of ALPC, the largest countries were USA, India, Canada, Australia, and Nigeria in 1961. The same generally held in 2001 except that Nigeria dropped significantly relative to other countries.

Agricultural Productivity

As mentioned earlier, the total factor productivity (TFP) measure is based on a directional distance function (DDF) approach (Chambers et al., 1996). Details on how TFP is measured using a DDF approach can be found in Nin et al. (2003) and Ludena et al. (2007). The DDF approach involves the formation of an efficient frontier based on observed production units. Productivity is measured as a percentage change from one year to the next, and this is a combination of relative and absolute change. Essentially, it combines how a country has moved relative to itself between \( t \) and \( t+1 \), and whether the country has improved relative to the rest of the world over the same time period. Specifically, it is the geometric mean of the two following values. First, the ratio of the distance from the production point in \( t \) and the \( t \) frontier to the production point in \( t+1 \) and the \( t+1 \) frontier. Second, the ratio of the distance between the \( t \) production point and the \( t+1 \) frontier to the distance between the \( t+1 \) production point and \( t+1 \) frontier. A value greater than 1 denotes a productivity improvement where 1.02 represents a 2% increase in productivity, for example.
TFP measures are more attractive than partial factor productivity measures, such as yield, because the latter are prone to overstating the growth in productivity by not accounting for factor substitution. Input and output variables are from FAOSTAT (2004), the database from the Food and Agriculture Organization of the United Nations. Inputs are feed, animal stock, pasture, land under crops, fertilizer, tractors, and labor. Outputs are crops and livestock. Within the class of TFP measures the DDF approach has a number of attractive characteristics primarily related to data irregularities violating model assumptions compared to methods such as primal and dual models, random coefficients regression approaches, and entropy based approaches. Nin et al. (2003) provides an overview. Sickles (2005) performs a Monte Carlo simulation to compare popular methods for measuring productivity and finds that distance function approaches perform well overall.

An attractive feature of the DDF approach to measuring TFP is that it is possible to measure productivity with respect to a particular input or output in multi-input and output production environments. In the case of agriculture this makes it possible to focus on crops versus livestock, or even specific types of livestock. This is an important feature since technological change often occurs independently in different agricultural sectors. Also, a particular land-use type may be affected differently by productivity changes in different outputs. For instance, the use of corn in livestock feed connects productivity and land-use change between the sectors. Productivity data used in this analysis separates between crops, ruminants, and non-ruminants. The latter two are categories for livestock based on the way the animals digest food. Ruminants are
hooved animals that digest food in two steps. This includes cattle, goats, sheep, and bison, among others. Important non-ruminant species include poultry and pigs.

The major drawback with directional specific measures is that there is often no solution to the programming problem when measuring productivity in an output specific direction, which tends to occur when a production unit is near the efficient frontier. There is no solution problem when a single ‘agriculture’ output variable is analyzed. This problem is partially alleviated here by transforming productivity to a lagged mean when used as an explanatory variable. This method has an intuitive appeal as well since the focus of the study is on how changes in productivity influence land use. Agriculture as a sector of the economy is defined by large production shocks in the form of weather variation. Taking the average of the previous 4 years of productivity changes smoothes the variation from weather. It also reduces the loss in sample from missing productivity numbers by taking the average of the observations present for the four year period. ‘Filling in’ data in this nature is of course second best to having observations for all periods. To limit cases where having very few observations could lead to anomalous results countries are only included if they had observations for more than half of the years from 1961 to 2001.

The average annual percentage change for crops and livestock by country from 1961 to 2001 is in Figure 3.5 and Figure 3.6. Extreme values are partially a result of countries with very few observations due to the solution problem described above. These are not included in sample for statistical analysis. World agriculture TFP has grown at just under a 1% per year over this time. As expected, countries in North America and Western Europe increased productivity in agriculture significantly relative
to the rest of the world. That said, there were a number of less developed countries in South America, parts of Africa, and Southeast Asia that experienced significant gains in productivity. It is worth noticing though that many countries that have been associated with rapid deforestation and loss of natural habitat achieved more modest productivity increases, such as Brazil, countries in Western Africa, and India.

Growth in non-ruminants productivity has been the most significant among the sub-sectors. Average annual percentage growth rates are estimated at 2.6% compared to 0.62% for ruminants. The performance in the non-ruminant sector has largely resulted from improved feed and controlled industrial facilities. There is a very strong trend across developed industrialized countries for greater productivity gains in crops than for livestock. For example, Western Europe collectively achieved an annual percentage growth rate for crops of 2.5% compared to 1.19% for livestock.

Differentiating between productivity in crops and livestock is not only important because some countries do better in one than the other, but also because the use of the land as an input into the production of each is very different. In many countries, growing crops is associated with intensive use of chemical pesticides and fertilizers. Also, practices such as tilling can lead to soil loss and erosion. Pasture on the other hand may be less intensively used in terms of additional inputs, but the average area of land is bigger on average than for crops. Also, the relatively low level of investment required to clear land for grazing makes it a bigger concern with respect to deforestation.
Other Factors Influencing Land-Use

Other variables that have been shown to influence land-use change are GDP per capita as a measure of income, population, population density, and political institutions.

Data for GDP per capita is from The World Bank national accounts data and is measured in constant 2000 $US. Focusing on the period from 1965 to 2001 shows that the wealthiest countries at the beginning of that time period not only stayed wealthier than poorer countries, but the distance widened substantially. GDP per capita increased on average at 2.4% per year for the wealthiest countries. At the same time, living standards in the former Soviet block countries did not improve at all, which was also true in the Middle East and North Africa. The largest rate of improvement was in Asia where many of the ‘Asian Tigers’ achieved rapid economic growth. Income improved slightly in Latin America (Southgate et al.). The poorest countries in both 1965 and 2001 were primarily in Sub-Saharan Africa. Observations for some countries in the sample are missing in the earliest years. Of the 130 countries with productivity data there are 98 with GDP per capita measures in 1965.

While the global population increased rapidly from 1961 to 2001 the fertility rate in most countries decreased at the end of the century. This has led many demographers to project that the rate of population growth has slowed to the point where the total number of people will peak in the middle of the 21st century. To say that the growth in the human population over recent decades has been historic would be an understatement. Tens of thousands of years passed with slight increases until the last couple hundred when the global population repeatedly doubled over short and shorter
time periods. It took a mere 50 years at the end of the last century to do so. While it is obvious that this growth in population has affected land-use throughout the world it is worth delineating between population and population density. Countries with a large land mass may be able to accommodate a rapidly growing population without people being driven out in the countryside if levels remain below a threshold. Canada and the US are two examples.

A number of studies have empirically estimated a statistically significant relationship between land-use change and the political and institutional makeup of countries. The general hypothesis is that poor institutions lead to a weak system of property rights which is necessary to avoid problems associated with the overuse of open access resources. The primary difficulty in this line of analysis is creating a representative variable or set of variables that adequately capture the strength of political and economic institutions. The process of quantification typically involves counting the intensity and frequency of political disruptions and upheavals. Data problems relevant to this study are essentially related to the lack of observations going back into the 1960’s that are measured frequently enough to capture variation over time. An index measuring strength of property rights is produced by Freedom House and is used here. It ranks countries on a 5 point scale where 1 is strong property rights and 5 is weak. The drawback is that it is not until the year 2000 that observations are available for nearly all the countries in the productivity sample. Therefore, analysis including the property rights variable will be limited to post 1990. Going further back would make it more likely that significant institutional change has taken place. Using only a single
observation for each country requires using a random effects model instead of fixed effects, which does improve efficiency of estimation but introduces greater risk for bias.

3.4. The Model

While lagged observations are used for all independent variables productivity differs slightly. As mentioned earlier, the average of the previous four years of annual productivity change observations is used to reduce loss of observations from missing data, and to smooth out weather shocks. Since the variable is a percentage change the geometric mean is used. The other variables are simply a one period lag.

This design has two motivations. First, planting decisions in agriculture are discrete in that they are made at the beginning of the year and can rarely be changed until the following year. For productivity four years is used because it is long enough to smooth out year to year fluctuations, but is also short enough to capture changes in values of variables over time. Results did not change significantly using 3 or 5 year lags. This general length of time has also been used in other studies. Deacon (1994) used 5 year non-overlapping blocks.

The primary regression framework used is a fixed effects panel model. This has the advantage of avoiding bias resulting from correlation between unobserved country characteristics that do not change over time, such as whether it is landlocked, and the included regressors. The model follows the general fixed effects transformation of differencing by the group mean.
which is estimated using OLS with a constant $\beta_0$. This assumes the demeaned errors are homoskedastic and serially uncorrelated. To partially guard against bias resulting from the violation of these assumptions robust standard errors are used throughout.

### 3.5. Results

Table 3.1 provides results from a fixed effects regression of PAST and ALPC combined with TFP for agriculture, not output specific, GDP per capita, population, and population density as the set of explanatory variables from 1969 to 2001. While some of the data is available back to 1961 the panel does not start until 1969 because it reduces missing observations for GDP per capita in the mid 1960’s, and the four period lagged mean for productivity means that the first land-use observation that can be used is 1966. Using agricultural land variables and TFP for agriculture is a less precise analysis than what follows, but it provides a useful general overview of the relationships among the variables. It also avoids the missing data problem for productivity since it is not an output specific measure.

The p-value for all coefficients is less than 0.05. The relationship between productivity and land is positive, which is interesting recalling from earlier that theoretical predictions vary depending on assumptions. The interpretation of the coefficient in terms of a marginal effect is that an average increase in productivity of 1% over the previous four years is associated with an increase of 62,000 ha of land in
agriculture. To provide some perspective on this amount of land, Japan has approximately 5,000,000 ha of land in ALPC and PAST combined, which constitutes about 1/7th of the total land mass.

An increase in GDP per capita was inversely related to agricultural land. It is important to note that a significant number of countries did not have observations in 1965, although the number decreases quickly moving into the 1970’s and 80’s. For obvious reasons related to reporting and monitoring poorer countries were more likely to be missing observations early on. The average value for 2001 GDP per capita for a country with an observation for 1965 was $7000, while it was $2500 for those without. In terms of marginal effects, a $1000 increase in GDP per capita leads to a decrease in agricultural land of 100,000 ha. Whether this is a relevant change varies drastically by country. Some countries achieved an increase much greater than $1000 over the time period while others do not come even close. Bangladesh only increased GDP per capita from $103 to $353 over the 30 year period. Australia on the other hand managed to grow from about $2000 to $20,000.

The sign of the coefficient is negative for population density and positive for raw population. Although, this is likely due to collinearity between the two variables. Population appears to be the more robust measure. Running the same regression without population density changes the coefficient on population by very little. When dropping population the coefficient on density is positive and significant. Further evidence on the importance of population is demonstrated shortly. Population numbers are divided by 1 million, so an increase in population of 1 million people is estimated to correspond to an increase in agricultural land of 178,000 ha. For an average country
based on this sample this corresponds to about a 3% increase. Even though the coefficients for all the explanatory variables were significant a comparison of the values for overall R-square demonstrates that population is clearly has the most power in explaining variation in the dependent variable. The right column in Table 3.1 shows the R-square for the model when dropping the variable on that line. The value changes very little when productivity and GDP per capita are not included. When population is dropped the value decreases by a factor of 10 from about 0.3 to 0.02.

Table 3.2 displays results from a model that takes advantage of the ability to measure productivity change with respect to specific sub-sectors of outputs within agriculture. This also motivates separating land into ALPC and PAST to isolate the effect of each explanatory variable on land allocated towards growing crops versus livestock. The productivity measures for crops, ruminants, and non-ruminants are all included for regressions for both ALPC and PAST because productivity change in each sector can have an influence on each type of land-use. The sample consists of only countries that had more than half of the productivity observations for all three of the sub-sectors.

The relationship between crop productivity and ALPC and PAST displays what has been generally found in developed industrialized countries over the last few decades. Most industrialized countries have increased cropland, but decreased pastureland more in raw terms resulting in a net loss in agricultural land. It appears this may be partially a result of increasing crop productivity, which was much higher in wealthier countries, where some pastureland was converted to grow crops or was taken out of production. This also comes through in the fact that the coefficient on crop
productivity in the PAST regression is about 4 times as large as that for the ALPC regression. To reiterate, all coefficients on productivity variables range between 10 and 50 meaning a 1% increase in productivity leads to an expansion or contraction, depending on the sign, of 10,000 ha to 50,000 ha.

This relationship between crop productivity and the change in allocation of land has interesting environmental implications. Countries like the U.S. have managed to increase forested land because the decrease in pasture has been larger than the increase in cropland. Therefore, there is a positive effect on decreasing deforestation. At the same time, crop production generally carries with it an increase in the use of chemical additives, which have significant environmental impacts, particularly on water related resources.

Increasing productivity in the non-ruminant sector was associated with an increase in both ALPC and PAST significant at a confidence level greater than 99% in both cases. A significant cause of productivity gains in developed countries in the pig and poultry sectors has been related to the science of feed (Nin et al. 2003). It is possible that this increased demand for crops that produce grains for animal feed. In the case of China Ludena et al. attribute the rapid increase in non-ruminant productivity to a process of ‘catching-up’ to methods already existing in developed countries that were adopted quickly once some element of private ownership was introduced into the agriculture sector around 1980. This mainly had to do with increased use of confined production systems.

Productivity gains in the ruminant sector have been more modest in general. Only China stands out as having achieved particularly strong improvements. Ruminant
productivity is not significantly related to ALPC, but does show a positive and significant relationship with PAST. This makes intuitive sense given that non-ruminant livestock rely primarily on pasture grazing. Although, corn has become an important feed stock for cattle in the U.S. and some other countries. It is interesting to view these results in the context of Figure 3.4 which shows that countries with the largest increases in PAST include Brazil and China. Latin America has achieved greater increases in ruminant productivity from 1980 to 2000 than industrialized countries after having made no gains at all in the previous 20 years. It is over this time period of realizing productivity gains that the rate of reduction of the rainforest has quickened. These results provide some evidence that increased productivity in ruminants has not slowed the rate of clearing.

Turning to the non-productivity related explanatory variables reveals that GDP per capita is not significantly related to either land variable in isolation. Population remains highly significant and positive for both ALPC and PAST. For ALPC, population density is significant even when population is included. As was true for the agriculture regression in Table 3.1 population density becomes positive and significant when population is dropped. Another interesting difference between the ALPC and PAST regressions is the difference in the overall R-square. Compared to other regressions in this study the R-square for PAST is very high considering the included regressors explain about 70% of the overall variation in permanent pasture and meadows. Alternatively, R-square for ALPC is more than a factor of 10 smaller at 0.02. This could mean that population change has very significant effects on pasture, but much less so on cropland. In terms of ALPC there is likely additional factors that
influence cropland decisions which should be investigated in future research. A likely candidate is output prices for agricultural goods. As mentioned earlier, it is additionally important given the confluence of predictions provided by increasing productivity and prices.

Table 3.3 shows results from a random effects regression that includes dummy variables for strength of property rights institutions from Freedom House. A random effects model is necessary because only one observation is available for each country, which applies to the year 2000. The sample is limited to the period from 1990 to 2001 to increase the relevance of the 2000 observation to each year in the sample. Again, the property rights variable is reported on a scale of 1 to 5 increasing inversely with strength of property rights. To discern between different levels of strength the ordinal variable is converted to a set of dummies. Category 1 is dropped. Most Western European and North American countries have a score of 1. Brazil has a score of 3, while countries such as the Congo and Haiti are rated at 5.

Results show that weaker property rights are associated with increasing land in agriculture to a point. The trend does not hold over the entire range of the variable. Compared to countries with full and complete property rights institutions those with scores of 2 and 3 have greater land in ALPC, but this is not so for countries with scores of 4 and 5. For PAST there is no difference between 1 and 2, but countries with scores of 3 and 4 have more land in PAST. While there could be signs of an interesting difference between PAST and ALPC being demonstrated here the lack of precision of the property rights variable given the time displacement issue make it unwise to draw overly strong conclusions.
This regression also provides an interesting comparison for different time periods by focusing on the later years in the sample. Estimates are insignificant for both crops and ruminants, but remain moderately significant and positive for non-ruminants in terms of both dependent variables. The most difference is for population. Comparing coefficients for the two dependent variables show that they are similar in magnitude, which is surprising since that for PAST tended to be larger when considering the full time period. The coefficient is also significant at a much higher confidence level for ALPC compared to PAST.

3.6. Conclusion

This study analyzed the determinants of land-use change in agriculture building on previous studies by incorporating total factor productivity measures that isolate technological change in different agricultural sectors. This is important for a number of reasons. The production of crops and different types of livestock experience technological change at varying times and rates. This is a fact that would not be captured with a general measure of agricultural productivity. Different sectors of agriculture also have unique environmental repercussions. Lastly, mechanisms exist that allow productivity change in one sector to influence land-use change in another. For example, the demand for grain for livestock feed has dramatic implications in terms of allocating land to crop production.
Results showed that increased productivity in different sectors of agriculture was most often associated with agricultural expansion, although this is by no means the entire story. Countries with increased crop productivity decreased land in pasture. This relationship was common in industrialized nations. Increased productivity in the non-ruminants sector was associated with increases in both ALPC and PAST. It is understandable how the association would exist for ALPC from increased demand for feed grain. It is less obvious how non-ruminants could be connected to changes in PAST since they are not grazed. Weaker property rights were associated with an more land in agriculture, although this result primarily existed for countries in the middle of the scale relative to countries with the strongest institutions defining ownership. While all the included variables demonstrated some relationship with land-use change population was clearly the most important in terms of explaining the variation in land-use.

Before moving on to policy implications it is important to recognize implicit assumptions about the relationships between the variables in this analysis made through the modeling framework. While the concurrent influence of each explanatory variable relative to the others is controlled for by their inclusion in the regression model considerable care should be taken in evaluating the necessary conditions for each influence to hold. The fact is that population, institutions, technological development, and wealth interact through feed-back loops with a change in one influencing the other. For example, an argument could be made that strong institutions are a necessary condition for investment in new technologies to be made, which is an integral part of creating economic growth. At the same time, it is difficult to establish strong
governance without a minimal level of economic activity to raise individuals out of poverty and create the necessary revenues needed to fund a stable government. It is in fact these chicken and egg problems that have resulted in many countries failing to advance economically over the last 50 years. This study had the more modest goal of quantifying what effect changes in political, economic, and demographic variables had on agricultural land-use decisions in subsequent years.

How would these results further inform how agricultural policy affects deforestation? First of all, it is clear that population should be the primary focus in any country where growth rates are high. That said, there are important reasons for not ignoring other variables. For one thing, population growth rates slowed significantly over the last 20 years of the 20th century. Therefore, the effects of population should continue to dissipate over the coming years. It was also shown that much more can be understood about technological change in agriculture by isolating between sub-sectors. Countries that increased crop productivity increased cropland, but took land out of pasture at a faster rate. While this relationship has existed primarily in industrialized economies it would be interesting to consider whether it will start to occur developing countries. This may mean a lessening of deforestation pressures, but an increase in environmental concerns related to intensive crop production. The important next step for this research is to focus analysis on subsets of countries according to the assumptions of the theoretical models reviewed in the introduction, while also incorporating the influence of output prices.
3.7. References


<table>
<thead>
<tr>
<th></th>
<th>Estimate</th>
<th>Overall R-square without Constant</th>
</tr>
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<tbody>
<tr>
<td>Constant</td>
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<td></td>
</tr>
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<td>(828)</td>
<td></td>
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</tr>
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<td>GDP per capita</td>
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</tr>
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</tr>
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<tr>
<td>Average T out of 32</td>
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</tbody>
</table>

Notes: Robust standard errors are in parentheses. ***, **, and * denote significant at 99%, 95%, and 90% confidence levels. The R-square without column provides the percent of overall variation in the dependent variable explained by all the listed regressors except the one on that row.

Table 3.1 Fixed Effects Regression on Determinants of Land Under Crops and Pasture from 1969 to 2001.
<table>
<thead>
<tr>
<th></th>
<th>ALPC</th>
<th>PAST</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Dependent Variable</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(1000 ha)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Constant</td>
<td>5728***</td>
<td>19814***</td>
</tr>
<tr>
<td></td>
<td>(206)</td>
<td>(746)</td>
</tr>
<tr>
<td>TFP Crops</td>
<td>12.6*</td>
<td>-49.7***</td>
</tr>
<tr>
<td></td>
<td>(7)</td>
<td>(14.2)</td>
</tr>
<tr>
<td>TFP Non-Ruminants</td>
<td>25.8***</td>
<td>59.5***</td>
</tr>
<tr>
<td></td>
<td>(8)</td>
<td>(12.7)</td>
</tr>
<tr>
<td>TFP Ruminants</td>
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<td>74.9****</td>
</tr>
<tr>
<td></td>
<td>(6.8)</td>
<td>(24)</td>
</tr>
<tr>
<td>GDP per capita</td>
<td>-0.013</td>
<td>-0.018</td>
</tr>
<tr>
<td></td>
<td>(0.014)</td>
<td>(0.013)</td>
</tr>
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<td>Population (millions)</td>
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<td>315***</td>
</tr>
<tr>
<td></td>
<td>(3.7)</td>
<td>(15)</td>
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<td>Population Density (people per sq. km)</td>
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<td>-66.9***</td>
</tr>
<tr>
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<td>(2.9)</td>
<td>(9.6)</td>
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<tr>
<td><strong>Overall R-square</strong></td>
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<td>N</td>
<td>55</td>
<td>59</td>
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<td>Average T out of 32</td>
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<td>21.6</td>
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Notes: Robust standard errors are in parentheses. ***, **, and * denote significant at 99%, 95%, and 90% confidence levels.

Table 3.2 Fixed Effects Regression on Determinants of Land in ALPC and PAST from 1969 to 2001.
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<thead>
<tr>
<th></th>
<th>ALPC</th>
<th>PAST</th>
</tr>
</thead>
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<tr>
<td>Dependent Variable</td>
<td>(1000 ha)</td>
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</tr>
<tr>
<td>Constant</td>
<td>1514</td>
<td>7134**</td>
</tr>
<tr>
<td></td>
<td>(1497)</td>
<td>(3240)</td>
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<td>TFP Crops</td>
<td>10.3</td>
<td>67.1</td>
</tr>
<tr>
<td></td>
<td>(7.7)</td>
<td>(8.2)</td>
</tr>
<tr>
<td>TFP Non-Ruminants</td>
<td>10.6*</td>
<td>12.1*</td>
</tr>
<tr>
<td></td>
<td>(5)</td>
<td>(7)</td>
</tr>
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<td>TFP Ruminants</td>
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<td>-8.5</td>
</tr>
<tr>
<td></td>
<td>(7.1)</td>
<td>(7.8)</td>
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<td>Population (millions)</td>
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<td>34*</td>
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<td></td>
<td>(8.7)</td>
<td>(18.7)</td>
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<td>Population Density (people per sq. km)</td>
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<td>-6</td>
</tr>
<tr>
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<td>Property Rights 2 Dummy</td>
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<tr>
<td></td>
<td>(3192)</td>
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<td></td>
<td>(3133)</td>
<td>(6941)</td>
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Notes: Robust standard errors are in parentheses. ***, **, and * denote significant at 99%, 95%, and 90% confidence levels. The property rights variable is on an ordinal scale from 1 to 5 where 1 represents strongest property rights, which is the dropped category.

Table 3.3 Random Effects Regression for Determinants of Land-Use from 1990 to 2001.
Figure 3.1 Total Amount of Land by Year in ALPC for all Countries in the Sample.
Figure 3.2 Total Land in Permanent Pasture and Meadow for all Countries in the Sample.
Figure 3.3 Percentage Change in Arable Land and Permanent Crops from 1961 to 2001.
Figure 3.4 Percentage Change in Permanent Pasture and Meadows by Country from 1961 to 2001.
Figure 3.5 Average Annual Change in Crop Total Factor Productivity from 1961 to 2001.
Figure 3.6 Average Annual Change in Livestock Total Factor Productivity from 1961 to 2001.
## APPENDIX

### Average Annual % Change in TFP and Total TFP Observations by Country and Sector

<table>
<thead>
<tr>
<th>COUNTRY</th>
<th>Annual Mean % TFP Change</th>
<th>Total Observations out of 40</th>
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</thead>
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<tr>
<td></td>
<td>CROPS</td>
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<tr>
<td>ALBANIA</td>
<td>-0.8</td>
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<td>ALGERIA</td>
<td>0.1</td>
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<td>ANGOLA</td>
<td>-1.6</td>
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<td>ARGENTINA</td>
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<tr>
<td>AUSTRALIA</td>
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<td>AUSTRIA</td>
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</tr>
<tr>
<td>BANGLADESH</td>
<td>2.9</td>
<td>-1.9</td>
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<tr>
<td>BELIZE</td>
<td>3.5</td>
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<tr>
<td>BELUX</td>
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<td>4</td>
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<tr>
<td>BHUTAN</td>
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Notes: NR = Non-Ruminants and RU = Ruminants.
LIST OF REFERENCES

Chapter 1


Kugler, T., G. Bornstein, M.G. Kocher, and M. Sutter. Trust Between Individuals and Groups: Groups are Less Trusting than Individuals but Just as Trustworthy. Forthcoming in *Journal of Economic Psychology* (Forthcoming).


Chapter 2


Kugler, T., G. Bornstein, M.G. Kocher, and M. Sutter. Trust Between Individuals and Groups: Groups are Less Trusting than Individuals but Just as Trustworthy. *Journal of Economic Psychology* (Forthcoming).


Chapter 3


