

# Trust, Trustworthiness, and Risk in Rural Paraguay

by

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Spring 2005

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# Abstract

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This dissertation looks at the relationship between trust, trustworthiness, and risk aversion in a rural Paraguayan setting. The first chapter of this dissertation looks at theft between farmers. Rural areas of developing countries often lack effective legal enforcement. However, villagers who know each other well and interact repeatedly may use implicit contracts to minimize crime. I construct a dynamic limited-commitment model in which a thief cannot credibly commit to forego stealing from his fellow villagers but may be induced to limit his stealing by the promise of future gifts from his potential victim. Using a unique survey from rural Paraguay which combines traditional data on production with information on theft, gifts, and trust, as well as with experiments measuring trust and trustworthiness, I test whether the data is consistent with predictions from the dynamic model. The results provide evidence that, in contrast with predictions from a one-period model with an anonymous thief, farmers do implicitly contract with one another to limit theft. Farmers who have more close family members in their village give fewer gifts, and farmers with plots which are more difficult to steal from give fewer gifts, experience less theft, and trust more. Gift-giving increases when trust is lower and the threat of theft is greater, turning the social capital literature on its head.

The second chapter of this dissertation looks at a different linkage between trust, trustworthiness, and risk. Trusting behavior in general and play in the traditional trust experiment specifically depend both on trust beliefs and on levels of risk aversion. I ran two experiments with a diverse set of subjects in fifteen villages of rural Paraguay, the traditional trust experiment and a new experiment measuring only risk aversion. I find that risk attitudes are highly predictive of play in the trust game. In addition, omitting risk aversion as a regressor in trust regressions significantly changes the coefficients of important explanatory variables such as gender and wealth.

*To my family.*

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# Chapter 1

## Introduction

This research lies at the intersection of development economics, behavioral economics, and contract theory. In particular I focus on the interrelated areas of trust, trustworthiness, and risk. Much of the impetus for this work comes from time spent in the Peace Corps in Paraguay. I saw that bearing risk was extremely painful for households, and that they tried to avoid it, often at the expense of potential profits. On the other hand, efforts to work on development projects were often thwarted due to the villagers' mistrust of one another. Formal and informal insurance mechanisms to avoid risk are interesting and important, as is the mistrust and limited commitment which constrain them.

The first essay, Chapter 2, looks at theft between farmers. Theft between farmers in rural Paraguay is important because it comprises a loss of a relatively large share of income and often encourages farmers to plant less profitable but less easily stealable crops. I model rural theft using a dynamic limited-commitment model in which the thief cannot commit to refrain from stealing, but the victim can give him transfers and promise him future transfers in order to limit theft. I test the predictions of this model against those of a one-period model with a rational anonymous thief using panel data from Paraguay. This unique panel data set, for which I collected the last round, includes both detailed survey data (including data on gifts and theft) as well as experimental data measuring trust and trustworthiness.

I find that villagers do contract with one another, giving gifts in order to avoid future theft. For example, households with fields which border commonly used footpaths experience more theft, give more gifts, and have a lower level of trust in their fellow vil-

lagers. Another example is that households which live in the same village with more of their close family members give fewer gifts. This is contrary to the common expectation that family members provide each other mutual insurance and so give each other more gifts, but these results are in accord with the predictions of the limited-commitment model if family members are either more trustworthy when interacting with one another or if they monitor each other's fields more. It is also interesting to note that households with more trustworthy neighbors plant more easily stealable crops in the first place, so fear of theft affects crop choice as well as gift-giving.

This chapter is important because it shows how informal mechanisms are used in the absence of formal enforcement. As fear of theft and untrustworthy neighbors may discourage farmers from planting crops which yield the most social surplus, this has important efficiency implications. It also shows that evidence of high gift-giving in a community is not necessarily a sign that the community has high social-capital or a high level of trust.

In the second essay, Chapter 3, I look at the determinants of trusting behavior. Trusting behavior depends both on levels of trust and risk aversion. Researchers who find that people who act in a trusting manner are wealthier may infer causality between levels of trust and wealth. However, if wealthier households are less risk averse in absolute terms, they may behave as if they are more trusting, confounding the analysis. I ran two experiments with Paraguayan farmers, one measuring risk aversion and the other measuring trusting behavior. Risk attitudes are highly predictive of play in the trust game, and ignoring risk aversion in trust regressions significantly changes the coefficients on gender and wealth. Females and less wealthy individuals act in a less trusting manner, but this is because they are more risk averse and not because they have lower levels of trust.

## Chapter 2

# Theft, Gift-Giving, and Trustworthiness: Honesty is Its Own Reward in Rural Paraguay

### 2.1 Introduction

Due to a lack of legal enforcement in rural areas around the world, theft between farmers is a common occurrence.<sup>1</sup> Fifty percent of survey respondents in rural Paraguay<sup>2</sup> reported that some item was stolen from them in the past year. Among those from whom something was stolen, median theft accounted for a loss of two percent of annual income. Not only is theft large, it also changes investment decisions, as forty-two percent of respondents said there was at least one crop they were discouraged from planting because of fear of theft.

Casual observation in Paraguay suggests that there is less theft from fields which are more difficult to steal from, and that there is more theft of crops such as watermelon which, in being easy to consume, are of greater value to thieves. Forty-two percent of households also admit to giving gifts to a person who is known to be a thief in the hopes that this untrustworthy person will limit the amount he steals from them.

A paper by Becker (1968) portrays a rational anonymous thief who weighs the benefits of stealing against the costs of possible punishment. This one-period model predicts that there will be more theft when the potential gains are greater and the probability of

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<sup>1</sup> Anthropologists have discussed theft between fellow villagers in the context of Mexico (Foster 1965), Vietnam (Paige 1975), Italy (Banfield 1958), and Malaysia (Scott 1985).

<sup>2</sup> The survey covered 225 households in rural Paraguay in 2002.

getting caught is smaller. A Beckerian model cannot shed light on how social ties can limit theft. Thus, while Becker's model can explain the casual observations above with regards to theft, it cannot explain why the same households which are vulnerable to theft also give more gifts or why a household would give gifts to an untrustworthy neighbor.

Research has shown that farmers in rural areas have extensive knowledge of each other's actions, interact with each other on a daily basis, and contract over many aspects of their lives (Platteau and Nugent 1992, Udry 1994). Given the lack of anonymity and the long-term nature of relationships that characterize life in rural Paraguay, villagers should be able to use informal contracts<sup>3</sup> with one another to prevent excessive theft as well.

In this paper I expand on Becker's one-period model of a rational thief by constructing a dynamic limited-commitment model in which the formal judicial system is ineffective. An agent cannot credibly commit to refrain from stealing from another agent, and so must be induced to limit his theft by the promise of future gifts.<sup>4</sup> This type of model has been used to investigate efficient dynamic contracts in the absence of commitment with regards to sovereign debt (Kletzer and Wright 2000) and mutual insurance mechanisms (Ligon, Thomas and Worrall 2002, Kocherlakota 1996), though it has not previously been applied to theft.

There is a large literature on property crime in the United States (Levitt 2004, Gould, Weinberg and Mustard 2002), but this literature focuses on anonymous urban crime by thieves who do not know the people from whom they are stealing. The model presented here is novel in the economic literature on crime, as most other papers do not consider interactions between thieves and their victims. Economists often model

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<sup>3</sup> Here, a contract does not refer to a formal written contract, but rather an unwritten system of sanctions and rewards.

<sup>4</sup> Udry (1994) finds that the inability to commit is more important than informational constraints in determining contracts in rural Nigeria.

thieves interacting with other thieves, teaching each other methods or exerting peer pressure (Glaeser, Sacerdote and Scheinkman 1996), or victims interacting in neighborhood watch programs (Huck and Kosfeld 2004). However, there are few models in which victims interact with thieves, and there are no empirical papers that I know of on the topic.

There are two notable papers which model interactions between thieves and victims from a theoretical perspective. While Akerlof and Yellen (1994) focus on urban crime and a community's decision to accept crime by gang members, Mui (1995) focuses on rural crime. One farmer sabotages a second farmer's product due to his feelings of envy, and the second farmer limits sabotage by giving gifts. The act of sabotage gives no monetary benefits in Mui's model, only serving to reduce the saboteur's envy. In the envy model thieves must be poorer than their victims, and gift-giving will occur even in the one-shot game.

Economists are accustomed to thinking of gift giving as something one does on the holidays, a means of trade, or a means of reciprocal exchange. The predictions of the dynamic limited-commitment model show that gifts are also given to potential thieves to deter theft. This is contrary to the predictions of fairness models in which agents reward actors with good intentions (Rabin 1993) or give gifts to reduce inequality (Fehr and Schmidt 1999), as well as contradicting predictions of mutual insurance models (Coate and Ravallion 1993) in which households give gifts to those households with whom they have fewer enforcement problems. Of course households give gifts for a myriad of reasons: a preference for fairness, a form of mutual insurance, and a desire to appease potential thieves. This last reason for gift-giving, while not the only reason, has been generally ignored in the economic literature but is economically significant in rural Paraguay.

Using data from rural Paraguay, I test for evidence of contracting between thieves

and their victims. Researchers in Paraguay and at the University of Wisconsin collected panel data from over 200 rural households in sixteen randomly selected villages of rural Paraguay at three points in time throughout the 1990's (Carter and Olinto 2003). I conducted a fourth round of data collection in 2002 adding questions designed to look specifically at the issues raised in this paper. In addition to the original, more standard, questions on income and production, detailed questions on theft experienced by a household, gifts they gave, and survey data on their level of trust in fellow villagers were added to the survey. I also ran a series of economic experiments measuring trust, trustworthiness, and risk aversion with the same households which responded to the survey. The main limitation of the dataset is the relatively small sample size of 223 households. There is a tradeoff though between data quality and quantity. This unique dataset combines repeated observations of real-world decisions made by the household, survey measures of trust and perceptions of theft, and experimental data on trusting and trustworthy behavior.

To empirically test the predictions of the model, I estimate a system of three equations using the generalized method of moments (GMM) with theft experienced, gifts given, and trust as the left hand side variables. Evidence is provided that farmers do contract with each other to limit theft, suggesting that the limited-commitment model constitutes an empirically important extension to the Beckerian model. Living closer to a police station actually increases the amount of theft experienced by a household, consistent with the local perception that the police are corrupt. Households with fields which do not border commonly used footpaths experience less theft, give fewer gifts, and have a greater level of trust in their fellow villagers. Thus people who own fields which are more difficult to steal from are doubly rewarded. They can give fewer transfers both in the form of theft and in the form of gifts to their fellow villagers.

Households which live in the same village with more of their close family members

give fewer gifts. This contradicts the perception in the existing ‘social capital’ literature that relatives give each other more gifts than other households.<sup>5</sup> Putnam states that “in communities where people can be confident that trusting will be requited, not exploited, exchange is more likely to ensue.” (Putnam 1993, page 172) However, these results are in accord with the predictions of the limited-commitment model if family members are either more trustworthy when acting with one another or if they monitor each other’s fields more. Instrumenting for crop choice and controlling for wealth effects I find that households which plant the five most commonly stolen crops give significantly more gifts than households which do not. These results taken together show the importance of informal enforcement mechanisms to limit theft.

The remainder of this paper is organized as follows. Section 2.2 briefly discusses anthropological literature on theft and then lists eight stylized facts about theft in rural Paraguay. In Section 2.3, I lay out the dynamic limited-commitment model and compare the implications of that model with those of a Beckerian model. Section 2.4 describes the survey data and experiments while Section 2.5 uses the data to test the implications of the two models. Section 2.6 concludes.

## **2.2 Stylized Facts about Theft**

Anthropologists discuss different reasons for sharing, including trade, altruism, reciprocity, and ‘tolerated theft’. Blurton-Jones (1987) claims that due to diminishing marginal returns, it will not always pay the owner of a stock of food to defend it against a hungry village-mate who will be willing to fight harder for the food. Food taken under the guise of tolerated theft may be taken through force, or it may be passively trans-

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<sup>5</sup> The giving we measure here does not include Christmas or birthday presents, only the giving of agricultural products or livestock.

ferred in an attempt to avoid force. Hawkes (1993) points out that a central difference between reciprocity and tolerated theft is that in the former those who acquire resources have control over *who* receives shares, while under the latter they only have control over as much of the resource as they can defend. Bliege-Bird and Bird (1997) found that when a sea turtle was caught in Australia's Torres Strait those households living near the butchering household, not near the household responsible for catching the sea turtle, received greater shares of the sea turtle, supporting the hypothesis of tolerated theft over reciprocity or trade.

Scott (1985) proposes another view of theft as an "everyday form of peasant resistance". In Malaysia the victims of theft tended to be the peasants who had mechanized instead of employing poorer peasants to do the same work. In Malaysia the threat of theft was used to ensure a continued stream of transfers specifically in the form of jobs, while in Paraguay it ensures a continued stream of transfers in the form of jobs, loans, and gifts.

I will now lay out some stylized facts about theft in rural Paraguay followed by evidence supporting each fact.

1. The motivation for stealing 'smaller' items is different than the motivation for stealing 'larger' items. Small items include all crops, chickens, pigs, and small tools such as machetes and hoes. Large items include cows, horses, and large tools such as chain-saws and tractors. For every item stolen from them, survey respondents were asked if they knew or suspected who stole it and if they said yes, they were asked a set of questions about the thief. Of those items for which the thief's identity was known, 70 percent of smaller items were stolen by a neighbor or a relative while only 18 percent of larger items were stolen by a neighbor (and none by relatives).

The theft of large items is more likely to be reported to the authorities than the

theft of small items. It might be difficult to prove the identity of a thief who steals a bit of corn every week, but it is less difficult to prove the identity of the thief of a branded cow or a chain-saw. While only four percent of known thieves of small items were reported to the police, 64 percent of thieves of large items were reported. Sixty-six percent of the known thieves of small items were given gifts, lent money, or hired by the victim before the theft while only 36 percent of the known thieves of large items were given these transfers. Because of the difference in motivations underlying the theft of small and large items I will only focus on the theft of smaller items, and the word theft in the rest of these stylized facts and of this paper refers only to the theft of smaller items.

2. Theft is common and economically important. Forty-three percent of households had some small item stolen from them in the past year. The median value stolen, conditional on being stolen from was 100,000 Guaranies (around \$17) which is a one percent loss of median household income.<sup>6</sup>
3. Victims know who is stealing from them. Forty-seven percent of those who experienced theft knew or suspected who the thief was of at least one of the items stolen from them in the past year.<sup>7</sup>
4. Thieves receive less disutility from thieving than do other households. Seventy percent of the victims who suspected a specific perpetrator said the thief committed the crime because of poverty, two percent because of revenge and four percent because of envy. Twenty-five percent added in their own option of either habit or 'no shame' (*sin vergüenza*).<sup>8</sup>

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<sup>6</sup> Total theft is two percent of median household income, while theft of small items is one percent.

<sup>7</sup> Local informants claim that even if they do not know exactly who stole from them that they can often narrow it down to one of two or three different households.

5. Victims do not report thieves to the police or punish them physically. Only 14 percent of households which suspected the identity of the thief yelled at him and only four percent reported him to the authorities. Households were asked why they did not report a thief to the authorities. Nine percent were not reported because of fear of reprisal, 30 percent were not reported because the victim said reporting the theft wouldn't do any good, there was no place to report it, or it was too difficult and 57 percent were not reported because the victim didn't feel the crime was serious.
6. Vigilance helps limit theft. When a crop is planted closer to home, or on a plot which is not located along a major footpath, there is less theft. Table 2.1 compares crops planted on plots which no non-household member walks past and those planted on plots which one or more people walk past per week. Note that the amount of theft is not negligible. More is stolen from fields which more people walk past, though for only two of the crops is the difference significant. If many people walk past a field they all know what is planted there and when it will be ready to harvest, and they can easily stick a bit of produce in their pocket as they walk past. A similar analysis shows that crops are more likely to be stolen when they are planted on plots further from home.
7. Households give transfers to thieving households to avoid being stolen from. Households were given a list of options of actions they might undertake to avoid theft such as monitoring their fields at night or planting easily stealable crops further from footpaths. One option was "If you know someone is a thief, do you give him gifts to avoid getting stolen from?" Forty-two percent of households answered yes.

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<sup>8</sup> One might think that even more victims would have chosen 'no shame' if it had been an option on the list.

Table 2.1: Number of different people who walk past the field each week and amount stolen

Crop	% quantity stolen in survey		% quantity stolen for each household	
	0 people	1 or more people	0 people	1 or more people
Banana	1.75%	4.20%	2.79%	3.39%
+			(2.17)	(1.80)
			[9]	[32]
Red Corn	0.17%	1.02%	0.47%	0.94%
+			(0.47)	(0.67)
			[54]	[115]
White Corn	0.00%	2.34%	0.00%	1.46%
+*			(0.00)	(0.71)
			[45]	[104]
Fresh Corn	0.57%	9.96%	2.22%	3.52%
+			(1.69)	(1.45)
			[51]	[123]
Melon	0.00%	2.57%	0.00%	2.45%
+			(0.00)	(1.59)
			[12]	[22]
Watermelon	0.39%	10.93%	0.83%	8.22%
+*			(0.62)	(4.61)
			[20]	[26]
Yucca	0.51%	0.57%	1.21%	1.06%
+/-			(0.79)	(0.32)
			[63]	[140]

Standard errors in parenthesis, number of observations in brackets.

The columns on the left are the total quantity of output stolen from fields past which no-one walks/people walk in the entire survey divided by the total quantity of crop output grown on those same fields. The columns on the right are the average percent stolen from all households in the survey.

+/- is the sign of the difference in percentages stolen, and \* means the difference is significant at the 10% level in a one-tailed  $t$ -test.

In general, victims are on friendly terms with thieves. Sixty-six percent of the suspected thieves received gifts, work, or loans from their victim before the theft, while 82 percent were from the same village as the victim. In fact, the thieves are often close neighbors (54 percent) or relatives (16 percent) of the victim. Some households continue giving transfers to thieves even after they are stolen from, while others stop transfers after they are stolen from. The survey asked “Did you [give gifts to the thief/hire him/lend him money] before the theft? after the theft?” Twenty-seven percent of households continue giving some type of transfer to the thief after the theft and 54 percent stop giving some type of transfer to the thief after the theft.

8. Investment decisions are distorted due to the potential of theft. Another option on the list of things a household could do to prevent theft was to avoid planting more easily stealable crops in plots adjoining popular footpaths. Fifty-six percent of households claimed to do so. The survey also asked each household if there was a crop they would have wanted to plant, but didn't because of fear of theft. Forty-two percent of respondents said there was a crop they were discouraged from planting and eight percent said there was an animal they were discouraged from raising because of fear of theft.

These stylized facts can give us a simple characterization of rural theft in Paraguay. Households claim to give transfers (of corn, chicken, yucca) to those households who they know are not trustworthy. Additionally, these households are implicitly allowed to steal a basic amount in order to prevent them from stealing larger amounts. Households are sanctioned if they steal more than is acceptable by being cut off from future transfers.

## 2.3 Dynamic Limited-Commitment Model

### 2.3.1 Layout of Model

The description above is in accord with a model of limited-commitment. The farmer gives two types of transfers to the thief: gifts and prescribed theft. The thief cannot commit to steal only the prescribed quantity. If the thief does steal more than he is prescribed to steal, the farmer will know, and will punish him by cutting him off from future transfers (both gifts and prescribed theft).<sup>9</sup> This game is repeated forever. The following model is similar to models used by Ligon et al. (2002) Kocherlakota (1996), and Kletzer and Wright (2000).

Before each period there is uncertainty as to what the cost of stealing will be in that period. For example, a farmer may be home eating his mid-morning breakfast when a potential thief walks past his field. If that is the case, the thief can much more easily pick a few watermelons as he walks by since nobody is there to see him. On the other hand, the farmer may be working in the field when the potential thief walks past, and then it will be quite difficult to steal. The farmer can give gifts, which do not depend on the state of nature (i.e., do not depend on how easy it is to steal in that period) and are not costly for the thief, and he can prescribe theft, which is state dependent (depending on how easy it is to steal in that period) and costly for the thief as he must wait for the moment when no one is around or sneak out in the rain to avoid being seen.

Note that the thief prefers his transfer as a gift, rather than as prescribed theft, so as not to incur the costs of theft. The farmer also prefers giving gifts because the value of the transfer he has to give to maintain the thief's utility at some level is smaller when it is in the form of a gift. If the farmer were able to give a state-contingent gift then there

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<sup>9</sup> If the farmer doesn't give the gift, the thief can punish him by stealing.

would never be any theft in equilibrium, but, as he is not, there will be some prescribed theft, even though it is costly for both agents.

Before the state is realized, the farmer sets the level of prescribed theft for every possible state and the size of the state-independent gift he will give the thief at the end of the period, if he finds that the thief has stolen no more than was prescribed. The state of nature is then realized and the thief decides how much to steal (and steals that amount). At this point the farmer is no longer able to change his promised gift level. The farmer observes how much the thief stole and decides whether or not to give him the gift. If the thief stole more than the prescribed amount, the farmer has no reason to give him the gift. If the thief stole the prescribed amount then the farmer may transfer him the gift.

The farmer plants a crop with sure output  $y^1$ , and the thief plants a crop with sure output  $y^2$ . If output were risky then theft would serve an insurance function, but for the purposes of this paper I assume no output uncertainty.<sup>10</sup> The farmer transfers a ‘gift’ of  $\omega$  to the thief. This transfer does not depend on the state of nature. He also prescribes a permissible ( $p$ ) amount of theft  $r_s^p$  for every possible state ( $s$ ) of nature. In equilibrium the farmer consumes  $y^1 - \omega - r_s^p$  and the thief consumes  $y^2 + \omega + r_s^p$ .

If the thief deviates, stealing an amount  $r_s^d$  greater than the prescribed amount  $r_s^p$ , he receives trustworthiness disutility from doing so, akin to his feeling of guilt or pride.<sup>11</sup> The more disutility an agent gets from stealing the more ‘trustworthy’ he is. This disutility from stealing is  $t(r_s^d)$  and it increases in the amount stolen at a non-decreasing rate (i.e.,  $t'(\cdot) > 0$  and  $t''(\cdot) \geq 0$ ). Trustworthiness disutility can be negative for small levels of theft, meaning that the thief receives utility from stealing. It is only necessary that the function be convex. The cost of stealing is  $c(s, r_s)$ , which is different in each state of

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<sup>10</sup> Fafchamps and Minten (2004) show that crop theft does increase with transitory poverty.

<sup>11</sup> Andreoni and Miller (2002) and Fehr and Gächter (2000) used experiments to show that individuals have heterogeneous preferences, some being selfish and others altruistic or reciprocating. Posner (1998) uses “moral pride” as an explanation for non-self interested behavior (i.e., some people do not like to think of themselves as thieves).

nature. This cost also increases in the amount stolen at a non-decreasing rate, in every state (i.e.  $c'(s, \cdot) > 0$  and  $c''(s, \cdot) \geq 0 \forall s$ ). Note that all theft is costly, but only deviation level theft yields trustworthiness disutility.

If this were not a repeated game and the thief and farmer only met once, then there would be a high level of deviation theft and no gift given. Recall that the timing of the model is 1) the farmer sets the gift level and the level of prescribed theft in each possible state, 2) the state is realized and the thief decides whether to steal the prescribed amount or some greater amount so as to maximize his momentary utility, 3) the farmer decides whether or not to give the thief the gift. One can use backwards induction and see that in the one-shot game the farmer will never give the gift. Knowing this, the thief will steal the amount which maximizes his momentary utility (and is in general greater than the prescribed amount).

### 2.3.2 Punishment for Deviating

In the infinitely repeated game, an equilibrium with no stealing above the prescribed amount is enforceable with threat of punishment. Abreu (1988) proves that all perfect equilibria can be found using the worst perfect equilibria for each player as punishment when that player deviates.<sup>12</sup> As autarky is the unique Nash equilibrium for the single-period game, permanent autarky is one sub-game perfect Nash equilibrium for the infinitely repeated non-cooperative game and a potential candidate for the punishment strategy.

Abreu (1988) discusses that it is often possible to design ‘stick and carrot’ punishments which are more harsh than simple reversion to autarky. These strategies employ a

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<sup>12</sup> Mailath, Nocke and White (2004) show that such simple penal codes may fail in repeated *extensive*-form games when there exist ‘within-period myopically suboptimal’ punishments, i.e., punishments that would not be optimal for the punisher if the game were not repeated. If the thief steals more than the prescribed amount, the most severe punishment the farmer can mete out is to give no gift, a punishment which would be optimal for the farmer even in the one-shot game. Thus, simple penal codes will not fail in the dynamic limited-commitment model described above.

‘stick’ punishment taken in the first few periods after deviation, followed by a more desirable ‘carrot’ played until another player deviates. The existence of a ‘stick and carrot’ punishment depends on the existence of an action the non-deviating agent can undertake which will make the deviator worse off no matter what action he undertakes.<sup>13</sup>

In the current model, if the thief deviates, there is no ‘stick’ the farmer can use which is worse than autarky, i.e., giving no transfer.<sup>14</sup> On the other hand, there is a ‘stick’ worse than autarky which the thief can employ. He can steal more than the amount maximizing his momentary utility for a few periods, in order to punish the farmer. The thief wouldn’t want to enforce this punishment, because he prefers stealing the amount optimal for him, and no more. To make this punishment strategy credible, the farmer must reward the thief for carrying it out by giving the thief a small gift in later periods. Thus, if the thief deviates then his punishment is reversion to autarky. If the farmer deviates, a possible punishment strategy would be for the thief to steal more from the farmer than he would have in autarky for a few periods. After that the thief steals the amount he would have in autarky, in addition to receiving a small gift from the farmer. If the farmer doesn’t give this gift he is punished again by the extra-high level of theft for a few periods.

### 2.3.3 Finding the Constrained-Efficient Frontier

Continuation utility after deviating given the punishments discussed above is  $D^1$  for the farmer and  $D^2$  for the thief. I assume that in autarky the thief receives trustworthiness disutility for whatever he steals. The farmer and thief’s momentary utility functions are represented by  $v(\cdot)$  and  $u(\cdot)$  respectively. The value function for the continuation utility

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<sup>13</sup> In Abreu’s oligopoly example the punisher produces a high amount, making the deviator worse off than he would have been with the Nash reversion solution of producing a medium amount.

<sup>14</sup> The comparative statics derived from the model would not change if the farmer had access to some costly punishment he could impose on the thief in addition to cutting off future gifts, though the level of cooperation would be higher.

of the farmer is  $V(\cdot)$ , and  $U$  represents the thief's continuation utility.

The Pareto efficient frontier is found by maximizing the farmer's utility subject to keeping the thief's (ex-ante expected) utility at  $U$  for all possible  $U$ . The probability of each state of nature is  $\pi_s$  and  $\beta$  is the discount factor. The Inada conditions hold, with  $\lim_{y \rightarrow 0} u'(y) = \infty$ ,  $\lim_{y \rightarrow \infty} u'(y) = 0$ ,  $u'(\cdot) \geq 0$ , and  $u''(\cdot) < 0$  (and likewise for  $v(\cdot)$ ). The gift and prescribed theft are constrained to be non-negative. The farmer's maximization problem is:

$$V(U) = \max_{\omega, \{U_s, r_s^p\}_s} \sum_s \pi_s [v(y^1 - \omega - r_s^p) + \beta V(U_s)]$$

subject to the following constraints.

$$\sum_s \pi_s [u(y^2 + \omega + r_s^p) - c(s, r_s^p) + \beta U_s] \geq U \quad (2.1)$$

$$u(y^2 + \omega + r_s^p) - c(s, r_s^p) + \beta U_s \geq u(y^2 + r_s^d) - c(s, r_s^d) - t(r_s^d) + \beta D^2 \quad \forall s, r_s^d \quad (2.2)$$

$$v(y^1 - \omega - r_s^p) + \beta V(U_s) \geq v(y^1 - r_s^p) + \beta D^1 \quad \forall s \quad (2.3)$$

$$r_s^p \geq 0 \quad \forall s \quad (2.4)$$

$$\omega \geq 0 \quad (2.5)$$

The first constraint is the promise keeping constraint which ensures that the thief's expected utility does not go below some level. The second and third are the thief and the farmer's incentive compatibility (IC) constraints which ensure that in each state of nature the agents are at least indifferent between the equilibrium strategy and deviating. The last two are non-negativity constraints on theft and the gift.

The contract can be computed recursively, given an initial value for  $U$ , by solving the dynamic program for the initial transfers, prescribed theft, and continuation utilities

in each possible state  $s$ . Then in the next period one solves the program again given the new value for the target utility level  $U$  (which will equal  $U_s$  from the previous period, depending on which state was realized).

The level of theft the thief would undertake when deviating will solve his maximization problem so that  $r_s^{*d} = \operatorname{argmax}_r u(y^2 + r) - c(s, r) - t(r)$  over all  $r_s^{*d} \geq 0$ . If the thief's IC constraint (2.2) binds, it will only bind for  $r = r_s^{*d}$ , and so one can ignore all  $r \neq r_s^{*d}$ . Interestingly, households for which  $u'(y^2) < c'(s, 0) + t'(0)$  for every possible state  $s$  will have a corner solution. These are households with such a high trustworthiness disutility that they will never steal more than the prescribed amount no matter what. This is a good motivation for dividing the model into two agents, one who is a potential thief and one who is not.

The first-order condition for  $U_s$  simplifies to

$$V'(U_s) = -\frac{\lambda + \mu_s}{1 + \nu_s}. \quad (2.6)$$

where  $\lambda$  is the multiplier on the promise keeping constraint (2.1),  $\mu_s \pi_s$  on the thief's incentive compatibility constraint (2.2),  $\nu_s \pi_s$  on the farmer's incentive compatibility constraint (2.3),  $\phi_s \pi_s$  on the theft non-negativity constraint (2.4), and  $\xi$  on the gift non-negativity constraint (2.5). I can also use the envelope theorem to show that

$$V'(U) = -\lambda. \quad (2.7)$$

The first order conditions with respect to  $r_s^p$  is

$$\frac{v'(y^1 - \omega - r_s^p)}{u'(y^2 + \omega + r_s^p) - c'(s, r_s^p)} - \frac{(\phi_s + \nu_s v'(y^1 - r_s^p))}{(1 + \nu_s)(u'(y^2 + \omega + r_s^p) - c'(s, r_s^p))} = \frac{\lambda + \mu_s}{1 + \nu_s}. \quad (2.8)$$

Combining the first order conditions with respect to  $r_s^p$  (2.8) and  $U_s$  (2.6) with

the envelope condition (2.7) we see that  $\lambda$  equals the ratio of marginal utilities in the previous period if prescribed theft was positive and the farmer's IC constraint didn't bind and  $\lambda$  equals the ratio of marginal utilities in the current period if neither agent's constraints bind and prescribed theft is positive.

### 2.3.4 Characterization of Contracts

It is possible to prove a proposition related to one found in Ligon et al. (2002), and as the proof is almost identical it is omitted here for the sake of brevity. The history of states up to and including date  $t$  is  $h_t = (s_1, s_2, \dots, s_t)$ .

**Proposition 1.** *Any constrained-efficient contract can be characterized as follows: There exist  $S$  state dependent intervals  $[\underline{\lambda}_s, \bar{\lambda}_s]$  such that  $\lambda(h_t)$  evolves according to the following rule. Let  $h_t$  be given and let  $s$  be the state which occurs at time  $t$ ; then*

$$\lambda(h_t) = \begin{cases} \underline{\lambda}_s & \text{if } \lambda(h_{t-1}) < \underline{\lambda}_s \\ \lambda(h_{t-1}) & \text{if } \lambda(h_{t-1}) \in [\underline{\lambda}_s, \bar{\lambda}_s] \\ \bar{\lambda}_s & \text{if } \lambda(h_{t-1}) > \bar{\lambda}_s \end{cases} \quad (2.9)$$

where  $\underline{\lambda}_s = -V'(\underline{U}_s)$ , and  $\bar{\lambda}_s = -V'(\bar{U}_s)$ . I define  $\underline{U}_s$  as the lowest sustainable continuation payoff that the thief could receive in state  $s$  so as to just satisfy his IC constraint (2.2). Likewise  $\bar{U}_s$  is the highest sustainable continuation payoff that the thief could receive in state  $s$  so as to just satisfy the farmer's IC constraint (2.3). This completely characterizes the contract once an initial value for  $\lambda(h_{t-1})$  is given.

Thus we see that, if possible, the transfers are fixed so as to keep the ratio of marginal utilities  $\left(\frac{v'(y^1 - \omega - r_s^p)}{u'(y^2 + \omega + r_s^p) - c'(s, r_s^p)}\right)$  constant over time and over states. If some constraint is binding, the ratio will be changed by the minimum possible to satisfy the

constraints.

### 2.3.5 Comparative Statics

I will now derive comparative statics to look at the effects of changes in exogenous features such as a) the cost of stealing ( $c(s, r_s)$ ), b) trustworthiness ( $t(r_s)$ ), and c) risk aversion on endogenous variables such as i) gifts given ( $\omega$ ) ii) prescribed theft ( $r_s^p$ ) and iii) trust.

I consider trust to be an endogenous variable (while trustworthiness is an exogenous variable effecting trust).<sup>15</sup> Hardin (2002) emphasizes that trust is relational (i.e., two peoples' level of trust depends on their ongoing interaction) as is the case here. He defines trust as “encapsulated interest”. One agent (the farmer) trusts a second agent (the thief) because he knows the thief values the continuation of the relationship, and because of that he will take the interests of the farmer into account. Levi (2001) claims that distrust raises the “transaction costs” of cooperation.

In accord, I measure (lack of) trust as the sum of the multipliers on the thief's incentive compatibility constraint (2.2) over states ( $\sum_s \pi_s \mu_s$ ) given some reference utility  $U$  for the thief. This reference utility could be the thief's utility in a world in which theft was impossible. This Lagrange multiplier is a measure of how the farmer's maximized expected utility reacts to a slight relaxation of thief's incentive compatibility constraint. If the thief's incentive compatibility constraint were never binding, and he would never steal anything in any state, then the multiplier will equal zero, and the farmer has complete trust in the thief. As the thief becomes more and more willing to steal and more costly to convince not to steal the multiplier increases and the farmer trusts him less. This corresponds with Hardin's definition of trust in that as the thief's utility in autarky

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<sup>15</sup> Much of the social capital literature considers trust to be endogenous, though there is a strain of empirical work which considers trust to be exogenous and looks at the effects of trust without looking at its causes.

increases he cares less about the continuation of the gift-giving relationship with the farmer. Then he becomes more costly to convince not to steal and the farmer trusts him less.

Looking at Equation (2.8) one finds that when  $\phi_s = 0$  (prescribed theft is greater than zero) and  $v_s = 0$  (the farmer's constraint does not bind),  $U_s$  is a non-decreasing function of  $\omega + r_s^P$ . Because Equation (2.8) has to hold in each state of nature and each period, states which offer higher continuation utility must also prescribe more theft, and so each  $U_s$  is an increasing function of the prescribed theft  $r_s^P$  in that state and of  $\omega + r_s^P$ .

If the thief's incentive compatibility constraint (2.2) is binding, then as his trustworthiness decreases (i.e., as  $t(\cdot)$  falls for all theft levels) he must have both higher consumption and higher continuation utility (since I have shown above that the two must go in the same direction). Thus, contrary to what one might expect, *ceteris paribus*, more trustworthy agents consume less and have lower utility. A farmer gives transfers to those agents who are not trustworthy in order to avoid being stolen from. Trustworthy agents provide a lower threat, and so do not have to be bribed by being given transfers.<sup>16</sup>

It has been shown that a less trustworthy agent has higher consumption, but does this come from a higher gift  $\omega$  or higher prescribed theft  $r_s^P$ ? Because this less trustworthy agent has a higher continuation utility ( $U_s$ ), his momentary utility must be higher in the next period as well. As theft is costly, the farmer will prefer to increase the thief's momentary utility through gifts rather than through prescribed theft when possible. This can also be seen by noting that for a less trustworthy agent  $\underline{U}_s$  will be higher, and so in the stochastic steady state he will consume more. As the gift is not costly, most of this higher consumption will come through a higher gift.

When a farmer has less trustworthy neighbors, his trust decreases as well. Because

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<sup>16</sup> I have assumed that villagers know each other's levels of trustworthiness, so a thief cannot misrepresent himself as being untrustworthy in order to receive more gifts.

$V'(U_s) = -\frac{\lambda + \mu_s}{1 + \nu_s}$  the higher  $U_s$  obtained by less trustworthy agents implies that  $\frac{\lambda + \mu_s}{1 + \nu_s}$  must be higher as well. As  $\lambda$  does not depend on the state  $s$ , and it cannot be the case that both agents' incentive compatibility constraints bind, if the thief's IC constraint (2.2) binds then  $\nu_s = 0$ . Thus the higher continuation utility  $U_s$  obtained by less trustworthy agents implies that  $\mu_s$  is higher as well. This means that a less trustworthy thief causes the farmer to be less trusting.

An analysis of the effects of a change in the cost structure of stealing is similar to the analysis of a change in trustworthiness. If the thief's IC constraint (2.2) is binding in a period in which it is easy to steal, and the probability of that easy state increases or the marginal cost in that state decreases the thief will steal more when deviating. The thief will have to have increased consumption ( $\omega + r_s^P$ ) and continuation utility  $U_s$  to compensate him. While a change in trustworthiness affects the thief's momentary utility when deviating in all states, a change in the marginal cost of stealing only affects momentary utility when deviating in the state in which the cost changes. A decrease in the cost of stealing in all states will cause an increase in the size of the gift, similar to the case of a decrease in trustworthiness disutility. An increase in the variance of the cost of stealing, on the other hand, will cause an increase in theft in the states in which theft is easiest. As an easy state becomes more probable or the marginal cost in a state decreases, the weighted average of  $U_s$  also increases, causing the weighted average of  $\mu_s$  to increase, which means that the farmer's level of trust is lower when it is easier to steal.

One can show that as the farmer becomes more risk averse he gives more gifts. As the farmer's risk aversion increases, his continuation utility from the deviation utility ( $D^1$ ) decreases. (This is because in autarky his consumption level will vary more as he will get stolen from more in easy states and less in difficult states.) As this relaxes his incentive compatibility constraint (2.3) the total transfer he gives will increase. Because he

is more risk averse and because theft is costly he must give a higher (state-independent) gift, and not higher (state-dependent) prescribed theft.

### **2.3.6 Model with Crop Choice**

Imagine that a farmer can choose between planting two crops. The more ‘easily stealable’ crop (e.g. watermelon) has a higher value per handful but a slightly lower quantity output. The less ‘easily stealable’ crop (e.g. cotton) has a lower value per handful but a slightly higher quantity output. Assume that in a world with no theft the more easily stealable crop would be more profitable. Given the possibility of theft, the less easily stealable crop may be more profitable, and so the potential for theft may affect crop choice. If fear of theft discourages a farmer from planting a more profitable crop, there will be a decrease in efficiency due to the lack of enforcement.<sup>17</sup>

Conditional on crop choice the comparative statics derived in the previous section should still hold, although they will not hold if one does not condition on crop choice. As a thief becomes less trustworthy he will be transferred a higher gift if the farmer continues planting the same crop. If the thief becomes so untrustworthy that the farmer switches to a lower value crop, then a less trustworthy thief will actually receive a gift which is lower in value. (The same analysis holds as the probability of a low cost state goes up).

Imagine two farmers who are both indifferent between planting the high value and low value crops, but for historical reasons one chooses to plant the high value crop and the other chooses to plant the low value crop. Using an analysis similar to that for a decrease in trustworthiness, I find that the farmer who plants the more easily stealable crop will give more gifts and trust less.

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<sup>17</sup> The Coase theorem does not hold because of the inability of the thief to commit to limiting theft.

### 2.3.7 Comparative Statics from a One-Period Anonymous Model

I derived comparative statics from a dynamic limited-commitment model above, and now derive comparable comparative statics from a Beckerian (one-period anonymous thief) model. In a simple Beckerian model, an anonymous thief decides whether or not to steal by comparing the gains from stealing with the probability of being caught and punished. The probability of being caught in this model and the cost of stealing in the dynamic limited-commitment model can be measured by quite similar variables in the data. As the probability of being caught rises, the potential thief becomes less likely to choose to steal. Also, as a farmer plants crops which are more valuable per handful stolen theft will increase.

It is possible to extend the Beckerian model to account for the risk aversion of the farmer. In the one-period anonymous model, a farmer who is more risk averse would rather spend a fixed amount on protection than run a greater risk of being stolen from. Thus, a more risk averse farmer will monitor more, increasing the thief's probability of being caught. Thus, a more risk averse farmer will experience less theft than a less risk averse farmer.

The Beckerian model can also be extended to take into account trust and trustworthiness. If the potential thief receives trustworthiness disutility when he steals, as a potential thief becomes more trustworthy he is less likely to choose to steal. One can also define trust, in a rather ad hoc way, as the probability with which a farmer thinks his neighbors will choose to steal from him. In this case, as the probability of being caught rises, a neighbor's trustworthiness rises, or the farmer's risk aversion increases, the farmer will become more trusting.

Though the simple model of a one-shot game and an anonymous thief can be extended to account for trust and trustworthiness, it will not give comparative statics for gifts given. The fact that it is a one period model and the thief is anonymous precludes

Table 2.2: Predictions from limited-commitment and one-period anonymous (OPA) models

		Theft (Th)	Giving (G)	Trust (Tr)
Cost of stealing (C)	Lim-Com	$\frac{dTh}{dVar(C)} > 0$	$\frac{dG}{dC} < 0$	$\frac{dTr}{dC} > 0$
	OPA	$\frac{dTh}{dC} < 0$	$\frac{dG}{dC} \leq 0$	$\frac{dTr}{dC} > 0$
Risk aversion ( $\gamma$ )	Lim-Com	$\frac{dTh}{d\gamma} < 0$	$\frac{dG}{d\gamma} > 0$	$\frac{dTr}{d\gamma} \leq 0$
	OPA	$\frac{dTh}{d\gamma} < 0$	$\frac{dG}{d\gamma} \leq 0$	$\frac{dTr}{d\gamma} > 0$
Trustworthiness (Tw)	Lim-Com	$\frac{dTh}{dT_w} \leq 0$	$\frac{dG}{dT_w} < 0$	$\frac{dTr}{dT_w} > 0$
	OPA	$\frac{dTh}{dT_w} < 0$	$\frac{dG}{dT_w} \leq 0$	$\frac{dTr}{dT_w} > 0$
Stealable crop (St)	Lim-Com	$\frac{dTh}{dSt} \leq 0$	$\frac{dG}{dSt} > 0$	$\frac{dTr}{dSt} < 0$
	OPA	$\frac{dTh}{dSt} > 0$	$\frac{dG}{dSt} \leq 0$	$\frac{dTr}{dSt} < 0$

the potential for using transfers as a means of contracting in order to limit theft.

### 2.3.8 Comparison of One-Shot and Limited-Commitment Predictions

Let us review and compare the comparative statics implied by the limited-commitment and one period models of theft. Comparative statics have been derived for the three endogenous variables: gifts given, theft experienced, and trust. The three main categories of exogenous variables are the cost of stealing, the risk aversion of the farmer, and the trustworthiness of his neighbors. Also, the crop choice decision is made by the farmer in the model before his other decisions regarding gifts and theft, so, one can derive comparative statics for that variable as well. I will look at each in turn, and a summary of the comparative statics can be found in Table 2.2.

The limited-commitment model predicts that as the cost of stealing goes up a farmer will a) give a lower total value of gifts, b) experience less theft, and c) trust more. As the farmer becomes more risk averse he should a) give more gifts and b) experience less

theft. The limited-commitment model also shows that a farmer with more trustworthy neighbors should a) give more gifts and b) trust more. Lastly, the limited-commitment model shows that, all else equal, if a farmer plants more easily stealable crops he will a) give more gifts and b) trust less (while the effects on the level of theft are indeterminate). In general, the one-shot model of an anonymous thief makes no predictions about gift-giving. On the other hand, some of the predictions about theft experienced which are quite strong in the one-period model are indeterminate in the dynamic limited-commitment model.

## **2.4 Data**

In 2002 in Paraguay I collected an exciting new data set combining traditional survey data on production with non-standard questions measuring real-world economic variables such as theft experienced and agricultural giving. Respondents were also asked their level of trust. To complement the survey data and be better able to answer questions raised by the model, I also ran experiments measuring the trust, trustworthiness, and risk aversion of the respondents. It is quite unusual to have both detailed economic survey data and experimental measures.

In 1991 the Land Tenure Center at the University of Wisconsin in Madison and the Centro Paraguayo de Estudios Sociológicos in Asunción worked together in the design and implementation of the original survey of 300 rural Paraguayan households in sixteen villages in three departments (comparable to states) across the country. This was a random sample, stratified by land-holdings. The original survey was followed up by subsequent rounds of data collection in 1994, 1999, and, most recently, I collected the last round in 2002. All rounds include detailed information on production and income. In 2002 I added questions related to theft experienced, levels of trust, and gifts given.

Table 2.3: Summary statistics

Variable	Mean	(Std. Dev.)
Theft Experienced <sup>a</sup>	111,000	(336,000)
Gifts Given	306,000	(524,000)
Annual Income	28,300,000	(72,100,000)
Family Size	5.6	(2.4)
Adult Males	1.8	(1.2)
Close Relatives in Village	3.2	(3.0)
No one Passes Field	44%	
Km to Police	4.06	(2.66)
# of Stealable Crops	2.3	(1.1)
Village Median Land Owned	24.4	(67.18)
Obs	223	

<sup>a</sup> The relevant exchange rate is approximately 4,800 Guaranies to the dollar.

Although the data set is rather small, with only 223 households interviewed in 2002, it is quite detailed, reducing potential omitted variable problems.

Theft experienced and gifts given were measured as defined by the respondents themselves. For every crop which the household planted in the last year they were asked the total amount they produced. Then they were asked how much of that was consumed within the household, how much was fed to animals, how much was given away to friends or fellow villagers, how much was stolen, and how much was still in storage. A similar procedure was used for animals owned and their derivatives (such as eggs, honey, and milk), and for extractives (such as firewood and coal). Households were also asked what tools were stolen from them in the last year, and to list any other items stolen from them. Summary statistics can be found in Table 2.3. Note that gifts given are approximately three times the size of theft (of small items) experienced. Given the dynamic limited-commitment model, it would be efficient on the equilibrium path for gifts to be larger than theft. In addition, the measure of gifts includes gifts given to limit theft and those given for other reasons.

I also carried out two economic experiments among survey respondents, one measuring trust and trustworthiness, and the other measuring risk aversion. A more detailed description of the games can be found in Appendix E, but I will describe them briefly here. After three or four days of surveying in each village the enumerators invited a player from each household which had participated in the survey to play the games. 188 of the 223 families surveyed sent a family member to play the game.<sup>18</sup> Between the two games, the players won an average of two days' wages in a period of two or three hours.

The game's instructions were given in a group setting in each village with no questions allowed. Then the players were called into the room one at a time, given a second explanation, and allowed to ask any questions in private. The risk game was played first. The investor was given a sum of money (equivalent to two-thirds of one day's wages) and was given five choices of how much (if any) to invest. The experimenter then rolled a die to determine the investor's payoffs.

After that the trust game was played.<sup>19</sup> I ran the trust/investment game originally described in Berg, Dickhaut and McCabe (1995). The trustor was given a sum of money. In the first move, the trustor decided how much, if any, to send to an anonymous trustee.<sup>20</sup> Any money sent to the trustee was tripled. The trustee made the second move, deciding how much money to return to the trustor. Under the assumption of selfish preferences, the only sub-game perfect Nash equilibrium is for the trustor to send no money to the trustee, using backward induction to infer that the trustee will never return any money. Money sent by the trustor is commonly used to measure his trust that

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<sup>18</sup> The nine households surveyed in the Japanese immigrant village did not participate in the games. Excluding the Japanese, who are much wealthier than the rest of the population, those households which did not send a player were wealthier and had younger household heads.

<sup>19</sup> As is often the case when games are played in rural villages the games were not double blind (Barr 2003, Karlan 2005). This is due to the importance of making sure players with varying levels of education understand the games, and difficulties in running experiments in a village setting.

<sup>20</sup> As the villagers all played together, they knew the pool from which their partner was drawn, though they did not know with whom they were paired up.

the anonymous trustee will return his money. Money returned by the trustee is used to measure his trustworthiness.

In order to have measures of both trust and trustworthiness from every household in the survey, I had every player play the role of trustor first and then the role of trustee. Burks, Carpenter and Verhoogen (2003) find that playing both roles in the trust game decreases both the amount sent and the share returned. They hypothesize that playing both roles reduces the player's sense of responsibility for the well being of his partner. If this is the case, then playing both roles will decrease correlation between the measure of trustworthiness and altruism, and will allow trustworthiness to be measured more purely.

## **2.5 Empirics**

### **2.5.1 System Estimation Before Controlling for Crop Choice**

#### **Methodology**

In Section 2.3 of this paper I derived comparative statics from two models for the three endogenous variables: gifts given, theft experienced, and trust, with regards to exogenous changes in the cost of stealing, the risk aversion of the farmer, and the trustworthiness of his neighbors. Before controlling for crop choice the regressors are all exogenous and so there is no need to instrument. Thus, I estimate a system of equations

$$y_1 = x\beta_1 + u_1$$

$$y_2 = x\beta_2 + u_2$$

$$y_3 = x\beta_3 + u_3$$

in which  $y_1$  is gifts given,  $y_2$  is theft experienced, and  $y_3$  is trust. Because this system is just identified and because there are no instruments the system analysis will simplify to equation by equation OLS (Zellner and Theil 1962).

When estimating this system, the measure of  $y_1$  is the log of one plus the value of theft experienced,  $y_2$  is measured as the log of one plus the value of gifts given. The variable  $y_3$  is trust as measured by the World Values Survey question “What share of your fellow villagers would try to take advantage of you if they had the opportunity?”, where the answers are 1-all, 2-more than half, 3-half, 4-less than half, and 5-none. In Appendix A I run the same analysis but use the experimental measure of trust rather than the survey measure and the results become somewhat weaker. In this setting I feel that the survey measure of trust is more appropriate because it measures how much respondents trust their fellow villagers given that they know the system of rewards and sanctions they can impose on each other. Trust as measured by the experiment is anonymous trust when no rewards or sanctions are possible.

The variables used as exogenous regressors common to all three equations include variables representing risk aversion, the cost of stealing, and the trustworthiness of neighbors. The amount the household bet in the risk experiment is included as a measure of (lack of) risk aversion, as the more they bet, the less risk averse they are. An indicator variable for households which did not participate in the experiments is included as well. I also include household size and the number of adult males to represent the cost of stealing. It is more difficult to steal from a household with more adult males, as a family member will be working in the fields more often. I include a variable indicating if any non-household member walks past the family’s main plot in any given week, which effects the cost of stealing as well. If no non-household member walks past a field then people do not know what crop is in the field or when it will be ripe, and will look more out of place if they are seen walking past the field. Fields on commonly used footpaths

are easier to steal from. I also include the number of households within 250 meters of the surveyed household so that the indicator for no-one walking past the field is not just proxying for a household having few neighbors, but actually represents a characteristic of the plot in which crops are planted.

I also include variables representing the trustworthiness of neighbors and villagers. I have GPS data on each household in the survey and the measure of trustworthiness from the experiment. I combine these to measure neighbor trustworthiness as the level of trustworthiness of the least trustworthy of the household's four closest neighbors. I focus on the level of trustworthiness of the least trustworthy person rather than the median because the model predicts that it is the least trustworthy people who must be contracted with to reduce theft. I focus on close neighbors because the evidence presented in Section 2.2 in Stylized Fact #7 suggested that close neighbors are often the culprits. A proxy for village level trustworthiness comes from a community-level survey and is the answer to the question "What share of people in this village contribute with time or money to church?"<sup>21</sup>

A last proxy for trustworthiness is the number of households in the village with members who are close relatives of the surveyed household. Close family members include parents, children, or siblings of the household head or his wife. They do not include cousins or other extended family members. A potential thief may experience a larger trustworthiness disutility when stealing from his own relative. Note that having close family members as neighbors who help monitor the fields could also make it more difficult for thieves to steal from that household, thus working through the cost of stealing as well as trustworthiness.

The log of household wealth, median land-holdings in the village, the number of

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<sup>21</sup> The community-level survey also asked what share of people in the community contribute with time or money to communal goals (which include electrification and road building). While contributing to electrification may be considered a gift to the community, contributing to the church is a better measure of religiosity and, potentially, trustworthiness.

years the household has lived in the village, and the distance between the house and the nearest police station are also included as controls. I do not control for village fixed effects in the analysis in the main text to preserve precious degrees of freedom, though I have bootstrapped clustered standard errors.<sup>22</sup> In Appendix B I show the results from a specification including village fixed effects, and although the standard errors on the coefficients are all much larger, the results are quite similar.

### **Implementation**

When not controlling for crop choice I estimate the system of equations using equation by equation OLS. Note that given omitted variables such as crop choice the results shown in Table 2.4 may be biased, but they give an interesting overview of the situation. A variable which represents an increase in the cost of stealing is ‘No-one passes field’. Households with fields which non-household members do not walk past give a significantly lower total value of gifts, experience significantly less theft and trust significantly more. In fact, a household which possess no plot which no-one walks past experiences approximately 80 percent more theft and gives 80 percent more gifts than a household which has a plot no-one walks past. One might think that the reason households with fields which no-one walks past give fewer gifts and experience less theft is that people who live on the outskirts of town have no neighbors to whom to give gifts. But, this result continues to hold even when including the number of households in a 250 meter radius of that household as an explanatory variable. Thus, this result is not caused by certain households having fewer neighbors, but is directly related to the number of people walking past the field. Households with more adult males do get stolen from slightly less, but they also give more gifts (though this may be because they produce more and so have more to give). The results for the cost of stealing show that a dy-

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<sup>22</sup> The resampling scheme is applied separately in each village, as suggested by Davison and Hinkley (1997).

Table 2.4: Gift giving, theft experienced, and trust regressions with no crop choice

	Log(Theft)	Log(Giving)	Trust
Bet	0.072 (0.094)	-0.019 (0.081)	-0.007 (0.037)
Didn't Play Games	0.613 (0.613)	-0.064 (0.622)	-0.445 (0.319)
No One Passes Field	-0.749** (0.332)	-0.808*** (0.309)	0.298* (0.153)
# HHs in 250 m Radius	0.037 (0.026)	-0.064*** (0.024)	-0.009 (0.013)
# Adult Males	-0.191 (0.138)	0.242* (0.135)	0.012 (0.070)
Family Size	0.025 (0.083)	0.095 (0.066)	0.003 (0.039)
Log(Wealth)	0.123 (0.098)	0.275*** (0.095)	-0.051 (0.047)
# Close Relatives in Vill	-0.076 (0.056)	-0.111** (0.053)	0.042 (0.028)
Years in Village	0.010 (0.009)	0.023*** (0.009)	0.012*** (0.004)
Vill Median Land Owned	-0.021 (0.031)	-0.109*** (0.031)	0.016 (0.016)
Neighbor Trustworthiness	0.336 (1.121)	1.719 (1.082)	1.109** (0.519)
% of Vill Helps Church	-0.029*** (0.010)	-0.006 (0.009)	0.016*** (0.005)
Kilometers to Police	-0.113* (0.063)	0.055 (0.050)	0.017 (0.030)
$R^2$	0.115	0.254	0.110
Obs.	223	223	223

OLS with bootstrapped clustered standard errors in parenthesis.

\*-90%, \*\*-95%, and \*\*\*-99% significant.

namic limited-commitment model is supported above and beyond the predictions of a one-period model, as both gifts given and theft experienced increase when the cost of stealing goes down.

At a first glance, the results on trustworthiness do not show evidence of gift-giving being used to limit theft. The higher the share of the village helping with church projects, the less theft a farmer experiences and the more trusting he is. The limited-commitment model predicted that in more trustworthy villages, farmers would give fewer gifts and could not sign the comparative statics for theft experienced. As his least trustworthy close neighbor becomes more trustworthy, a farmer trusts more, but there is no effect on gifts or theft.

However, a different measure of trustworthiness, the number of close family members living in the same village, does show effects consistent with the dynamic limited-commitment model. Households with *more* close family members in the village give significantly *fewer* gifts, experience less theft, and trust more. For every additional family member living in their village, a household gives approximately ten percent fewer gifts. This is contrary to what one might expect, i.e., that households with more close family members would give more gifts, not less, and contrasts with the view of gifts held by Putnam (1993) and Platteau (1997). This result fits directly with the limited-commitment model's predictions that as trustworthiness increases gifts given decrease and trust increases, while the effect on theft experienced is ambiguous.

The coefficients on risk aversion are all insignificant, perhaps because the measure of risk aversion is only for one member of the household and not for the family as a whole.<sup>23</sup> I also find that households in villages with higher median land holdings give fewer gifts. This result should not hastily be used to conclude that households in these

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<sup>23</sup> I also have information showing if the household did not take out credit for fear of putting themselves at risk, but this variable also had an insignificant coefficient.

villages are more trustworthy, as I have not yet controlled for crop choice and villages with large land-holdings plant quite different crops than do villages with smaller land-holdings. Wealthier households give significantly more gifts but do not experience more theft than poorer households. This effect is not as large economically as one might expect. A household that is ten percent wealthier gives less than three percent more gifts. This implies that although wealthier households do give a higher total value of gifts, they give a smaller proportion of their wealth than do poorer households. The relatively small coefficient on wealth suggests that models in which gifts are given out of altruism or in order to mitigate envy are not driving the results. It suggests that thieves are stealing simply because they desire the object they are stealing, and that farmers are giving in order to limit the amount taken.

Households which live closer to a police station actually experience more theft, which is what one might expect if the police were corrupt and participating in the theft.<sup>24</sup> To test that distance to a police station was not proxying for local development I estimated the system including both distance to a police station and distance to a paved road but the distance to the police station maintained a significant negative coefficient while the coefficient on distance to a paved road was insignificant.

## **2.5.2 System Estimation Controlling for Crop Choice**

### **Methodology**

When controlling for crop choice, an endogenous decision made by the farmer, it will have to be instrumented for. There are multiple potential instruments for crop choice. Instead of using OLS I must now estimate the system of equations using GMM. The

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<sup>24</sup> I do not believe this effect is due to the fact that police stations may be placed where crime is worst. These police stations have been there a long time. Additionally, these results refer to the theft of smaller items, while the police focus on combating cattle theft, armed robberies, and homicide.

system of equations estimated is

$$y_1 = x\beta_1 + v\gamma_1 + u_1$$

$$y_2 = x\beta_2 + v\gamma_2 + u_2$$

$$y_3 = x\beta_3 + v\gamma_3 + u_3$$

where  $x$  are the exogenous regressors and  $v$  is crop choice. The instrument set  $z$  includes all of the elements of  $x$ , as well as a set of instruments for crop choice. The moment conditions require that  $E(z'u_g) = 0$  for every equation  $g$ .

Define the matrix of regressors

$$X_i = \begin{pmatrix} x_{i1} & 0 & 0 \\ 0 & x_{i2} & 0 \\ 0 & 0 & x_{i3} \end{pmatrix}$$

for each individual  $i$  so that  $x_{i1}$  includes all of the regressors in the first equation (including both  $x$  and  $v$ ),  $x_{i2}$  includes all of the regressors in the second equation, etc. The matrix  $X$  is obtained by stacking the matrices  $X_i$  for all individuals. The matrix of instruments  $Z$  has a similar structure. The matrix  $Y$  is obtained by stacking the individual vectors

$$Y_i = \begin{pmatrix} y_{i1} \\ y_{i2} \\ y_{i3} \end{pmatrix}$$

I estimate the coefficients in the following way.

1. Estimate an initial consistent estimator of  $\beta$  and call it  $\widehat{\beta}$ . For this step I use the

2SLS estimator.

$$\widehat{\beta} = [X'Z(Z'Z)^{-1}Z'X]^{-1}X'Z(Z'Z)^{-1}Z'Y$$

2. From this one obtains the residual vectors  $\widehat{u}_i = y_i - X_i\widehat{\beta}$ .
3. Using these residuals, I estimate the optimal weighting matrix  $\widehat{W} = (N^{-1} \sum_{i=1}^N Z_i'\widehat{u}_i\widehat{u}_i'Z_i)^{-1}$ .
4. Using this weighting matrix one can obtain the optimal linear GMM estimator  $\widehat{\beta} = [X'Z\widehat{W}Z'X]^{-1}X'Z\widehat{W}Z'Y$ .

### Implementation

The most commonly stolen crops in the survey are watermelons, melons, bananas, corn, and yucca. The dynamic limited-commitment model predicts that a household planting these crops will give more gifts and trust less. Crop choice is included as an explanatory variable indicating how many of the above listed crops the household planted. Note that crop choice is measured as the number of easily stealable crops planted rather than the total value planted in these crops. This is the appropriate choice if it is the decision to plant watermelons, and not how many to plant which affects theft, i.e., if whether a farmer plants 200 watermelons or 1000, the thief steals the same amount.<sup>25</sup>

While conserving degrees of freedom in comparison with including a dummy for each of those five crops planted, using the number of crops planted as an explanatory variable imposes a linearity on the effect of crop choice. I have also tried using the square and the log of the number of commonly stolen crops which are planted, as well

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<sup>25</sup> This seems true from casual conversations with farmers and is also suggested by the coefficients found in Table 2.4 on wealth which showed that more wealthy farmers give fewer gifts and experience less theft as a proportion of income than poorer farmers (though more overall).

Table 2.5: 'First stage' crop choice regressions with and without instruments.

	# of Stealable Crops		
Bet	-0.004 (0.043)	0.012 (0.036)	0.002 (0.037)
Didn't Play Games	-0.079 (0.309)	0.188 (0.293)	0.027 (0.287)
No One Passes Field	-0.051 (0.155)	-0.129 (0.138)	-0.115 (0.143)
# HHs in 250 m Radius	-0.016 (0.011)	-0.025** (0.012)	-0.030*** (0.011)
# Adult Males	-0.059 (0.061)	-0.006 (0.060)	-0.025 (0.059)
Family Size	0.117*** (0.041)	0.112*** (0.037)	0.121*** (0.038)
Log(Wealth)	-0.021 (0.054)	-0.003 (0.049)	0.034 (0.046)
# Close Relatives in Village	-0.008 (0.026)	-0.021 (0.024)	-0.023 (0.024)
Years in Village	0.006 (0.236)	0.003 (0.005)	0.001 (0.004)
Vill Median Land Owned	-0.036** (0.014)	-0.051*** (0.012)	-0.049*** (0.012)
Neighbor Trustworthiness	1.007** (0.504)	0.856* (0.461)	0.786* (0.464)
% of Village Helping in Church	0.001 (0.004)	-0.003 (0.004)	-0.003 (0.004)
Kilometers to Police	0.043 (0.033)	0.027 (0.027)	0.012 (0.026)
Plant Green Manure	0.472** (0.236)	0.375* (0.213)	
Village Banana Price in 99	-0.005 (0.038)	-0.008 (0.034)	
Village Watermelon Price in 99	0.419*** (0.117)	0.280** (0.111)	
Village Yucca Price in 99	-0.771 (0.766)	-0.499 (0.833)	
# of Stealable Crops in 1999	0.263*** (0.091)		
$R^2$	0.328	0.264	0.226
Wald Test for Inst. Sig.	29.396 ( $p = 1.00$ )	9.937 ( $p = 0.96$ )	
F Test for Inst. Sig.	6.120 ( $p = 1.00$ )	2.620 ( $p = 0.92$ )	
Obs.	177	223	223

OLS with bootstrapped clustered standard errors in parenthesis.

\*-90%, \*\*-95%, and \*\*\*-99% significant.

as converting the count data into an indicator variable for planting three or more of those crops and the results are not substantially different.<sup>26</sup>

As crop choice is endogenous I instrument for the number of crops planted in 2002 with the village prices of bananas, watermelon, and yucca in 1999, as well as an indicator variable for whether or not the household planted a green manure cover crop in 2002. In Appendix D I show results when including the number of stealable crops planted in 1999 as an additional instrument for the number planted in 2002. I use past rather than current prices to avoid incorporating effects the amount planted in a year may have on the price in that year.

The planting of green manures is a relatively new soil conservation technique in Paraguay. The households which plant green manures are not necessarily the households with the worst soil. They tend to be households which are curious and enjoy trying new crops. The planting of green manures is potentially a good instrument for crop choice because households which plant green manures tend to be more adventurous in their crop choice and plant more of the easily stealable crops. On the other hand, as a thief would never want to steal a green manure, the planting of green manures should have no direct effect on gift giving, theft, or trust.

When estimating a system of equations using GMM, there is no real first stage regression as there is with 2SLS. However, I include a table with the regression of crop choice on all of the instruments, similar to a ‘first-stage’ regression to give the reader some idea of the correlates of crop choice. Table 2.5 shows the determinants of crop choice both including and excluding the instruments (as well as after including past crop choice). The  $F$ -statistic and the heteroskedasticity consistent Wald-statistic testing the joint significance of the four instruments are 2.62 and 9.94 respectively which means

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<sup>26</sup> The results when using the number of crops planted or the square of the number planted are the strongest. This suggests that the effect of planting more easily stealable crops increases at an increasing rate.

that the instruments are jointly significant at above the 95% level.

Households in villages with high median land-holdings plant fewer of these more easily stealable crops. Farmers in these villages are much larger scale farmers and tend to plant soy and wheat for export. Farmers with more trustworthy neighbors plant more easily stealable crops, perhaps because they worry less about theft. Households living in more densely populated areas plant fewer stealable crops, hinting at why they give fewer gifts before controlling for crop choice. Larger families plant more of the more easily stealable crops. The planting of a green manure and the price of watermelons in 1999 are both highly significant in predicting current crop choice, as is past crop choice.

Table 2.6 shows the GMM results. The first three columns estimate the system using many explanatory variables, while the last three columns use fewer, due to concerns of degrees of freedom. Hansen's  $J$ -statistic tests whether the instrument set is uncorrelated with the errors (Hansen 1982). The  $J$ -statistics for the system are 10.66 and 11.39 (for the larger and smaller set of explanatory variables respectively) with  $p$ -values of .70 and .75. Though we know that these tests tend to be weak with small data sets (Kocherlakota 1990), the hypothesis that the instruments are exogenous cannot be rejected.

Households which plant more easily stealable crops give significantly more gifts, though there is no significant effect on theft or trust. A household planting one easily stealable crop gives approximately double the value of gifts as a household planting no easily stealable crop. A household planting two of the crops gives triple the value of gifts as a household planting none. This is in accord with the predictions of the limited-commitment model, and slightly contrary to those of the one-period model which predicts that theft will go up as a household plants more easily stealable crops but not gifts.

Also, while the coefficient on wealth remains significant, it decreases in size a bit after controlling for crop choice. The fact that wealthy households give a smaller

Table 2.6: Gift giving, theft experienced, and trust regressions controlling for crop choice

	Theft	Giving	Trust	Theft	Giving	Trust
Bet	0.077 (0.112)	-0.042 (0.079)	-0.004 (0.041)			
Didn't Play	0.998 (0.698)	-0.130 (0.592)	-0.386 (0.367)			
Don't Pass Field	-0.891** (0.389)	-0.634** (0.305)	0.326* (0.170)	-0.957*** (0.353)	-0.901*** (0.308)	0.153 (0.172)
HHs in 250 m	0.043 (0.044)	-0.022 (0.030)	-0.013 (0.018)			
Adult Males	-0.202 (0.165)	0.264** (0.134)	0.012 (0.076)	-0.193 (0.171)	0.184 (0.126)	-0.025 (0.073)
Family Size	0.050 (0.157)	-0.037 (0.100)	0.004 (0.054)			
Log(Wealth)	0.085 (0.118)	0.261*** (0.092)	-0.045 (0.053)	0.024 (0.096)	0.140* (0.075)	-0.015 (0.044)
Close Relatives	-0.076 (0.067)	-0.093* (0.052)	0.033 (0.031)	-0.056 (0.058)	-0.083* (0.049)	0.022 (0.029)
Years in Village	0.011 (0.010)	0.022*** (0.008)	0.012*** (0.005)			
Median Land	-0.015 (0.056)	-0.053 (0.042)	0.012 (0.023)			
Trustworthiness	0.184 (1.421)	0.925 (1.183)	1.111* (0.587)	1.995 (1.565)	1.837 (1.272)	0.365 (0.655)
% Help Church	-0.028** (0.011)	-0.001 (0.009)	0.015*** (0.006)			
Km to Police	-0.110 (0.073)	0.049 (0.051)	0.017 (0.031)			
Crop Choice	0.055 (0.975)	1.223* (0.635)	-0.066 (0.330)	-0.365 (0.662)	0.964* (0.545)	-0.053 (0.301)
Overid. ( <i>J</i> ) test	10.657 ( $p = 0.70$ )			11.386 ( $p = 0.75$ )		
Obs.	223	223	223	223	223	223

GMM with bootstrapped clustered standard errors in parenthesis.

\*-90%, \*\*-95%, and \*\*\*-99% significant.

proportion of their wealth in gifts than do poorer households, suggests that thieves are not stealing due to envy and that victims are not giving due to altruism or inequality aversion. It supports the dynamic limited-commitment model in which farmers give gifts in order to limit the amount stolen from them.

The only variables which lose significance are village median land-holdings and the number of households in a 250 meter radius. After controlling for crop choice, households in villages with large median land-holdings and households in densely populated areas do not give significantly fewer gifts than other households. This is because those households planted significantly fewer of the easily stealable crops and that is what causes them to give fewer gifts.

The main results which held before controlling for crop choice still hold. Households with fields which no-one passes still give fewer gifts, experience less theft, and trust more. Households in the same village with close family members still give significantly fewer gifts, experience less theft, and trust more. As there are many reasons why people give gifts, only one of which is the desire to limit theft, the fact that the coefficient on the number of close relatives in the village in the gift-giving equation is significant is quite convincing.

## **2.6 Conclusion**

Rural theft in Paraguay is not carried out by anonymous agents. Farmers claim to know who is stealing from them and have designed a system of informal sanctions and rewards to limit the amount of theft they experience. I have laid out a dynamic limited-commitment model in which a potential thief cannot commit to refrain from stealing. A farmer will thus give him gifts, and promise him continued gifts in the future if he limits his level of theft to some acceptable level. This model yields new predictions above and

beyond those of a one-period Beckerian model with a rational anonymous thief. These results also contrast with many models of fairness and gift exchange in which increased trust is associated with more gift-giving rather than less.

Using an unusual new data set from rural Paraguay I test whether this model has predictive power over a one-period model with an anonymous thief. The data set includes extensive information on theft experienced, gifts given, and survey measures of trust, as well as panel data on past production decisions. In addition, it includes measures of trustworthiness, trust, and risk aversion from a set of economic experiments carried out with the survey respondents. This experimental data provides novel controls which allow me to partially overcome omitted variable bias.

In rural Paraguay the predictions of the limited-commitment model are supported. Households with more close relatives living in the same village give fewer gifts, contrary to what one might expect. These households give fewer gifts because they know that their family members are less likely to steal from them, and so they do not need to entice them away from theft by giving them gifts. Households from which it is more difficult to steal give fewer gifts, experience less theft, and trust more. I conclude that farmers in Paraguay do use giving and the promise of future giving as a means of limiting theft.

## Chapter 3

# Traditional Trust Measurement and the Risk Confound: An Experiment in Rural Paraguay

### 3.1 Introduction

The trust/investment game, originally described in Berg et al. (1995) (BDM), has become the trademark means of measuring trust in a burgeoning literature on trust. Some authors have noted that the trust game does not allow one to distinguish between a highly trusting person and a person with low levels of risk aversion (Karlan 2005, Eckel and Wilson 2004); i.e. a person may take more trusting actions because he actually trusts more or because he is more willing to take a gamble.<sup>1</sup> Consistent with Gambetta (1988) we define trust to be an agent's subjective probability that another agent will perform an action beneficial to him. In the trust game it is represented by the player's assessment of the probability distribution over the actions of his anonymous partner, where a higher level of trust means a subjective distribution with higher mean and lower variance.

In this paper, we run both the traditional trust game, and a very similar gambling game with 188 players in fifteen villages of rural Paraguay, and compare agents' actions in the two games. We find that play in the risk game is significantly predictive of play by the trustor (player 1) in the trust game.<sup>2</sup> This effect is not dissipated when we control for altruism. In addition, controlling for risk aversion in trust regressions significantly

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<sup>1</sup> In fact, Andreoni, Castillo and Petrie (2003) found "unexpectedly" that risk aversion importantly affects play in ultimatum games as well.

<sup>2</sup> Henceforth when we write "play in the trust game" we are referring to the trustor's move, not the trustee's move (player 2). The trustee's move will be briefly analyzed in Section 3.4.3, but we do not focus on it as it involves no risk.

changes the coefficients of some of the correlates of play in the trust game. Males have often been found to be more trusting than woman in the trust game (Chaudhuri and Gangadharan 2002, Burks et al. 2003, Eckel and Wilson 2000, Buchan, Croson and Solnick 2003). In this paper we find that this effect is due to females' higher levels of risk aversion, and not to lower levels of trust *per se*.

The benefit of running both the trust game and a gambling game with similar payoff structure is that, in theory, the only difference between the players' moves in the two games should be due to differences in their assessments of payoffs from the random gamble and from trusting their fellow villagers. On the other hand, as the games are similar and the players played the risk game first, they may then frame the trust game as a gamble as well. We do run a robustness check and find that while a player's behavior as trustor has strong predictive power for his behavior as trustee, his bet in the risk game does not have any. This suggests that the player considers the trust decision a different decision than the risk decision. Still, the issue of framing is inherent in the design of the games, and leaves an area open for future investigation.

If play in the trust game is correlated with trusting behavior in the real world, and if trusting behavior is correlated with economic growth (Knack and Keefer 1997), better functioning organizations (Fukuyama 1995, La Porta, Lopez-de-Silanes, Shleifer and Vishny 1997) and increasing village incomes (Narayan and Pritchett 1999), then it is interesting to look at how much of trusting behavior in the trust game is due to trust and how much to low risk aversion. The rest of this paper is organized as follows: Section 3.2 discusses the game design and previous applications of trust and risk games, Section 3.3 discusses the data and the experimental procedures, Section 3.4 disentangles the contribution of risk aversion to play in the trust game, and section 3.5 concludes and discusses directions for future research.

## 3.2 Game Design and Previous Applications of Trust and Risk Games

In the original trust game (sometimes called the investment game) designed by Berg et al. (1995), the trustor is given a sum of money. In the first move, the trustor must decide how much, if any, to send to an anonymous trustee. Any money sent to the trustee is tripled. The trustee makes the second move, deciding how much money to return to the trustor. Under the assumption of selfish preferences, the only sub-game perfect Nash equilibrium is for the trustor to send no money to the trustee, using backward induction to infer that the trustee will never return any money. Money sent by the trustor is commonly used to measure his trust that the anonymous trustee will return his money. Money returned by the trustee is used to measure his trustworthiness. In fact, participants do not tend to play the sub-game perfect equilibrium. In the U.S., Berg et al. (1995) find that only two out of 32 trustors sent nothing, and of the 30 trustees who were sent money, only six returned nothing.<sup>3</sup>

Results from the investment game confound differing levels of risk aversion with differing levels of trust. Two people with the same (non-zero) level of trust, but different levels of risk aversion will play the role of trustor differently (Karlan 2005, Eckel and Wilson 2004). Assume two players believe that half of the trustees will return double and half will return half of their original investment. Although both players are equally trusting, the more risk averse trustor will send less money, and appear less trusting. Thus, play by the trustor in the trust game depends both on trust beliefs and on risk aversion.

Many researchers have already noted this confound. Barr (2004) found that vil-

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<sup>3</sup> A trustee who returns money may do so out of concerns for fairness or reciprocity, but we do not focus on why he would return money rather than keeping it.

lagers in resettled villages of Zimbabwe sent less in the trust game than those in older villages. She hypothesizes that this is because resettled villagers are more uncertain about each other's behavior, but cannot reject the possibility that this is due to self-selection of more uncertainty averse individuals into resettled areas (although she claims this is unlikely). Karlan (2005) finds that, in Peru, individuals who sent more in the trust game were more likely to default on their microfinance loans and saved less. He concludes that apparently highly trusting people may actually just be "more willing to take on risks".

Other papers have compared trust and risk aversion in a controlled setting (Ashraf, Bohnet and Piankov 2003, Eckel and Wilson 2000, Eckel and Wilson 2004) using university students as their subjects. Ashraf et al. (2003) ran both trust and risk experiments. Their risk experiment was a choice between cash and a 50/50 lottery to win \$300 or nothing. They find that risk aversion has no significant effect on trust decisions, though the effects do go in the correct direction. The game they used to measure risk aversion is quite different from the trust game, and so may not lead as easily to direct comparison. In addition, though the stakes were relatively high, only one player in a group of approximately thirty was randomly chosen to be paid according to his or her choices. If players make their decisions based on the expected payoff, or if they take into account that their decision only has a three percent chance of mattering, the subjects may not have the right incentives to make a careful decision.

Eckel and Wilson (2000) find that more risk averse trustors choose less risky trust games, but don't look at how risk aversion affects trustors' behavior within the trust game. Eckel and Wilson (2004) play a binary choice trust game and a binary choice risk game with similar payoffs. They find that risk and trust are not correlated. Because their bet size is only \$5 it is improbable that this measures the risk aversion of American

college students.<sup>4</sup>

Our game design allows us to begin to disentangle actual trust (belief that the trustee will reciprocate) from risk aversion. We ran two experiments, one measuring players' risk aversion, as well as the more traditional BDM investment game. The risk experiment was designed to resemble the first move in the investment game but involved only risk and no trust, as the payoffs were decided by the roll of a die. A major contribution of this paper is that a) the players are not students, they are rural villagers with diverse wealth levels and ages, b) the payoffs were quite large, as players won in total an average of two days' wages, c) the trust game was not played as a binary decision, but, as in the version played by Berg et al. (1995), with a range of discrete choices, and d) the risk game was designed to be quite similar in format and have quite similar payoffs to the trust game (though this could be a disadvantage as well in terms of priming the subjects to think of the trust game as a gamble).

The rules of the risk game were as follows: the investor was given a sum of money (the same amount he was given in the trust game) and was given the same five choices of how much (if any) to invest. The experimenter then rolled a die to determine the investor's payoffs. A roll of one meant the investor lost his investment, two meant he recovered only half his investment, three meant he recovered his investment, four meant he earned 1.5 times his investment, five meant he doubled his investment, and six meant he earned 2.5 times his investment. We designed the risk game to yield similar returns to those from trust games played in rural Zimbabwe (Barr 2003).

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<sup>4</sup> In fact, 75% of the subjects chose the risky gamble over the certain amount with the *same* expected value, indicating apparently risk-seeking behavior.

### 3.3 Data Source and Experimental Procedures

The data used in this paper was collected in 2002 as the fourth round of a panel data set.<sup>5</sup> More detailed experimental procedures are given in Appendix E, but we will give a brief summary here. After three or four days of surveying in each village we invited a player from each household which had participated in the survey to play the games. They were told they would win, on average, one and a half days' wages, or 18,000 Guaranies.<sup>6</sup> In the two largest villages, we held the game in two sessions, one in the morning and one in the afternoon. The groups for the two sessions were chosen based on location of the households, and there seemed to be no communication between the two groups, as the houses of the two groups were quite far apart. 188 of the 223 families surveyed sent a family member to play the game.<sup>7</sup>

The risk game was played first. The game's instructions were given in a group setting with no questions allowed. Then the players were called into the room one at a time, given a second explanation, and allowed to ask questions in private. They then made their bet, saw the roll of the die, and were given an IOU. The players were then all called back into the room to hear the explanation of the trust game. Every player played both the role of trustor and trustee. They came into the room one at a time to put the money they were sending to the trustee in an envelope, and watched me triple it. The envelopes were then shuffled and the players came back into the room one at a time. We used the strategy method, asking the trustees how much they would send back

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<sup>5</sup> In 1991 the Land Tenure Center at the University of Wisconsin and the Centro Paraguayo de Estudios Sociológicos implemented a survey of 300 rural Paraguayan households in three departments and sixteen villages across the country. The sample was random, and stratified by land-holdings. The original survey was followed up by subsequent rounds in 1994, 1999, and, most recently, 2002.

<sup>6</sup> I predicted average winnings based on results of experiments run by other researchers in developing countries, but preferred to exceed expectations rather than disappoint. In actuality the players won, on average, 24,000 Guaranies each.

<sup>7</sup> None of the nine households in the Japanese immigrant village were interested in playing. Excluding the Japanese, who are very much wealthier than the rest of the population, those households which did not send a player were significantly more wealthy and had significantly younger household heads.

given each of the four possible amounts they might receive and told them that they were then committed to sending back that amount. Then they opened the envelope that was assigned to them, took out the amount that they had precommitted to taking out, and left the rest in the envelope. The players then came into the room one at a time to open their original envelope and see how much was left. At this point we paid them their total winnings.

As in many experiments in rural villages (Barr 2003, Karlan 2005), due to the importance of ensuring players with varying levels of education all understood the game, and difficulties in running experiments in a village setting, the game was not double blind. In addition, Burks et al. (2003) find that playing both roles in the trust game decreases both trust (the amount sent) and trustworthiness (the share returned). They hypothesize that playing both roles reduces the player's sense of responsibility for the well being of his partner and reduces his sense of guilt for behaving selfishly. If this is the case, playing both roles will decrease the correlation of play in the trust game with altruism and cause trust beliefs and risk aversion to be the two main determinants of play.<sup>8</sup>

In Table 3.1 we find summary statistics for the players. The players are of extremely diverse ages, education levels, and wealth levels. In Table 3.2 we find the summary statistics for the villages surveyed. They are also of diverse levels of wealth, inequality, and size. A description of the variables is found in Appendix F. In the risk game nine percent of the players bet nothing and seven percent of the players bet all 8000 Guaranies, while the mean bet was 3,436 Guaranies. The average amount sent in the trust game was slightly higher, with seven percent of the players sending nothing, nine percent sending everything, and a mean amount sent of 3,745 Guaranies. Trust did pay

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<sup>8</sup> In addition, if each player only plays one role, then giving endowments only to the first mover creates a confound between trust and fairness. As players knew that everyone would play both roles this concern was somewhat alleviated.

Table 3.1: Individual summary statistics

Variable <sup>a</sup>	Mean	Min	Max
Male	69.7%		
Catholic	95.7%		
Guarani Language	81.4%		
Brazilian	9.0%		
Age	48.67	18	84
Educ (years)	4.80	0	12
Family Size	5.59	1	12
Land Owned (hectares)	22.37	0	580
Per-Capita Wealth <sup>b</sup>	23,700,000	40,000	763,000,000
Gifts given	309,060	0	3,290,000
Donations Given	211,684	0	2,140,000
P.I. at Survey	31.9%		
Bet in Risk Game <sup>c</sup>	3,436	0	8,000
Sent in Trust Game	3,745	0	8,000
Share Returned by Trustee <sup>d</sup>	.434	0	1
No. of Obs.	188		

<sup>a</sup> The variables are described in more detail in Appendix F.

<sup>b</sup> The relevant exchange rate is approximately 4,800 Guaranies to the dollar.

<sup>c</sup> For both the risk and trust game the choice set was 0, 2,000, 4,000, 6,000, or 8,000.

<sup>d</sup> Note, any share greater than .33 means that trust has positive payoffs, as the amount the trustor sent had been tripled originally.

Table 3.2: Village summary statistics

Variable	Mean	Min	Max
Households	175.7	30	720
Households Migrated In	12.2	0	55
Km to Bus	.67	0	7
Mean Wealth	25,500,000	2,272,317	140,000,000
Gini of Wealth among Players	.577	0.273	.838
No. of Obs.	15		

on average, as trustees returned 43.4 percent of the amount they received.<sup>9</sup> Forty percent of players bet the same amount in both games, while 23 percent of the players bet more and 36 percent trusted more. A Wilcoxon signed-rank test for paired data rejects the hypothesis that the median difference between the bet in the risk game and the amount sent in the trust game is zero with a  $p$ -value of .039.

We compare our results with those of other trust games (Barr 2003, Berg et al. 1995) to test for understanding by the players and comparability of results. The trust game played by Barr in rural Zimbabwe was also designed to give payoffs to the trustor of approximately one half day's wages. The principal difference between her experiments and ours is that in Paraguay players played both the role of trustor and trustee. In addition, the Paraguayan players played the risk game first, which they did not in Zimbabwe. A Mann-Whitney rank sum test of equality in the distributions of the amount sent in the Paraguayan and Zimbabwean populations cannot reject the null that the two distributions are the same with a  $p$ -value of .1374, and a two-sample Kolmogorov-Smirnov test for equality of distributions cannot reject the null with a  $p$ -value of .580.

The average percent of a bet recouped from a fair die, given our rules, would be 125% with a standard deviation of 85.6. (The sample average from the actual rolling of the die was 118%.) The average percent of the amount sent by the trustor recouped from all of the different strategies elicited by the trustee was 131% (with a standard deviation of 64.2). If we ignore all strategies elicited which were not actually used we find that the average percent recouped was 130% (with a standard deviation of 61.0).<sup>10</sup>

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<sup>9</sup> While trustees did return more money to trustors who sent more, as a proportion of what they received they actually sent slightly less. Players who received 6,000 Guaranies returned 44.2 percent of the money while players who received 24,000 Guaranies returned 42.4 percent. (Women returned 41.5 percent of 6,000 Guaranies, but only 36.8 percent of 24,000 Guaranies.) It seemed much easier for the trustees to be 'fair' when the stakes were small, but when they were faced with splitting two days' wages (especially women who seldom have access to money of their own) they were tempted to keep a larger share.

<sup>10</sup> The trustee chose a strategy for each amount he might receive. This acts as a check that the game was truly anonymous. If the players had somehow known how much their friends had sent or with whom they were playing, we might expect the actual returns to be higher than the average returns from all strategies elicited.

## 3.4 Disentangling Risk from Trust

We will disentangle risk aversion from trust in Section 3.4.1 by running three different types of regressions. We will look at correlates of (1) the amount bet in the risk game, (2) the amount sent in the trust game without controlling for the amount bet, and (3) the amount sent in the trust game controlling for the amount bet.<sup>11</sup> In Section 3.4.2 we see if our results still hold after controlling for altruism and reciprocity. In Section 3.4.3 we run some robustness checks to see what effects having players play both games may have on their actions.

### 3.4.1 Correlates of Risk Aversion and Trust

Variation in play in the trust game is largely explained by risk attitudes. As the amount the player bets in the risk game increases, so does the amount he sends in the trust game. In all regressions, no matter what other variables are included, play in the trust game depends importantly on risk attitudes.

Column (1) of Table 3.3 shows that males are less risk averse than females, betting more. In the trust regression which does not control for risk attitudes (column (2)), men also seem to trust significantly more than women, but this is due to risk attitudes. Once we control for risk aversion in column (3), men and women no longer have significantly different levels of trust. Other researchers have found that women trust significantly less than men in the trust game (Chaudhuri and Gangadharan 2002, Burks et al. 2003, Buchan et al. 2003, Eckel and Wilson 2000) but in Paraguay we find that this is solely due to their higher level of risk aversion.

We also see that wealthier households are less risk averse, implying decreasing

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<sup>11</sup> Although results presented here are OLS, the ordered probit model gives quite similar results. The OLS results are presented for ease in interpretation of the coefficients. In all regressions we divide the amounts sent and bet by 1,000.

Table 3.3: Risk game and trust game regressions

	Bet in Risk Game		Amount Sent in Trust Game
	(1)	(2)	(3)
Male	.778** (.328)	.578* (.335)	.362 (.324)
Age	.069 (.044)	.004 (.042)	-.014 (.040)
Age-Squared	-.0007* (.0004)	-.00009 (.0004)	.00004 (.0004)
Education	.077 (.067)	-.157** (.076)	-.178** (.077)
Catholic	.583 (.702)	-1.584*** (.592)	-1.746*** (.565)
Family Size	.057 (.075)	-.087 (.067)	-.103 (.068)
Log(Per-Capita Wealth)	.221** (.096)	.132 (.108)	.071 (.102)
Brazilian	-2.121 (1.729)	-.164 (1.236)	.424 (1.213)
Guarani	-1.565** (.646)	-.332 (.582)	.102 (.552)
P.I. at Survey	.532* (.314)	.222 (.318)	.074 (.301)
Roll of Die	.093 (.089)	.108 (.089)	.082 (.084)
Bet			.277*** (.079)
Obs.	188	188	188
$R^2$	.271	.219	.278

OLS with heteroskedasticity-consistent standard errors in parenthesis.

\*-90%, \*\*-95%, and \*\*\*-99% significant.

Game session fixed effects were included in the regression.

absolute risk aversion. These wealthier households are also slightly more trusting before one controls for risk aversion, though after controlling for risk aversion they trust no differently than less wealthy households. More educated people send less in the trust game, suggesting that they are less trusting. Households which speak Guarani at home, instead of Spanish or Portuguese, are slightly more risk averse but trust no more or less than others. Catholic households are much less trusting, and no more or less risk averse, though there are only eight non-Catholic (Protestant) households in the sample.

The dummy variable for whether or not I sat in on that household's survey (meaning that the household met me a few days prior to playing the game) is slightly significant in explaining the amount bet on the roll of the die. Perhaps those households felt more comfortable with me, and thus bet more, or perhaps the presence of a 'gringo' convinced them that this strange situation was real and that there would be monetary payoffs. This did not effect play in the trust game, possibly because by the time we played the second game all players believed the stakes were real.

Because the risk game was played first, we might worry that players who were lucky in the risk game (had high die rolls) might send more in the trust game feeling they were on a lucky streak or send less feeling their luck was bound to change. This is not borne out by the evidence, as the roll of the die<sup>12</sup> is statistically insignificant in explaining the amount sent in the trust game.

In Table 3.4, we include five village characteristics instead of dummies for the 17 game sessions held. The individual-level results are not greatly affected by the change. Players in smaller villages with more immigration bet less, perhaps because these players live in a more rapidly changing environment which makes them more risk averse. Villages further away from a road on which a bus passes are more trusting. Mean wealth

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<sup>12</sup> We allocated the nine percent of players who bet nothing and thus did not roll the die a roll of 3.5, the mean of all possible rolls of the die.

Table 3.4: Risk game and trust game regressions including village characteristics

	Bet in Risk Game		Amount Sent in Trust Game	
	(1)	(2)	(2)	(3)
Male	.749** (.319)	.668** (.303)		.479 (.296)
Age	.084** (.042)	-.004 (.038)		-.025 (.036)
Age-Squared	-.0009** (.0004)	-1.00e-05 (.0004)		.0002 (.0004)
Education	.069 (.066)	-.137* (.075)		-.154** (.078)
Log(Per-Capita Wealth)	.189* (.106)	.119 (.105)		.072 (.103)
Guarani	-.702 (.526)	-.567 (.437)		-.391 (.433)
P.I. at Survey	.523 (.319)	.340 (.308)		.208 (.293)
Bet				.252*** (.084)
Size of Village	.004** (.002)	.002 (.002)		.001 (.002)
# of Incoming Households	-.050** (.022)	-.012 (.023)		-.0003 (.022)
Km. to Bus Route	.002 (.066)	.344*** (.107)		.344*** (.105)
Mean(Log-Wealth)	-.031 (.247)	.204 (.226)		.212 (.225)
Gini of Wealth	.967 (1.236)	.434 (.942)		.191 (.943)
Obs.	188	188		188
$R^2$	.165	.123		.179

OLS with heteroskedasticity-consistent standard errors in parenthesis.

\*-90%, \*\*-95%, and \*\*\*-99% significant.

Table 3.5: Including interactions with bet size in trust game regression.

Bet	0.288*** (0.096)	Bet	0.290** (0.116)	Bet	0.312*** (0.097)
Bet · Female	-0.158 (0.208)	Bet · No Prim Ed	-0.065 (0.161)	Bet · Non-Guar	-0.231 (0.185)
Sum	0.130 (0.180)	Sum	0.225* (0.115)	Sum	0.081 (0.160)
Male	<i>N</i> = 131	Primary Ed.	<i>N</i> = 76	Guarani	<i>N</i> = 153
Female	<i>N</i> = 57	No Primary Ed.	<i>N</i> = 112	Non-Guarani	<i>N</i> = 35

Each column is a separate regression. Controls included as in Table 3.4.

OLS with heteroskedasticity-consistent standard errors in parenthesis.

\*-90%, \*\*-95%, and \*\*\*-99% significant.

of the players and wealth inequality among the players are insignificant in all regressions. In results not shown here, we included the number of players in each game session and the share of male players in each game session, but their effects were insignificant. Risk attitudes remain strongly predictive of trust play.

We might wonder if the relationship between risk and trust is the same for all players. In other words, do some groups view the trust game as a pure game of risk while others view it purely as a game of trust? In Table 3.5 we rerun the trust regressions from Table 3.4 three times, the first time including the bet size and its interaction with gender, the second time with the bet size interacted with an education dummy,<sup>13</sup> and lastly with the bet size interacted with a primary language dummy. In Tables 3.3 and 3.4 we saw that men are less risk-averse than women. Nevertheless, in Table 3.5 we see that the correlations between risk attitudes and play in the trust game for men and women are not significantly different (though men's risk attitudes affect their play in the trust game more so than do women's).

Men and women, educated and non-educated people, and speakers of Spanish and

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<sup>13</sup> This is whether or not the player completed elementary school.

Guarani all seem to view the trust game as a similar combination of risk and trust, though this test has extremely low power. We calculate the power (the probability of rejecting the null when it is false) of a test of the null that the true coefficient on the interaction term is zero, against the alternative that the coefficient is equal to the one found given a significance level of .90. The power of that test in the gender regression is .187, in the education regression is .107, and in the language regression is .344, all quite low. In order to approach a power level of .70 we would have needed 1535 observations in the gender regression, 5430 in the education regression, and 570 in the language regression. While the sample size here does not permit such subsample analysis, it leaves an interesting area for further examination.

One goal of this paper is to uncover the consequences of using trusting behavior in the trust experiment as a measure of actual trust without controlling for risk aversion. Are the coefficients in the trust regression significantly different when one does and does not control for risk aversion? Due to budget and time constraints, it may not be possible to play multiple games so it is desirable to know the implications of results from the most commonly played economic games. Throughout this paper I equate controlling for the bet in the risk game with controlling for risk aversion in general. It is important to keep in mind that this measure of risk aversion is crude, as it measures how the person played in just one game on one day of his or her life.

We look at whether or not the coefficients in the trust regressions, including and excluding the bet in the risk game, are significantly different from each other, allowing for a correlation in the errors between the two regressions. A summary of these results is presented in Table 3.6. Five of the explanatory variables from Table 3.3 do not have significantly different coefficients at the 10% level when one does and does not control for the bet in the risk game. The coefficient on Guarani is significantly different at the 1% level, gender and wealth at the 5% level, and age-squared, Brazilian, and P.I.

Table 3.6: Difference in coefficients before and after controlling for risk aversion.

Table	Insig.	10%	5%	1%	Total w/o fixed effects	Total
Table 3.3	5	3	2	1	.0041	.0008
Table 3.4	4	4	4	0	.0005	.0005

First set of columns is the number of variables whose coefficients differ significantly in the trust regressions before and after controlling for risk aversion.

Second set of columns is the  $p$ -value with which we can reject equality of all coefficients before and after controlling for risk aversion.

Results use covariance matrix from SUR for trust regressions, including risk aversion (restricting its coefficient to be as in OLS regression) and excluding risk aversion.

at survey at the 10% level. We can reject at the .0041 level that all the explanatory variables have the same coefficient excluding the village dummies, and at the .0008 level when including the village dummies. Looking at the results in Table 3.4, four of the coefficients are not significantly different between the two regressions. The remaining eight include gender, age and age squared, and wealth at the 5% level and Guarani, P.I. at survey, size of village, and number of new households entering the village in the last three years at the 10% level. We can reject the hypothesis that all the coefficients are equivalent with a  $p$ -value of .0005. Variables such as gender, age, wealth, and indigenous heritage are often included in trust regressions, but their effects on trusting behavior are not stable when one does and does not control for risk attitudes.

### 3.4.2 Trust and Altruism or Fairness

Many researchers have argued that the measure of trust in the trust game confounds trust with altruism or fairness (Andreoni and Miller 2002, Carter and Castillo 2003, Cox 2004). There are many reasons a player may send money to his anonymous partner including the possibilities that a) he trusts his village-mates (believing they will return a high share of the amount they receive), b) he is not very risk averse, c) he cares about increasing the total sum of money won by the village as a whole, d) he is altruistic, or e)

he has a preference for fairness. We now control for altruism or fairness and see if this affects our results on the relationship between trust and risk aversion.

In columns (1) and (2) we control for the share of money the player returned when he played the role of trustee, as well as the average share returned by all trustees in the same game session. One might hypothesize that an altruistic player will send more as trustor and return more as trustee, thus appearing more trusting and trustworthy. Looking at Table 3.7 we find that the share the player returns to the trustor when playing the role of trustee is highly correlated with the amount he sends to the trustee when playing the role of trustor. Village level trustworthiness is, surprisingly, insignificant in determining trust. Trust and trustworthiness may also be correlated because a player plays as trustee in the same way he expects others to play (his trust beliefs). Another possibility is that the player remembers his own first move as trustor when he chooses his second move as trustee. A player who sends a large amount as trustor may return a large amount as trustee, hoping the person who receives his money will do the same.

In columns (3) through (6) we use two other proxies for altruism: the log of gifts (of farm production) given to friends and family and the log of donations (in time or money) made to the church, road repairs, and other communal projects. Neither is a significant predictor of trust. The other coefficients in the table change very little, both across the columns of Table 3.7, and in comparison with the results in Tables 3.3 and 3.4. While avoiding the debate on the relation between trusting behavior and altruism, we find that controlling for altruism has little effect on the relationship between trust play and risk aversion.

### **3.4.3 Issues of Framing**

Throughout this analysis we have been assuming that although risk aversion may affect play in the trust game, trust does not affect play in the risk game. As play in the risk

Table 3.7: Trust game regressions including village characteristics and proxies for generosity

	Amount Sent in Trust Game					
	(1)	(2)	(3)	(4)	(5)	(6)
Male	.500* (.298)	.333 (.297)	.603** (.304)	.435 (.301)	.617** (.306)	.448 (.302)
Age	-.006 (.037)	-.030 (.035)	-.0004 (.037)	-.023 (.035)	.009 (.038)	-.015 (.035)
Age-Squared	-2.58e-06 (.0004)	.0003 (.0004)	-.00006 (.0004)	.0002 (.0004)	-.00009 (.0004)	.0001 (.0004)
Education	-.119 (.075)	-.140* (.078)	-.129* (.075)	-.150* (.078)	-.125* (.074)	-.146* (.077)
Log(PC Wealth)	.125 (.104)	.075 (.103)	.095 (.111)	.048 (.107)	.118 (.106)	.069 (.104)
Guarani	-.442 (.423)	-.275 (.419)	-.588 (.440)	-.416 (.439)	-.557 (.432)	-.387 (.428)
Bet		.256*** (.082)		.256*** (.084)		.256*** (.084)
Own Trustworthiness	1.891** (.895)	1.864** (.850)				
Village Trustworthiness	-1.006 (2.244)	-.985 (2.093)				
Log(Gifts)			.065 (.068)	.059 (.066)		
Log(Donations)					-.090 (.088)	-.078 (.084)
Size of Village	.002 (.002)	.0006 (.002)	.002 (.002)	.001 (.002)	.002 (.002)	.001 (.002)
# of Incoming Hhs	-.009 (.023)	.003 (.022)	-.017 (.023)	-.003 (.022)	-.015 (.024)	-.001 (.022)
Km. to Bus Route	.330*** (.117)	.332*** (.114)	.345*** (.109)	.346*** (.106)	.356*** (.110)	.355*** (.107)
Mean(Log-Wealth)	.206 (.225)	.212 (.223)	.253 (.229)	.254 (.227)	.233 (.229)	.236 (.229)
Gini of Wealth	.458 (.979)	.191 (.986)	.439 (.945)	.177 (.937)	.548 (.962)	.273 (.960)
Obs.	188	188	188	188	188	188
R <sup>2</sup>	.147	.206	.122	.181	.121	.180

OLS with heteroskedasticity-consistent standard errors in parenthesis.

\*-90%, \*\*-95%, and \*\*\*-99% significant.

game depends only on the roll of a die, and not on expectations over the actions of other players, this seems to be a valid assumption. Still, one might think that because we played the risk game before the trust game we encouraged the players to think of the trust game as a gamble as well.<sup>14</sup> This is an especially serious issue given the recent literature on framing. Liberman, Samuels and Ross (2004) find that something as seemingly innocuous as calling the prisoner’s dilemma the “Wall Street Game” instead of the “Community Game” makes players much more likely to defect. Harrison, Johnson, McInnes and Rutström (forthcoming) find that “prior experience with one task affects behavior in a subsequent task” when making players decide between a series of risky decisions.

We have shown in Section 3.3 that the distribution of our results for play in the trust game is similar to that in Zimbabwe where the risk game was not played first. In addition, in Table 3.8 we run two regressions, one on trustor behavior and one on trustee behavior. In both regressions we include as regressors the bet made by the player and his play in the other role in the trust game. We find that both risk-aversion and trustworthiness are significant predictors of trust. On the other hand, a player’s play as trustor is a significant predictor of his play as trustee, while his risk aversion is not. This robustness check shows that play in the trust game and in the risk game are measuring two very different quantities. The player sees his play as trustor as being partly related to his trust and trustworthiness and partly related to his risk aversion. On the other hand, his trustworthiness is only related to his trust. Trustworthiness is not correlated with risk aversion, as it shouldn’t be since the trustworthiness decision is not made under any uncertainty.<sup>15</sup> This is not conclusive evidence players aren’t primed to view the trust

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<sup>14</sup> This problem arises in any study playing multiple games with the same subjects. Eckel and Wilson (2004) play the trust game followed by 11 risky decisions, Ashraf et al. (2003) play two dictator games and a trust game (in different orders) and then six risky decisions, Karlan (2005) plays a trust game and then a public goods game, while Carter and Castillo (2003) play a dictator game and then a trust game.

<sup>15</sup> Households which give more gifts are significantly more trustworthy. Also, females are slightly less trustworthy, as found by

Table 3.8: Trust game regressions for play as trustor and trustee

	Amt Sent in Trust Game	Share Returned in Trust Game
	(1)	(2)
Male	.339 (.298)	.049 (.032)
Age	-.030 (.035)	.005 (.004)
Age-Squared	.0003 (.0004)	-.00004 (.00004)
Education	-.136* (.079)	-.005 (.008)
Log(Per-Capita Wealth)	.059 (.106)	-.006 (.012)
Guarani	-.274 (.424)	-.076 (.049)
Log(Gifts)	.037 (.065)	.012** (.006)
Bet	.255*** (.082)	-.003 (.007)
Amt. Sent as Trustor		.018** (.009)
% Returned as Trustee	1.680** (.831)	
Size of Village	.0006 (.002)	.0004** (.0002)
# of Incoming Households	.003 (.021)	-.003* (.002)
Km. to Bus Route	.334*** (.113)	.001 (.010)
Mean(Log-Wealth)	.230 (.223)	.010 (.022)
Gini of Wealth	.054 (.950)	.070 (.114)
Obs.	188	188
$R^2$	.206	.132

OLS with heteroskedasticity-consistent standard errors in parenthesis.

\*-90%, \*\*-95%, and \*\*\*-99% significant.

game as a gamble, and further investigation in this area is warranted.

### 3.5 Conclusion

The traditional trust game first studied by Berg et al. (1995) measures a combination of trust beliefs and levels of risk aversion. Risk aversion plays an important role in determining play in the trust game and this result is robust to including variables representing altruism. In addition, including the bet in the risk game as an explanatory variable in trust play regressions significantly changes the coefficients of other explanatory variables. Though men are often found to be more trusting than women, this seems to be due to risk aversion, and not due to differing levels of trust. The finding that wealthier people trust more than poorer people is also muted when one controls for risk aversion. In general, the finding of a correlation between trusting behavior and wealth must be interpreted with caution as wealthier people are also often less risk averse.

Given the experimental design here it is difficult to know if players treated the trust game as a gamble because they were primed to think that way by playing the risk game first. It would be interesting to rerun the same two games in the future but alternate their order in different villages. One could also design a risky decision with tradeoffs similar to those in the trust game but not so obviously similar to the trust game to the players. Another interesting possibility would be to run both games in addition to asking survey questions on recent natural shocks experienced by the player (such as whether his cow died, pests ate his crops, or a family member got sick) which should affect his level of risk aversion but not his level of trust. These variables could be used as instruments for the risky decision made in the game.

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Barr (2003). From discussions with the players, this seemed to be because women were not accustomed to having access to money of their own and so were much less willing to give it up.

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## Appendix A

### Using Experimental Trust Rather than Survey Trust

In the main text I used the measure of self-reported trust from the survey as a dependent variable. In this appendix I use the experimental measure of trust instead. This restricts the number of observations to the 188 respondents who participated in the experiments. This also allows us to remove the indicator variable for didn't play in games. As seen in Table A.1, although all of the previously significant variables in the trust regression lose significance, most of the results found in the main text continue to hold for the gifts and theft part of the system. The only significant predictor of trust in the trust experiment is the size of the bet in the risk experiment. This corresponds with results found in Chapter 3 showing that play in the trust game actually measures a combination of trust and risk aversion.

Both the fact that significant predictors of self-reported trust are not significant in predicting trust in the experiment, and the fact that the  $J$ -statistic when using experimental trust is much higher and the hypothesis that all the moment conditions hold can be rejected, are not unexpected given the new measure of trust being used. The experiment measures generalized trust in an anonymous setting with no recourse to future punishments. The survey question asks whether or not a farmer trusts his fellow villagers. The farmer knows his village-mates and in which situations he can and can not trust each of them and the punishments he would be able to impose on each of them. Whereas the number of years a household has lived in the village, and whether or not they have a field which no one passes predict relational trust between village-mates, they do not effect generalized anonymous trust. On the other hand, there are surely omitted variables

Table A.1: Gift giving, theft experienced, and experimental trust regressions

	Theft	Giving	Trust	Theft	Giving	Trust
Bet	0.113 (0.115)	-0.024 (0.078)	0.206** (0.087)			
Don't Pass Field	-0.741* (0.443)	-0.657* (0.343)	0.008 (0.340)	-0.742* (0.397)	-0.724** (0.321)	0.050 (0.310)
HHs in 250 m	0.041 (0.051)	-0.016 (0.028)	0.051 (0.039)			
Adult Males	-0.205 (0.178)	0.236* (0.143)	-0.111 (0.128)	-0.327** (0.154)	0.147 (0.124)	-0.156 (0.130)
Family Size	-0.015 (0.183)	-0.043 (0.115)	-0.074 (0.112)			
Log(Wealth)	0.116 (0.133)	0.350*** (0.097)	0.115 (0.098)	0.094 (0.118)	0.301*** (0.086)	0.132 (0.088)
Close Relatives	-0.047 (0.076)	-0.101* (0.056)	-0.004 (0.064)	-0.019 (0.073)	-0.051 (0.051)	-0.008 (0.065)
Years in Village	0.006 (0.013)	0.021** (0.010)	-0.007 (0.010)			
Median Land	-0.225 (0.425)	-0.287 (0.359)	0.228 (0.309)			
Trustworthiness	-0.946 (1.619)	0.176 (1.261)	-0.896 (1.302)	-0.448 (1.500)	0.655 (1.225)	-0.144 (1.307)
% Help Church	-0.024* (0.013)	-0.014 (0.009)	-0.011 (0.011)			
Km to Police	-0.102 (0.088)	0.011 (0.065)	-0.028 (0.063)			
Crop Choice	0.483 (0.973)	1.498*** (0.569)	0.442 (0.681)	0.363 (0.773)	0.961* (0.506)	0.442 (0.613)
Overid. ( <i>J</i> ) Test	17.802 ( $p = 0.96$ )			16.977 ( $p = 0.95$ )		
Obs.	188	188	188	188	188	188

GMM with bootstrapped clustered standard errors in parenthesis.

\*-90%, \*\*-95%, and \*\*\*-99% significant.

such as social norms and upbringing which determine generalized trust but have less of an effect, if any, on specific relational trust.

## **Appendix B**

### **Using Village Fixed Effects**

In the analysis in the main text village fixed effects were excluded. As there are 16 villages (and three equations), including village fixed effects uses up valuable degrees of freedom in a small data set. On the other hand, it is of interest to see how the results change when including village fixed effects. If I include village fixed effects, I can no longer use past village level prices as instruments. As the planting of green manure alone is not a strong instrument, I use both the planting of a green manure and past crop choice as instruments here. I include the same explanatory variables as in the right hand side columns of Table 2.6. The results in Table B.1 are weaker than before, but the main trends still hold. Households with fields off of main footpaths still experience less theft, give fewer gifts, and trust more; households with more close relatives living in their village give fewer gifts, experience less theft, and trust more; and households planting more easily stealable crops give more gifts. This is reassuring evidence that the findings in previous sections of this paper are not due to unobserved village effects.

Table B.1: Gift giving, theft experienced, and trust regressions with village fixed effects

	Log(Theft)	Log(Giving)	Trust
No One Passes Field	-0.421 (0.464)	-1.159*** (0.385)	0.330 (0.213)
# Adult Males	-0.415** (0.171)	0.213 (0.160)	-0.044 (0.088)
Log(Wealth)	-0.100 (0.156)	0.193 (0.127)	-0.083 (0.085)
# Close Relatives in Village	-0.057 (0.076)	-0.054 (0.078)	0.089** (0.040)
Neighbor Trustworthiness	0.577 (2.381)	0.096 (1.972)	0.696 (1.013)
# of Stealable Crops	1.438 (1.076)	1.904** (0.831)	0.421 (0.466)
Overidentification ( $J$ ) Test		1.389 ( $p = 0.29$ )	
Obs.	177	177	177

GMM with bootstrapped clustered standard errors in parenthesis.

\*-90%, \*\*-95%, and \*\*\*-99% significant.

## **Appendix C**

### **Excluding the Japanese Households**

One of the sixteen villages in the survey, from which nine households responded, consists of households of Japanese heritage. These households are much wealthier than the households of Paraguayan or Brazilian heritage, and they plant mostly soy and wheat for the export market. To be sure that the inclusion of these nine households is not biasing the results I reestimate the system of equations excluding these households. The results in Table C.1 which do not include the Japanese are quite similar to the earlier results.

Table C.1: Gift giving, theft experienced, and trust regressions excluding the Japanese

	Theft	Giving	Trust	Theft	Giving	Trust
Bet	0.081 (0.119)	-0.044 (0.081)	-0.007 (0.041)			
Didn't Play Games	0.940 (0.749)	-0.215 (0.612)	-0.339 (0.372)			
Don't Pass Field	-0.810* (0.415)	-0.584* (0.327)	0.284 (0.183)	-0.887** (0.379)	-0.789** (0.309)	0.121 (0.176)
HHs in 250 m	0.044 (0.045)	-0.019 (0.031)	-0.017 (0.019)			
Adult Males	-0.220 (0.183)	0.289** (0.144)	-0.011 (0.082)	-0.224 (0.175)	0.170 (0.123)	-0.024 (0.073)
Family Size	0.039 (0.178)	-0.063 (0.118)	0.023 (0.059)			
Log(Wealth)	0.104 (0.128)	0.297*** (0.097)	-0.070 (0.056)	0.112 (0.115)	0.247*** (0.084)	-0.046 (0.050)
Close Relatives	-0.073 (0.068)	-0.101* (0.053)	0.033 (0.033)	-0.048 (0.064)	-0.088* (0.049)	0.024 (0.030)
Years in Village	0.007 (0.011)	0.018* (0.010)	0.015*** (0.005)			
Median Land	-0.296 (0.407)	-0.354 (0.346)	0.182 (0.154)			
Trustworthiness	0.254 (1.477)	0.900 (1.198)	1.096* (0.603)	1.241 (1.471)	1.015 (1.182)	0.540 (0.621)
% Help Church	-0.031*** (0.012)	-0.003 (0.009)	0.017*** (0.006)			
Km to Police	-0.160** (0.080)	0.024 (0.062)	0.031 (0.033)			
Crop Choice	0.121 (1.089)	1.408* (0.738)	-0.176 (0.354)	-0.600 (0.827)	0.880 (0.619)	-0.064 (0.335)
Overid. ( <i>J</i> ) Test	12.743 ( $p = 0.83$ )			11.101 ( $p = 0.73$ )		
Obs.	214	214	214	214	214	214

GMM with bootstrapped clustered standard errors in parenthesis.

\*-90%, \*\*-95%, and \*\*\*-99% significant.

## **Appendix D**

### **Including Past Crop Choice as an Instrument**

In the main text the instruments used for past crop choice were past village level prices and whether or not the household planted a green manure. In this appendix we also include crop choice in 1999 as an instrument for crop choice in 2002. Including past crop choice limits the sample size from 223 to the 177 households for whom data is available in both 1999 and 2002. Although the value of lagged variables as instruments has been questioned, past crop choice has strong predictive power for current crop choice (as shown in Table 2.5). The system results when including past crop choice as an additional instrument for current crop choice are shown in Table D.1. Even after including lagged crop choice as an instrument the hypothesis that the instruments are exogenous cannot be rejected. Again, the main trends do not change.

Table D.1: Gift giving, theft experienced, and trust regressions using past crop choice as an instrument

	Theft	Giving	Trust	Theft	Giving	Trust
Bet	0.050 (0.119)	-0.043 (0.085)	0.009 (0.045)			
Didn't Play	0.612 (0.775)	0.171 (0.688)	-0.194 (0.441)			
Don't Pass Field	-0.718* (0.409)	-0.956*** (0.359)	0.479** (0.204)	-0.665* (0.386)	-1.163*** (0.339)	0.335* (0.195)
HHs in 250 m	0.045 (0.031)	-0.008 (0.023)	-0.009 (0.016)			
Adult Males	-0.266 (0.171)	0.259* (0.151)	-0.002 (0.088)	-0.379*** (0.138)	0.146 (0.125)	-0.073 (0.076)
Family Size	0.023 (0.117)	-0.008 (0.084)	-0.025 (0.049)			
Log(Wealth)	-0.109 (0.119)	0.170 (0.107)	-0.057 (0.068)	-0.117 (0.094)	0.126 (0.087)	-0.014 (0.052)
Close Relatives	-0.089 (0.065)	-0.107* (0.062)	0.054 (0.036)	-0.078 (0.063)	-0.097* (0.059)	0.029 (0.034)
Years in Village	0.009 (0.012)	0.024** (0.010)	0.014** (0.006)			
Median Land	0.003 (0.038)	-0.023 (0.040)	0.023 (0.023)			
Trustworthiness	0.889 (1.355)	1.664 (1.169)	1.185* (0.618)	1.785 (1.298)	1.814* (1.088)	0.424 (0.572)
% Help Church	-0.030*** (0.011)	0.000 (0.009)	0.017*** (0.006)			
Km to Police	-0.168** (0.081)	0.014 (0.069)	0.055 (0.037)			
Crop Choice	0.088 (0.454)	1.301*** (0.364)	0.200 (0.203)	0.133 (0.412)	1.140*** (0.341)	0.138 (0.200)
Overid. ( <i>J</i> ) Test	8.776 ( $p = 0.28$ )			11.316 ( $p = 0.50$ )		
Obs.	177	177	177	177	177	177

GMM with bootstrapped clustered standard errors in parenthesis.

\*-90%, \*\*-95%, and \*\*\*-99% significant.

## Appendix E

### Detailed Description of Experimental Procedures and Protocol

The three enumerators and I spent three or four days in each of the sixteen villages. The first two or three days were spent surveying the households. Before we began the survey we mentioned to the households that we would be playing a game a few days later with all the survey respondents. We said that one person per household could go to play (and we preferred, if possible, that it be the same person who answered the survey questionnaire), and that he or she would win on average one and a half days' wages (18,000 Guaranies). When we settled on a time and place to hold the game we informed each of the households, told them they would receive 1,000 Guaranies if they showed up on time, and offered to drive them to the game in our vehicle. The location was either the village church or the village dance hall. Two of the villages were so large that people lived quite far apart, so we split the households into two groups and played the game with half in the morning and half in the afternoon.<sup>1</sup> Participants were assigned to one of the two sessions based on their proximity to each other, and there didn't seem to be any communication between players of the morning group and the afternoon group, as the households were quite far apart.

Of the 223 households surveyed, 188 showed up for the game session. None of the nine households surveyed in the village of Japanese immigrants were interested in playing such a game. Even ignoring the Japanese, the households who did not show

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<sup>1</sup> In these two villages we interviewed twenty and twenty-four households, while in the other villages we only interviewed between seven and sixteen households.

up were significantly wealthier than those who did,<sup>2</sup> have significantly younger household heads,<sup>3</sup> and trust significantly less (as measured by the World Values Survey trust question).

Almost all players showed up on time and received their 1,000 Guaranies immediately. We went inside the room where I hung a chart on the wall showing different play and the payoffs each would lead to. I first explained the risk game and gave four examples of bets and rolls of the die and their payoffs to the players in Guarani (the indigenous language of Paraguay). After that, one of the enumerators went through the exact same explanation and three different examples in Guarani, using the excuse that he thought people might not understand my accented Guarani (in fact we just wanted them to hear the instructions twice, though, my accented Guarani may have been an issue as well). They were not allowed to ask questions in the group setting, and were told to reserve questions until they came in individually to play the game.

After the explanation the players left the room and went outside to wait. The three enumerators waited outside with them, and were there to ensure no one discussed the game. (The players were told that if they were caught talking about the game they would be disqualified.) I called the players into the room one at a time from a randomly sorted list. I asked each player if he or she had any questions, and went through a few more examples with them. Then I gave the player 8,000 (fake plastic) Guaranies. They could choose to bet 0, 2,000, 4,000, 6,000, or 8,000 on the roll of the die by placing their bills on the table. If I rolled a 1, the player lost his bet, if I rolled a 2 he lost half of his bet, if I rolled a 3 he recouped his bet, if I rolled a 4 he received 150% of his bet, a roll of 5 meant he doubled his bet, and a roll of 6 meant he received 250% of his bet. If the player chose to bet, I rolled the die, and we calculated his payoffs. I then gave him an

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<sup>2</sup> This is probably not due to their higher opportunity cost of time, as they did respond to the long survey with no pay.

<sup>3</sup> This may be because older people have more free time to attend meetings.

IOU which he saved until the end of both games.

After players had played the first game (the risk game), we called them back into the room and explained the second game (the trust game). We had a second poster explaining the payoffs of the trust game hanging on the wall, and again both I and an enumerator explained the game using the same instructions but different examples. The players were each given the same endowment of 8,000 Guaranies and the exact same choice options as in the first game, i.e. sending 0, 2,000, 4,000, 6,000, or 8,000. I told them I would triple the amount they decided to send and put it in an envelope with a design on the front (curve, circle, diamond, triangle, etc.) and told them not to tell anyone what their symbol was. I called them each into the room one at a time in the same order as the previous game and each one made his decision. The player handed me back his IOU on which I added the amount he had kept (i.e. not sent). After all players had chosen how much money to send I went outside and shuffled the envelopes and had one of the players ‘cut the deck’ of envelopes (upside down so he couldn’t see the figures on the front of the envelopes).

I then called the players back into the room one by one and asked them how much they would keep if they received 6,000, 12,000, 18,000, and 24,000 Guaranies respectively, eliciting data on all 4 possibilities. The order of the shuffled envelopes was the order in which they were given out.<sup>4</sup> When a player opened the envelope he counted the bills inside, and took out the amount he had precommitted to take, replacing the remaining bills in the envelope. I added the amount he had taken out of the envelope to his IOU.

After that, each player was called into the room individually one last time and was given back his original envelope. Each player opened his envelope and counted how

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<sup>4</sup> Before the person entered the room, I checked the design on the envelope to make sure that it was not his own envelope. If it was (which did happen sometimes) I returned that envelope to the middle of the deck and gave him the next one.

much money had been returned to him. Then I added that amount to the other three numbers on his IOU and gave him the cash. Playing both games took approximately two and a half hours. The players were always extremely grateful for the cash they won, since as of late it is extremely difficult to find a paying job. Sometimes the players would jokingly complain that we should have brought them cookies too, because they got hungry. We did always bring ice and yerba mate so that they could drink the traditional Paraguayan tea while they were waiting.

### **E.0.1 Game Protocol**

[This protocol is closely related to that employed by Barr, Barrett, Bolyanatz, Cardenas, de la Pena, Ensminger, Gil-White, Gurven, Gwako, Henrich, Johnson, Marlowe, McElreath, Lesorogol, Patton, and Tracer in their project “The Roots of Human Sociality: An Ethno-Experimental Exploration of the Foundations of Economic Norms in 16 Small-Scale Societies”.]

#### INTRODUCTORY COMMENTS

Thank you all for taking the time to come today. Today’s games may take 2 to 3 hours, so if you think you will not be able to stay that long let us know now. Before we begin I want to make some general comments about what we are doing here today and explain the rules that we must follow. We will be playing games with money. Whatever money you win will be yours to keep and take home. I will be supplying the money. You should understand that this is not my own money. It is money given to me by the University of California to use for research. There are many researchers in different countries in North America, South America, Asia, and Africa playing these same games.

Before we proceed any further, let me stress something that is very important. Many of you were invited here without understanding very much about what we are

planning to do today. If at any time you find that this is something that you do not wish to participate in for any reason, you are of course free to leave whether we have started the game or not.

We will be playing two games here today. If you have heard anything about any other games, you should try to forget about that. These games are completely different. It is important that you listen as carefully as possible, because only people who understand the games will actually be able to play. We will run through some examples here while we are all together. You cannot ask questions or talk while here in the group. This is very important. Please be sure that you obey this rule, because it is possible for one person to spoil the game for everyone. If one person talks about the game while sitting in the group, we would not be able to play the game today. Do not worry if you do not completely understand the game as we go through the examples here in the group. Each of you will have a chance to ask questions in private to be sure that you understand how to play.

After we have explained the first game, you will all go outside and wait while I call you in one at a time to play. While you are outside you can talk about soccer, medicinal herbs, or anything else you want other than the games played here today. Fulgencio, Ever and Vicente will be waiting with you all and if they hear you talking about the game then you will not be allowed to play.

#### INSTRUCTIONS FOR THE FIRST GAME [i.e. the risk game]

This game is played by one person alone. I will give 8,000 Guaranies to each player to start the game. The player will then have the opportunity to bet a share of this money. The player can bet 8,000, 6,000, 4,000, or 2,000 Guaranies, or can choose not to bet. After the player decides how much money he would like to bet, I will roll a six-sided die. If the die lands on one, the player will lose the money he bet. If the die lands on two, the player will lose half of the money he bet. If the die lands on three, the player

will recoup his bet, thus he will neither lose nor win money. If the die lands on four, the player will receive 1.5 times his bet. If the die lands on five the player will double his bet, and if the die lands on six the player will win 2.5 times his bet. Thus, rolls of one and two are bad, a roll of three is neither good nor bad, and rolls of four, five, and six are good.

This is the end of the game. The player will go home with the share of the original 8,000 Guaranies he did not bet, plus whatever money he won in the bet. This game will only be played once with each person and then the game is over.

Here are a few examples [These examples were all given using fake plastic money and a die. I gave the first four examples and an enumerator repeated the above instructions and then gave the last three examples.]:

1. Imagine that the player bets 8,000 Guaranies. He is left with no money. Laura throws the die. The die lands on 3. This means that Laura will give the player back his original bet. Thus the player will return home with 8,000 Guaranies.
2. Now we will try another example. Imagine that the player bets 6,000 Guaranies. He is left with 2,000 Guaranies. Laura throws the die. The die lands on 2. This means that the player loses half of his bet. The player loses 3,000 Guaranies and Laura gives him back 3,000 Guaranies. Thus the player has the 2,000 Guaranies he didn't bet plus the 3,000 Guaranies that Laura gave back to him, and so he goes home with 5,000 Guaranies.
3. Now we will try another example. Imagine that the player bets 4,000 Guaranies. He is left with 4,000 Guaranies. Laura throws the die. The die lands on 4. This means that Laura gives the player back his original bet plus an extra half of his original bet. This means she gives him 4,000 plus 2,000, i.e. 6,000 Guaranies. Thus the player has the 4,000 Guaranies he didn't bet plus the 6,000 Guaranies

that Laura gave back to him, and so he goes home with 10,000 Guaranies.

4. Now we will try another example. Imagine that the player bets 2,000 Guaranies. He is left with 6,000 Guaranies. Laura throws the die. The die lands on 5. This means that the player doubles his bet. The player bet 2,000, and 2 times 2,000 is 4,000 so Laura gives him back 4,000. Thus the player has the 6,000 Guaranies he didn't bet plus the 4,000 Guaranies that Laura gave back to him, and so he goes home with 10,000 Guaranies.
5. Now we will try another example. Imagine that the player bets 6,000 Guaranies. He is left with 2,000 Guaranies. Laura throws the die. The die lands on 6. This means that the player doubles his bet, plus gets an extra half of his bet in addition. The player bet 6,000, and two times 6,000 is 12,000. He wins an additional extra half of his original bet, or 3,000 Guaranies. Thus Laura gives him 12,000 plus 3,000 or 15,000 Guaranies. Thus the player has the 2,000 Guaranies he didn't bet plus the 15,000 Guaranies that Laura gave back to him, and so he goes home with 17,000 Guaranies.
6. Now we will try another example. Imagine that the player bets 8,000 Guaranies. He is left with nothing. Laura throws the die. The die lands on 1. This means that the player loses his entire bet. Thus the player goes home with 0 Guaranies.
7. Now we will try another example. Imagine that the player doesn't bet anything. He is left with all 8,000 Guaranies. There is no need for Laura to throw the die. The player goes home with 8,000 Guaranies.

Note that, the more money the player bets, the more he can win, but the more he can lose as well. He could go home with more or less than 8,000 Guaranies as a result. Please remember that you are not betting the money you may have brought with you in

your pocket here today. The money you will be using to bet is money that I have given you for that purpose.

We will discuss a few more examples with you when it is your turn to come play. At that point you can ask any question you want. Please remember that while you are waiting you cannot talk about the game or you will be disqualified.

[Then each person was taken in one at a time. There was another list of examples and test questions of which I went through as many as seemed necessary until the player understood the game. Then the player decided how much money to bet, and if he bet some positive amount I rolled the die. Then I gave him an IOU stating how much I owed him.]

Now you must wait outside until all of the other players have played this game. Then we will play another game, and at the end of both games I will pay you. Remember that you cannot talk about the game while you are waiting.

#### INSTRUCTIONS FOR THE SECOND GAME [i.e. the trust game]

This game is played by pairs of individuals. Each pair is made up of a Player 1 and a Player 2. Each of you will play this game two times, once as a Player 1 and once as a Player 2. Each of the two times you play it will be with a different person. You will be playing with someone from your own village. However, none of you will know exactly with whom you are playing. Only I know who is to play with whom and I will never tell anyone else. It is important for you to remember that each time you play will be with a different person. When you play as Player 1, you will play with one person from this room. When you play as Player 2 you will be playing with a totally different person.

I will once again, as in the previous game, give 8,000 Guaranies to each Player 1. Player 1 then has the opportunity to send a portion of his 8,000 Guaranies to Player 2. He could send 8,000, or 6,000, or 4,000, or 2,000, or nothing. I will triple whatever amount Player 1 decides to give to Player 2 before it is passed on to Player 2. Player 2

then has the option of returning any portion of this tripled amount to Player 1. Then the game is over.

I will triple any money that Player 1 decides to send to Player 2 before it is put in an envelope. Each envelope has a different symbol on it, such as a circle, triangle, square, etc. You can try to remember the symbol on your envelope, but if you don't I will remember it. It is extremely important not to tell anyone the symbol on your envelope. If you are sending money to Player 2, I will put the tripled amount into the envelope with your symbol on it, if you are not sending money to player 2, the envelope with your symbol on it will remain empty.

After every player has decided how much, if any, to put into the envelope with his symbol on it I will shuffle all the envelopes. Then, each of you will come into the room one at a time, and you will be assigned the envelope that is on the top of the stack. You will not receive your own envelope; it will be the envelope that another player in this room has sent. [This stack of envelopes was placed behind some kind of border, so that the player could not see how thick they were before we elicited his strategies.] You will then decide how much (if any) of the money in the envelope you want to keep and how much (if any) you want to leave in the envelope to be returned to the person who placed the money there.

After every player has decided what to do with the money in the envelope and opened an envelope to do as he precommitted to doing, I will call you into the building one last time one at a time to open up your original envelope and see how much, if any, money is left in it. Thus in playing the role of Player 1, the player will go home with whatever he kept from his original 8,000 Guaranies, plus anything returned to him by Player 2. In playing the role of Player 2 he goes home with whatever was given to him by Player 1 and then tripled by me, minus whatever he returned to Player 1. Then I will pay you the amount I owe you from both the first and second games.

Here are some examples [I worked through these examples having all the possibilities laid out in front of people. When each hypothetical Player 1 made their choice I visually showed the effect of tripling the money and putting it in the envelope. Then I visually showed Player 2 opening the envelope and making his decision. I gave the first three examples and the enumerator repeated the above instructions and gave the last two examples.]:

1. Imagine that Player 1 gives 8,000 Guaranies to Player 2. Laura triples this amount, so Player 2 gets 24,000 Guaranies (3 times 8,000 equals 24,000). At this point, Player 1 has nothing and Player 2 has 24,000 Guaranies. Then Player 2 has to decide whether he wishes to give anything back to Player 1, and if so, how much. Suppose Player 2 decides to return 6,000 Guaranies to Player 1. At the end of the game Player 1 will go home with 6,000 Guaranies and Player 2 will go home with 18,000 Guaranies.
2. Imagine that Player 1 gives 6,000 Guaranies to Player 2. Laura triples this amount, so Player 2 gets 18,000 Guaranies (3 times 6,000 equals 18,000). At this point, Player 1 has 2,000 Guaranies and Player 2 has 18,000 Guaranies. Then Player 2 has to decide whether he wishes to give anything back to Player 1, and if so, how much. Suppose Player 2 decides to return nothing to Player 1. At the end of the game Player 1 will go home with 2,000 Guaranies and Player 2 will go home with 18,000 Guaranies.
3. Imagine that Player 1 gives 4,000 Guaranies to Player 2. Laura triples this amount, so Player 2 gets 12,000 Guaranies (3 times 4,000 equals 12,000). At this point, Player 1 has 4,000 Guaranies and Player 2 has 12,000 Guaranies. Then Player 2 has to decide whether he wishes to give anything back to Player 1, and if so, how much. Suppose Player 2 decides to return 6,000 Guaranies to Player 1. At the end

of the game Player 1 will go home with 10,000 Guaranies and Player 2 will go home with 6,000 Guaranies.

4. Imagine that Player 1 gives 2,000 Guaranies to Player 2. Laura triples this amount, so Player 2 gets 6,000 Guaranies (3 times 2,000 equals 6,000). At this point, Player 1 has 6,000 Guaranies and Player 2 has 6,000 Guaranies. Then Player 2 has to decide whether he wishes to give anything back to Player 1, and if so, how much. Suppose Player 2 decides to return 4,000 Guaranies to Player 1. At the end of the game Player 1 will go home with 10,000 Guaranies and Player 2 will go home with 2,000 Guaranies.
5. Imagine that Player 1 doesn't send anything to Player 2. There is nothing for Laura to triple. Player 2 gets 0 Guaranies and so can't return anything. At the end of the game Player 1 will go home with 8,000 Guaranies and Player 2 will go home with nothing.

Note that the larger the amount that Player 1 gives to Player 2, the greater the amount that can be taken away by the two players together. However, it is entirely up to Player 2 to decide what he should give back to Player 1. The first player could end up with more than 8,000 Guaranies or less than 8,000 Guaranies as a result.

We will go through more examples with each of you individually when you come to play the game. In the meantime, do not talk to anyone about the game. Even if you are not sure that you understand the game, do not talk to anyone about it. This is important. If you talk to anyone about the game while you are waiting to play, we must disqualify you from playing.

Now I will call in each person one by one to decide whether or not to send any money to the other anonymous player, and if so, how much. After all of you have played as Player 1 and decided what to do with your envelope I will come back out to

shuffle the envelopes and then redistribute them. Then each of you will come in a second time to play as Player 2.

[Then I brought in each player one by one and used more examples from a list of examples and asked some test questions until the person understood.]

**First player:** Now you will play as Player 1. Here are your 8,000 Guaranies. [At this point 8,000 Guaranies are placed on the table in front of the player.] You should hand me the amount of money you want to be tripled and passed on to Player 2. You can give me nothing, 2,000 Guaranies, 4,000 Guaranies, 6,000 Guaranies, or 8,000 Guaranies. Player 2 will receive this amount tripled by me. Remember the more you give to Player 2 the greater the amount of money at his or her disposal. While Player 2 is under no obligation to give anything back, we will pass on to you whatever he or she decides to return. [Now the player hands back whatever he or she wants to have tripled and passed to player 2.]

**Second player:** Now you are playing as Player 2. Before you get to look at the envelope which is assigned to you I will ask you how much you would keep and how much you would give back depending on how much money you find in the envelope. Whatever you say now will be binding when you actually open the envelope. Remember you can return nothing or keep nothing or anything in between. So, if Player 1 put 2,000 Guaranies in the envelope, and I tripled it, so that you open the envelope and find 6,000 Guaranies inside, what will you do with the 6,000 Guaranies? [Write down their response.] If player 1 put 4,000 Guaranies in the envelope, and I tripled it so you find 12,000 Guaranies in the envelope, what will you do with the 12,000 Guaranies? [Write down the response.] If player 1 put 6,000 Guaranies in the envelope, and I tripled it so you find 18,000 Guaranies in the envelope, what will you do with the 18,000 Guaranies? [Write down the response.] If player 1 put 8,000 Guaranies in the envelope, and I tripled it so you open it and find 24,000 Guaranies, what will you do with the 24,000 Guaranies?

[Write down the response.] Here is the envelope that is assigned to you. You can now open it and count the money inside. How much is in it? You said that if you found  $X$  Guaranies you would keep  $Y$  and return  $Z$ . Please take  $Y$  out of the envelope and put  $Z$  back in.

## Appendix F

### Description of Variables

- Brazilian – A dummy for players of Brazilian heritage. One village was entirely Brazilian while another was a mixture of Brazilians and Paraguayans.
- Distance to bus – Kilometers the closest house in the village was to a bus route. In only three of the villages was the answer positive.
- Donations – The sum of money a household donated to the church and communal projects such as electrification, road repair etc. as well as the number of days of work they donated (without pay) to the church and communal projects where a day of work was valued at 12,000 Guaranies per day. Here we use  $\log(((\text{monetary donations} + 12,000 * \text{work donations}) / 1,000) + 1)$ .
- Gifts – The total value of all agricultural or animal products a household produced that it gave to family and friends. Here we use  $\log((\text{gifts} / 1,000) + 1)$ .
- Guarani – Paraguay is officially bilingual, with all schools taught in both Spanish and Guarani. It is not the case that those who speak Guarani at home have more indigenous heritage. The survey asked which language was spoken most at home. The Brazilian immigrant population speaks German or Portuguese and the Paraguayan population speaks either Guarani, Spanish, or both at home.
- New households – The number of new households which moved into the village in the past 3 years (from the community survey).

- P.I. at survey – A dummy for whether I sat in on the survey with that household.  
I attended surveys with a different enumerator each day, alternating between the three and there was no specific type of household I tended to visit more.
- Wealth – This is the sum of the value of the land, tools, and animals they own.  
Here we use  $\log(\text{wealth}/1,000)$ .