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Behavioral Responses to Natural Disasters

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Abstract Catastrophic events can dramatically alter existing social and economic relationships. The consequences can be long-lasting and give rise to heterogeneity of behavior across populations. We investigate the impact of a large negative shock on altruism, trust and reciprocity in 30 small Honduran communities diversely affected by Hurricane Mitch in 1998. We conduct a survey of communities and behavioral experiments three and four years after the event. We find that the mean and variance of behavior are nonlinearly related to the severity of the weather shock affecting the community. Also, there is a substitution away from formal local organizations to informal arrangements.

JEL classifications: C72, C92, C93.

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1. Introduction

It has been long argued that adaptation to the environment might favor the persistence of certain traits or behaviors that help the survival of the group (Darwin 1871, Becker 1976, Bowles 2006, 2008, 2009, Boyd et al. 2002). Recent cross-cultural experimental work has revealed that pro-social behavior correlates with the returns to cooperation in production and the institutions necessary for the development of impersonal relationships (Boyd et al. 2001, Henrich et al. 2006, 2010). This paper asks to what extent do environmental variables influence other-regarding behavior in groups and to what extent do they help explain differentiation in behavior across them. Assessing the importance of environmental variables in behavior is complicated by the fact that it is difficult to know whether differences across groups are due to hard-to-measure unobserved variables or to the need and opportunities for cooperation.

We attempt to answer these questions by experimentally evaluating the change in pro-social behavior in small and isolated Honduran communities after experiencing a negative shock: Hurricane Mitch. We exploit the random degree of severity by which the communities were affected by the hurricane to try to understand the mechanisms behind changes in behavior. This event allows us to directly measure the effect of an exogenous change on the need to cooperate, keeping unobservables constant. We take advantage of a unique data set that combines experiments and survey data across communities in Honduras diversely affected by Hurricane Mitch. Experiments across comparable small communities allow us to observe the diversity of behavior within the boundaries of cultural and economic systems. A natural disaster permits the observation of changes in past economic conditions on future social relationships. Natural disasters can expose people to gains from cooperation in a rather dramatic way, even more so for those living in small and isolated communities where outside help might be tardy. In the face of a disaster, communities can break away from past coordination failures, face new conditions where cooperation is more profitable or feel closer and attached to those sharing the experience.

Hurricane Mitch is ranked as the fourth strongest hurricane affecting the Atlantic basin on record (Morris et al. 2002). The hurricane passed through Honduras between October 28, 1998 and November 1, 1998, and the Economic Commission for Latin America and the Caribbean (ECLAC, 1999) considers it responsible for 5,657 deaths and significant damages that affected 1.5 million people. Not only was infrastructure destroyed, but many planted and stored staple foods consumed by the poor were washed away (ECLAC 1999). By all accounts, the exact path and severity of the hurricane was unpredictable, making its local impact a matter of luck.

We measure social interactions through two economic experiments: a modified investment game (Berg, Dickhaut and McCabe, 1995) and a modified dictator game (Forsythe et al., 1993). Experimental subjects were composed of at most one adult member of a household and were invited to participate in the experiment a few days prior to the experiment. The experiments were conducted in a period of two months in the summer of 2002. All the experiments were conducted by the exact same set of experimenters following the same script and procedures. The experiments reproduced many of the features commonly found in laboratory settings. Subjects were randomly assigned to rooms, experimental conditions and roles, and efforts were made to prevent other subjects and experimenters from observing individual decisions. These identical conditions help us identify the underlying variance in individual behavior across communities. Together with the experimental measures, a living standard survey was conducted with a random sample of households. The survey was conducted in October of 2001.

To measure the severity of the weather shock, we collected monthly rainfall data for Honduras between 1950 and 1999. Our main controls are the amount of rain experienced in the month of October 1998 and the average amount of rain experienced any month between 1950 and 1999. Our measures are extrapolations of measures of rain with half a degree of precision. This measure is, by construction, uncorrelated with features of communities that are fixed over time. That is, the rain variable is unlikely to capture unmeasured differences across communities. More importantly, measuring the impact of rain on behavior in experiments and socio-economic variables collected in our survey allows us to identify the effect of economic conditions on behavior.

We find that behavior across communities is quite diverse. The average percent passed in the modified dictator game ranges from 22 percent to 69 percent while the average percent passed in the modified trust game ranges from 26 percent to 67 percent. The lowest average percent sent back in the trust game is 25 percent while the highest is a 63 percent. This shows that measured social interactions can be quite different even among groups sharing many of the same characteristics. Most importantly, we find that not all of this variance is random. Individuals in communities experiencing more rain tend to send and return more in the trust game. We find that the weather shock affects the mean and the variance of behavior. This result is robust to several specifications and additional controls. Our estimates suggest that a 5 percentage points increase in rain in October 1998 yields 8.5 percentage points increase in the amount passed in the trust game. The effect, however, is nonlinear. A 10 percentage point increase in the amount of rain in October 1998 represents only 4 percentage point increase in the amount passed in the trust game. While negative shocks might promote cooperation, too large negative a shock might not help it.

We also present evidence that our results are unlikely due to randomness or mispecification. The results are robust to the inclusion of covariates controlling for personal, experimental session and community characteristics. For instance, while consumption in areas affected by the hurricane is lower than in other areas, our experimental results are robust to the inclusion of controls for socio-economic conditions. Similarly, while behavior is affected by the familiarity of subjects to other participants, the direct effect of the hurricane remains large. The results do not seem to be a statistical artifact either, we cannot reproduce our results by simply replacing the measure of rain in October 1998 by the reported amount of rain in other months. Despite being a coarse measure of the severity of the event, our measure of the weather shock seems to have captured its variance across communities.

Additional data collected in our study gives further evidence that the hurricane had a lasting impact in social interactions. We find that subjects living in communities more severely affected by the hurricane are more likely to report that they trust others and that they have more close friends and emergency contacts. Interestingly, these subjects also report a significant decrease in involvement in formal local organizations. While only partial evidence, this suggests a substitution of formal local institutions by informal and direct interactions. In all cases, it advances the case that natural events might have lasting impacts on the way people interact with one another.

The main contribution of our paper is to show that variations in local conditions can have a lingering impact on pro-social behavior and that experimental methods can help us uncover some of the reasons behind observed heterogeneity in behavior. However, the fact that the variance in behavior also increases with negative shocks suggests that changes in behavior might not necessarily be the expression of an ongoing state-dependent set of norms.

Local response to environmental challenges is heterogenous and might eventually have long-term consequences. However, our data cannot answer the question of whether these changes are temporary or not.

Our work relates to several strands of research. For instance, Roth et al. (1993) show that bargaining behavior across cultures are consistent with the existence of norms. Similarly, Henrich et al. (2001, 2004) provide evidence that gains from cooperation foster more cooperative behavior in experiments. Our paper adds to the literature by showing that these norms might be diverse because of responses to changes to environmental conditions and that durable changes can be rapid. While these results do not preclude that certain norms might be more likely to appear among some populations, i.e. the possibility of heterogenous treatment effects, they suggest that behavior does respond to changes in local conditions (Smith, 2003). Importantly, our design has the advantage of reducing the likelihood that variations in behavior are due to the existence of correlated unobservables. As argued above, the existence of several isolated communities along the path of the hurricane gives a unique opportunity to observe the effect of environmental changes on local behavior. We find that shocks, when not too severe, can move communities towards more cooperative equilibria.

Our experiments are consistent with the results by Bullows and Miguel (2009) and Chen (2010) that show that membership in civil and religious organizations are affected by violence and economic distress. Our study shows that these effects are present even when interactions are anonymous and that changes might not be uniform across different forms of personal interaction. More importantly, our study showcases one nice feature of experimental methods: all subjects faced the same controlled conditions. We can therefore conclude that systematic differences in behavior across communities are due to changes in preferences or expectations. Eckel, El-Gamal and Wilson (2009) have shown that survivors of Hurricane Katrina in New Orleans tended to act more risk lovingly. We show that environmental variables can have persistent consequences at the group level as well.

Our study shows the advantage of using cross-sectional methods combined with experimental methods to detect casual effects of shocks on behavior. Carter and Castillo (2005, 2011) show that community level experimental measures can help explain income dynamics and recovery from bad shocks in Honduras as well as South Africa. The present study builds on these earlier findings by exploring how these norms are formed.

Voors et al. (forthcoming) show that social, risk and time preferences are all affected by political conflict in a sample of Burundian communities. They find an increase in altruistic, risk taking and impatient behavior as a consequence to exposure to political violence. Our study is different in that it concentrates on climatic events and the behavior in games. Climatic events, while stressing social organizations, are likely to be uncorrelated with pre-existent and unobservable social norms. The comparison of individual behavior in the dictator game and the trust game allows us to directly contrast whether equilibrium behavior itself is affected by a negative shock. We find robust evidence of the influence of the negative shock in the strategic environment, but less so in the individual decision exercise. The potential effect of a negative shock on social interactions captured by our experiments is reproduced by the survey data on local organizations.[1] Our study, and also Carter and Castillo (2005, 2010), therefore suggests that attention to equilibrium behavior, as well as to preferences, is necessary. Recent data collected by Cassar, Healy and Kessler (2011) on the effects of a tsunami in Thailand confirms our result that negative shocks affects individual behavior. However, our results show that an increase in cooperation is not a foregone conclusion, severely damaged communities show no increase in cooperation.

The paper is organized as follows. Section 2 describes the impact of Hurricane Mitch. Section 3 describes experimental procedures. Section 4 presents the main results and robustness checks. Section 5 concludes.

2. Measuring the Size and Impact of the Disaster

To estimate the differential impact of the hurricane across Honduran communities we

[1] While changes in community level risk sharing might generate income effects that express themselves in social preferences and risk preferences experiments (Mazzoco 2004), these effects are harder to reconcile with the evidence on impatience.

rely on the monthly rainfall estimates produced by Willmott and Matsuura at University of Delaware

(http://climate.geog.udel.edu/˜climate/). While other sources of rainfall data are available, e.g. the Global Precipitation Climatology Project (http://precip.gsfc.nasa.gov/), we rely on the former because it is geographically more detailed. The data are based on a grid of half degree precision that gives us forty observations relevant to Honduras. In addition, the data set compiles monthly information for a period of over fifty years. In our study, precipitation data is extrapolated to the community level using a inverse-distance weighted method with a weight of 2 (Lam 1983, Kelway 1974).

Our measure of the weather shock is the observed precipitation in October 1998 and the average observed monthly precipitation between 1950 and 1999. October 1998 is the month in which Hurricane Mitch hit Honduras (Oct 28 through Oct 31, 1998). This measure is, by construction, uncorrelated with local characteristics that are constant over time. This is important because, in general, it is difficult to control for factors that might produce a correlation between economic conditions and behavior (Manski 1993, 2000).

The household survey data came from a random sample of 850 producers from 5 departments in Honduras. These producers were surveyed regarding the 2000 agricultural year. In addition to standard current income and expenditure data, the 2001 survey also solicited detailed information on damages suffered during Hurricane Mitch. Assets shocks include the value of land washed away, permanent crops (primarily coffee plantations) destroyed, as well the value of livestock and machinery that were killed or destroyed. Income and expenditure shocks include the imputed net value of crops that were washed away, costs of medical expenses, lost off-farm earnings and reductions in remittances. Assets were priced using median values by geographic locale, and all the values of asset and income shocks were inflated to the price level at the time of the 2001 survey. For those households suffering loss of productive assets, the median loss varies from about 7500 to 13,000 Lempira. To help place these figures in perspective, median (mean) household income in this sample was 13,500 (30,200) Lempira in 2001.

Table 1 presents linear regression estimates of the effect of the weather shock on economic conditions as of year 2000. We include the impact on consumption and productive assets as well as the value of aid received. All the dependent variables are measured in logarithms of the original variable plus one. All the regressions control for sex, age and education of the household head, family size and the logarithm of value of assets prior to Hurricane Mitch. We find that our measure of the weather shock has a large and significant impact on the household's consumption and assets. Rain is associated with a drop in weakly consumption expenses and assets holdings. The relationship, however, is nonlinear. Interestingly, we find that the value of aid received is not significantly correlated with the severity of the weather shock. This is consistent with the results by Morris et al. (2002) that report weak targeting of relief aid in Honduras using a national living standard survey.

In sum, we find that our measure of weather shock is strongly correlated with socioeconomic conditions and that Hurricane Mitch had an impact that lasted 3 years later.

3. Experimental Design and Procedures

This study employed experiments based on the dictator game (Forsythe, Horowitz, Savin, and Sefton, 1994) and the investment game (Berg, Dickhaut, and McCabe, 1995). In the modified dictator game we use, the proposer was endowed with an amount of money that he had to decide to keep or share with a responder who was not given an endowment. Each unit of money passed by the proposer was tripled before reaching the responder, making it relatively cheap for the proposer to give money to the responder (i.e., the price of giving one unit of money was $\frac{1}{3}$). In the modified investment game, the sender was endowed with an amount of cash that she had to decide to keep or share with an individual without an endowment[2]. Money sent to the responder was again tripled, and the responder had the opportunity to send back none, part or all the amount received.

These experiments were implemented in 30 separate rural Honduran communities.[3]

[2] In the original game, the responder also was given an endowment.

[3] We collected data in two additional communities, but we did not collect enough detailed personal information as to include them in the analysis.

These communities were selected at random from the communities included in the household survey. The communities are spread across the major geographic regions of Honduras. One in seven of the experimental subjects was recruited from the respondents to the survey, while the others were selected from other families in the same communities. Recruitment of other participants was made with the help of local leaders (typically school principals) who were asked to recruit adults among families of different backgrounds. Not more than one participant per household was allowed. All the participants were at least 18 years of age and they were not told about experimental payments at the time of recruitment.

Table 2 compares the age and education of the experimental sample to the 2002 Honduran census on the same communities. The average age of participants was 41 years old, with 3 out of 5 being male. Twenty five percent of the sample was at least 50 years of age and 25% was at most 31 years of age. Twenty five percent of participants had at most 5 years of education and 25% of them had at least 6 years of schooling. On average, there were 24 subjects per session. Two sessions were smaller (16 participants), and three sessions were larger (32 participants). All participants in each session belonged to the same community or neighborhood. On average, participants knew 88% of the people in the session by name.

Before starting the experiment, participants were randomly assigned to one of three separate rooms at a local school.[4] A quarter of the participants were assigned to each of the two proposer rooms, Rooms A and B. The remaining 50% of the participants were assigned to a single responder room, Room C. As mentioned above, the intention of this design was to hold the community-level contextual effects constant across Rooms A and B. Two rounds of games were played, and all individuals ultimately participated in one round of the trust game and one round of the dictator game.

After all individuals had been assigned and physically separated into their room groups, the Room C responders were internally subdivided into two sub-groups. Sub-group C_{AB} served as the responders for the Room A senders in the first round game, and they were the responders for the Room B senders in the second game. Sub-group C_{BA} played the opposite

[4] A team of three people implemented the experiments.

roles This arrangement permitted us to tell senders that they would interact with two different responders for their first and second games and avoid dynamic effects. Responders did not know with which sender room they were interacting. Subjects were not allowed to talk to one another during the experiment. To protect each participant's privacy, subjects were given a privacy box where they could handle money without the risk of being seen by others. Each sender had two coded colored envelopes if she was playing the modified dictator game and 3 coded colored envelopes if she was playing the modified investment game. Decisions were made by passing money from one envelope to another. Experimenters then picked up the envelopes with the money to be passed to responders in a box without looking at the contents. A different experimenter added the necessary tripled amounts of money and delivered the envelopes to the responders' room.

The Room A senders played the dictator game first and the modified investment game second. To test for game order effects, Room B proposers first played the trust game and then the dictator game. The endowment for the dictator game was 40 Lempiras ($2.5) and the endowment for the trust game was 50 Lempiras ($3.1). Each Lempira sent to the other room was tripled in both games. The average payment to a participant in the experiment was 90 Lempira (or around $5), which amounts to two-days wage in rural areas. In all rooms, instructions were read out loud, and then a series of questions were asked to make sure that the games were clearly understood. To avoid letting trustee's decisions influence Room B dictator choices, Room B senders did not learn how responders had responded to their modified investment game decisions until after they had completed the dictator game. Finally, after all games had been played, we administered a post-experiment questionnaire that concentrated on game understanding and demographic and economic background.

Figure 1 shows the location of the visited communities in Honduras. Figure 1 also shows the path of Hurricane Mitch between Oct 28, 1998 and Oct 31, 1998. Communities are marked in different colors to represent the amount of rain received. On average, communities experienced three times the amount of rain than in an average month. The least affected communities received more than double the monthly average and the most affected received about four times the average amount of rain. The actual impact of the hurricane was heterogenous due to the diversity of geography.

4. Results

4.1. Overview of the Data

Table 3 reports the summary statistics of the experiments. Subjects sent 42% of their endowment in the dictator game, 49% in the modified investment game, and the unconditional proportion returned by responders was 42% of the amount received.[5] In the dictator game, 7% of the subjects sent no money, and 12% sent all the money. In the modified investment game, 4% sent no money and 13% sent all the money. Average amounts passed in our dictator game are higher than commonly found in experiments with college students (Forsythe et al, 1994; Eckel and Grossman, 1996). However, results from both games are consistent with previous results with non-college students (see Burks, Carpenter, and Verhoogen, 2005). All decisions presented a high degree of variability at the individual level. This variability is also present at the community level; the lowest average share passed in the dictator game was 22% and the highest was 69%, and the lowest average share passed in the modified investment game was 26% and the highest was 67%.

While the experimental protocol resulted in substantial variation in individual behavior, it is possible that observed differences are an artifact of the relatively small size of sessions. It is therefore necessary to test whether the behavior across communities is a reflection of real behavioral differences. We conduct two such tests. First, we estimate a linear regression model where the only explanatory variables are dummy variables for each community. This model explains 21 percent of the variance in the dictator game, 14 percent of the variance in the behavior of senders and 23 percent of the variance in the behavior of responders in the modified investment game.[6] This suggests the existence of systematic

[5]The sample percentage returned is a decreasing function of the amount received. For instance, responders returned 57% if they received L15, 38% if they received L90 and 37% if they received L150.

[6]The corresponding p-values for the F-test of joint significant of the dummy variables are 0.000, 0.003 and 0.000.

difference across communities.

Second, we perform a test of the hypothesis that all sessions are drawn from the same distribution. To do this, we create an indicator variable that equals one if a subject passes strictly more than half of the available money to other subject. This redefinition of individual decisions is done to minimize the potential unreliability of $\chi 2$ tests when not all individual cells are well populated. We can reject the null hypothesis that all sessions belong to the same distribution for all three decision (p-values of 0.000 for the dictator game, and 0.056 for senders and 0.000 for responders in the modified investment game.) The results are similar if we construct indicator functions for the case in which the share passed exceeds sixty and seventy percent.

In sum, we conclude that individual behavior is different across communities. That is, the evidence suggests that behavior across communities is a reflection of differences in norms. The next section explores potential reasons for this diversity in behavior.

4.2. Rainfall and Individual Behavior

In this section we discuss the relationship between individual behavior and the weather shock. Figure 2 shows scatter plots of average behavior by community as a function of the total amount of rain (in mm) received in October 1998. The graphs show that behavior across communities is quite varied. The figure also includes the prediction of a regression of individual behavior on the amount of rain experienced and its square. These regressions indicate that the relation between a negative shock and behavior in the experiments might be nonlinear. A first look at regression results is given in Table 4. Since weather patterns might be ex-ante correlated with local characteristics and institutions, these regressions also control for the amount of rain in an average month and its square. All estimates in the paper allow for correlation in behavior at the community level.

Table 4 illustrates that the effect of the hurricane can be sizable. For instance, the estimates suggest that a subject in a community that experienced 725mm of rain in October 1998 versus another that received 675mm will on average pass 10.45% more as a sender and return 7.35% more as a responder in the modified investment game. Due to the nonlinearity of the effect of a negative shock on behavior, the same difference in 50mm across communities receiving above 725mm of rain in October of 1998 will represent a decrease in the amount passed and returned in the modified investment game. The estimates therefore suggests that while negative shocks might promote cooperation, too large a shock might actually destroy cooperation.

Finally, while the estimates show a positive effect of negative weather shocks on giving, as measured by the dictator game, we have not been able to find a robust, statistically significant, relationship in this game. We will therefore concentrate the discussion on the behavior in the modified investment game, while still presenting results from the dictator game.

Table 5 explores the robustness of the results to the inclusion of extra covariates. It presents linear regressions of the effect of rain in October 1998 conditional on the socio-economic characteristics of the subjects, how well a subject knows those participating in the experiment, the average characteristic of the subjects in the room, geographical characteristics of community and order and experimenter controls. We find that the measured effect of a negative shock diminishes, but it remains large and significant. This is remarkable considering that our measure of the negative shock is not only measured with error, but that the hurricane itself is expected to have had a direct impact on many of the covariates included as controls. For instance, one might expect that community members might become better acquainted due to the emergency and than some segments of the population might have been more able to migrate away from the region. This means that even controlling for other confounds, the measured direct impact of the hurricane is significant.

Table 6 addresses the issue of variance in behavior. Table 6 presents interquantile regressions on the share of budgets passed or returned in the dictator and modified investment game. These regressions include similar controls as in Table 5. We find that the presence of a negative shock not only increases the average level of cooperation, but that it coexists with an increase in the variance in behavior. The negative shock therefore creates opportunities for community members to cooperate with one another, but it is not at all granted that all respond similarly to these incentives.

In sum, we find that negative environmental shocks have an impact on social interactions as measure by economic experiments. A negative shock can increase cooperation, but too large a shock can hurt it. Negative shocks also increase variance in behavior, implying that increased cooperation is not a foregone conclusion.

4.3. Robustness Checks

As mentioned above, our measure of a weather shocks is coarse and imprecisely measured. While we are careful to control for the average monthly level of rain, it is possible that given the small number of communities in the study our results are due to spurious correlation. To test this, Table 7 reproduces the results of Table 5 for the amount passed and returned in the modified investment game, but introduces placebo measures of weather shocks. The alternative measures of weather shocks are the amounts of rain in the months of October 1958, 1968, 1978 and 1988. These regressions allow us to evaluate to what extent our results are the result of chance. Keeping in mind that the level of rain in these periods are correlated with the level of rain in October 1998,[7] we find that none of these measures can reproduce the patterns or magnitude of the effect of rain reported in this paper. Our main results are therefore unlikely due solely to spurious correlation.

Our study collected additional information on trust, informal relationships and group membership. Table 8 presents linear regression estimates of the effect of the weather shock on the answer to the questions: "When a lot of money is at stake, how much do you trust others?", "When little money is at stake, how much do you trust others?", "In thinking of people other than your household members; how many close friends would you say you have?", "How many people can you count on in case of an emergency." In addition, the table presents linear regression estimates on membership in local organizations. All the regressions follow the same specification as in Table 5 and include subjects that participated in different roles in the experiments. The number of observations per question varies due to attrition.

[7]The correlation coefficients between the level of rain in October 1998 and October 1958, 1968, 1978 and 1988 in the sample are 0.91, 0.45, 0.89, and 0.94.

The first thing to notice is that our measure of a weather shock has a large and significant impact on these measures as well. This not only gives us confidence that the experimental results are capturing a true change in behavior, but also allow us to see what potential mechanisms might be behind this change. Table 8 shows that personal relationships are positively, yet nonlinearly, correlated with a negative shock. Subjects in communities that experienced larger weather shocks are more likely to express trust in others and have a larger numbers of friends and emergency contacts. Also, subjects experiencing larger negative shocks are more likely to say that they do not belong to local formal organizations. Specifically, we find a significant drop in membership to local government organizations, e.g. producers' associations, water management authority, parents' association and local council.

Given that our estimates on the effect of a negative shock on unconditional giving in the dictator game are not robust, these additional regressions suggests that part of the change in these communities have been a change from formal relations to informal reciprocal relations. The fact that losses in consumption and assets and increases in the amounts shared with others are both related to the weather shock suggests that the result might be an expression of a change in economic conditions. If we assume that sharing is a normal good, this finding would suggest that it is a result of larger benefits to sharing. However, as already shown by Goette, Huffman and Meier (2006), sharing an experience can affect preferences directly. If the main mechanism by which behavior is correlated with excess rainfall is through increased affection towards those sharing the experience, we would expect a general increase in sharing by all subjects.

Our robustness checks show that the effect of a negative weather shock on social interactions is large and robust to additional controls and unlikely due to measurement error. Survey data on social relations and group participation confirm the results in the experiments.

5. Conclusions

We set out to investigate the impact of environmental changes on social norms and social interactions. To do this, we implemented a series of experiments measuring giving and trust along the path of Hurricane Mitch that ravished Honduras in October 1998. The experiments were conducted in small stable communities that share socio-economic characteristics. To minimize procedural variance across communities, the experiments were implemented following identical protocols by the same set of experimenters. All the interactions in the experiment were anonymous.

Our main result is that environmental changes have a direct impact on trust and reciprocity. Negative weather shocks are associated with an increase in cooperative behavior, but this relationship is not linear. A negative shock might foster cooperation, but too large a shock might not. An extra 5 percentage points in rain in October 1998 yields 8.5 percentage points increase in the amount passed in the trust game, but a 10 percentage point increase in the amount of rain in October 1998 represents only 4 percentage point increase.

While the communities affected by the shock might not have fully recovered by the time of the experiments (four years later), our results are robust to a series of controls for socio-economic background of participants and experimental sessions. Importantly, we present evidence suggesting that a strengthening of informal relationships might have occurred as a result of the weather shock. Negative events are related to increased variance in behavior, suggesting that new norms are developing or that different groups have different contingent norms. This is consistent with behavior in experiments being a reflection of local social norms and norms being an expression of multiple equilibria.

Our study shows that field experimental methods can be very useful in investigating the reasons behind observed heterogeneity in equilibrium behavior across populations. While personal experiences can have an impact on individual behavior, our study shows that this naturally extends to equilibrium behavior.

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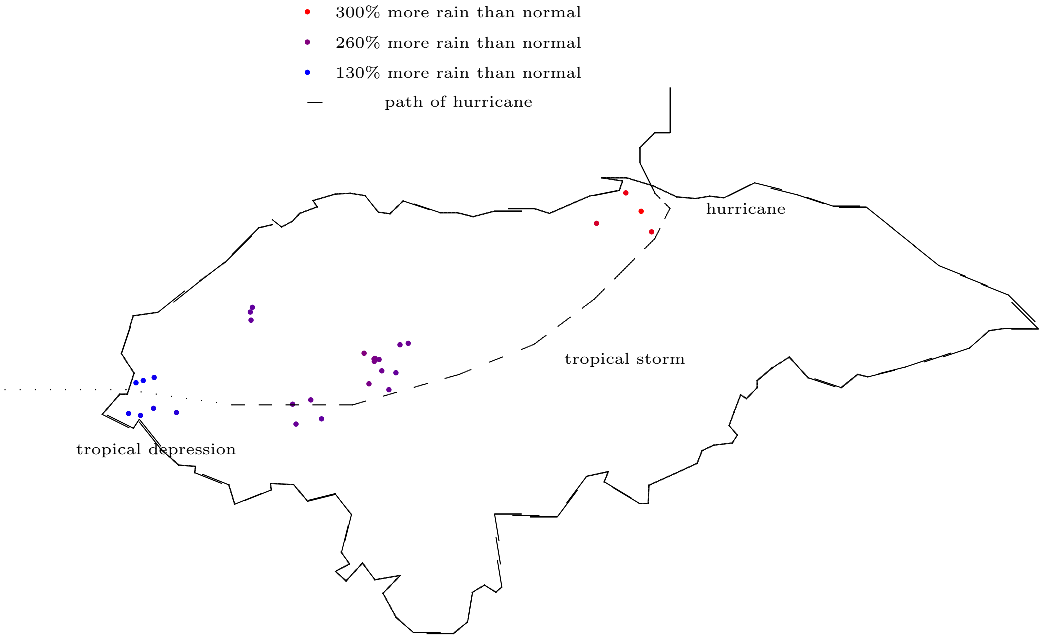
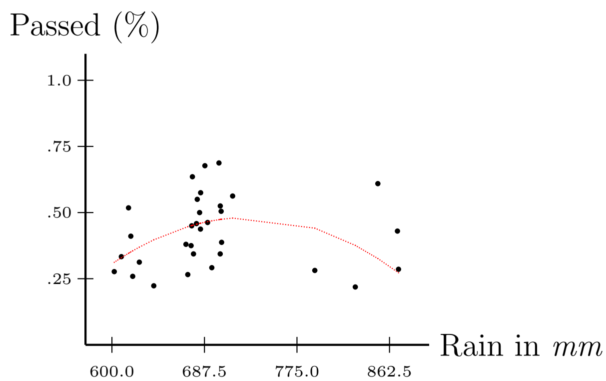
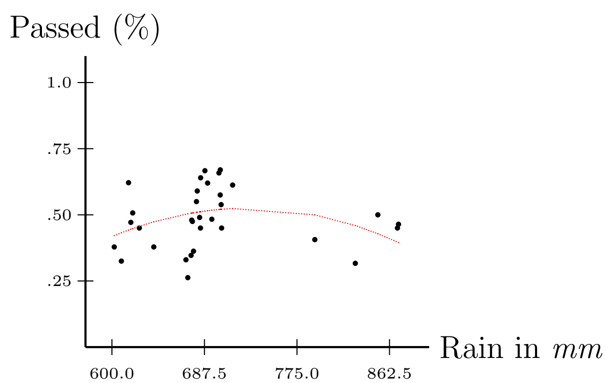


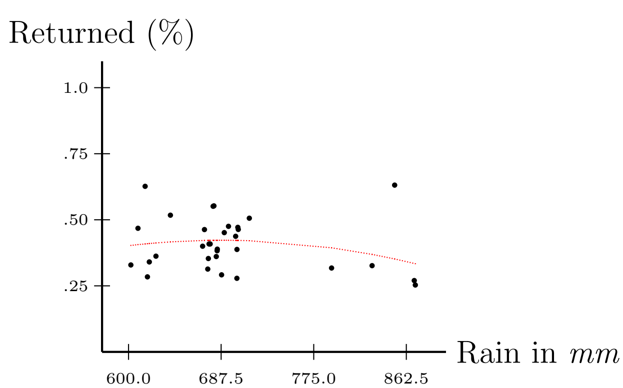
Figure 1. Communities visited along hurricane Mitch path



Dictators



Senders



Responders

Figure 2. Rainfall and Community Level Behavior

Table 1. Linear regressions estimates of the effect of rain on economic variables

VARIABLES	Weakly Consumption Expenses (L./)	Value of Assets (L./)	Value of Aid (L./)
Rain in Oct 1998 (cm×10)	-2.76**	-18.07***	-3.43
	(0.044)	(0.001)	(0.376)
Rain in Oct 1998 squared (cm×10)	0.20**	1.24***	0.35
	(0.037)	(0.000)	(0.198)
Male	-0.14*	-0.20	1.17***
	(0.074)	(0.540)	(0.005)
Years of age	-0.01***	0.00	0.03**
	(0.003)	(0.873)	(0.038)
Primary Ed.	0.17	0.16	0.19
	(0.114)	(0.621)	(0.406)
Secondary Ed.	0.63***	1.86***	0.45
	(0.000)	(0.000)	(0.132)
Family size	0.06***	0.13***	0.07
	(0.001)	(0.004)	(0.106)
Assets before hurricane (L./)	0.08***	0.70***	-0.02
	(0.000)	(0.000)	(0.772)
Constant	13.94***	63.81***	5.29
	(0.007)	(0.001)	(0.696)
Observations	834	834	834
R-squared	0.16	0.24	0.14

Clustered errors at the municipality level, p-values in parentheses

*** $p<0.01$, ** $p<0.05$, * $p<0.10$

Table 2. Descriptive Statistics

	Communities	2001 Population Census				2002 Experimental Study			
Province	Visited	N[a]	Age[b]	%Men	Education[c,d]	N[e]	Age[b]	%Men	Education[b,d]
Colon	4	361.0	37.9	49%	1.9	24.5	46.7	62%	1.1
Comayagua	12	79.2	37.5	49%	1.9	22.0	39.9	50%	1.1
Intibuca	4	88.3	36.7	51%	1.7	20.5	39.1	56%	0.8
Ocotepeque	7	240.4	38.0	50%	2.0	25.4	39.5	72%	1.1
Santa Barbara	3	83.0	38.9	56%	1.9	24.7	44.3	64%	0.7

[a]Average number of households per community, [b]conditional on being older than 18 years of age,[c]all ages, [d]0=no education,1=Grade School,2=High School,3=college, [e]Average number of subjects per session

Table 3. Descriptive Statistics for Shares Sent and Returned

	Dictator	Trustor	Trustee
N	389	389	336*
Mean	42%	49%	41%
Std. Deviation	30%	29%	29%
% who sent no money	7%	4%	7%
% who sent all the endowment	12%	13%	12%

* some data was lost due to miscoding

Table 4. Linear regression estimates of the effect of rainfall on individual decisions

	Amount Passed			
VARIABLES	Dictator	Sender	Responder	Responder
Rain in Oct 98 (cm×10)	2.640	3.583***	3.250***	4.091***
	(0.148)	(0.008)	(0.004)	(0.001)
Rain in Oct 98 squared (cm×10)	-0.179	-0.241***	-0.219***	-0.276***
	(0.139)	(0.009)	(0.004)	(0.001)
Average monthly rain (cm×10)	3.512	0.701	-6.381	-6.688
	(0.672)	(0.888)	(0.413)	(0.434)
Average monthly rain sq. (cm×10)	-0.966	0.029	2.202	2.349
	(0.712)	(0.985)	(0.367)	(0.378)
Amount Received				-0.002***
				(0.004)
Constant	-12.300*	-13.831***	-6.944	-9.786*
	(0.078)	(0.010)	(0.183)	(0.091)
Observations	384	384	367	367
R-squared	0.047	0.038	0.023	0.073

Clustered errors at the community level, p-values in parentheses

*** p<0.01, ** p<0.05, * p<0.10

Table 5. Linear regression estimates of the effect of rainfall on individual decisions

	Amount Passed			
VARIABLES	Dictator	Sender	Responder	Responder
Rain in Oct 98 (cm×10)	1.735	2.919***	1.855	2.474**
	(0.243)	(0.006)	(0.154)	(0.044)
Rain in Oct 98 squared (cm×10)	-0.118	-0.195***	-0.122	-0.163*
	(0.227)	(0.006)	(0.167)	(0.051)
Average monthly rain (cm×10)	0.668	1.227	-8.197	-9.268
	(0.929)	(0.796)	(0.236)	(0.170)
Average monthly rain sq. (cm×10)	-0.131	-0.213	2.619	3.005
	(0.956)	(0.886)	(0.221)	(0.151)
Years of age	0.002**	0.001	-0.001	-0.001
	(0.041)	(0.332)	(0.664)	(0.718)
Male	0.060	-0.016	0.017	0.004
	(0.132)	(0.654)	(0.657)	(0.900)
Primary education	0.081	0.023	0.010	0.026
	(0.101)	(0.707)	(0.868)	(0.631)
Secondary education	0.017	-0.066*	-0.045	-0.054
	(0.709)	(0.054)	(0.483)	(0.358)
Family size	0.003	-0.003	-0.007	-0.005
	(0.607)	(0.553)	(0.237)	(0.286)
People known by name	0.135**	0.178***	-0.036	-0.043
	(0.032)	(0.006)	(0.590)	(0.536)
Poor	-0.053*	-0.042	-0.011	-0.007
	(0.057)	(0.298)	(0.800)	(0.868)
Distance to Municipality	-0.002**	-0.002**	0.000	0.000
	(0.037)	(0.025)	(0.867)	(0.682)

Clustered errors at the community level, p-values in parentheses

*** p<0.01, ** p<0.05, * p<0.10

(continue in next page...)

Table 5. Linear regression estimates of the effect of rainfall on individual decisions (continuation...)

	Amount Passed			
VARIABLES	Dictator	Sender	Responder	Responder
Altitude	-0.000	-0.000	0.000	0.000
	(0.274)	(0.474)	(0.384)	(0.218)
Urban	0.004	0.075	0.053	0.032
	(0.917)	(0.107)	(0.226)	(0.500)
Amount Received				-0.002***
				(0.001)
Room level averages, order and experimenter controls	Yes	Yes	Yes	Yes
Constant	-6.035	-11.247***	-0.349	-1.777
	(0.235)	(0.009)	(0.961)	(0.795)
Observations	351	351	331	331
R-squared	0.245	0.185	0.066	0.135

Clustered errors at the community level, p-values in parentheses

*** $p<0.01$, ** $p<0.05$, * $p<0.10$

Table 6. Interquantile regression of the effect of rainfall on individual decisions

	Amount Passed			
VARIABLES	Dictator	Sender	Responder	Responder
Rain in Oct 98 (cm×10)	3.062	6.270***	6.235**	6.223**
	(0.269)	(0.005)	(0.036)	(0.012)
Rain in Oct 98 squared (cm×10)	-0.212	-0.422***	-0.413**	-0.416**
	(0.248)	(0.005)	(0.039)	(0.014)
Average monthly rain (cm×10)	12.729	6.053	-18.008	-15.021
	(0.334)	(0.640)	(0.268)	(0.211)
Average monthly rain sq. (cm×10)	-3.805	-1.530	5.909	4.996
	(0.362)	(0.708)	(0.250)	(0.186)
Amount received				-0.001
				(0.117)
Controls as in Table 5	Yes	Yes	Yes	Yes
Constant	-21.247***	-28.231***	-8.991	-11.327
	(0.010)	(0.001)	(0.443)	(0.306)
Observations	351	351	331	331
Pseudo-R2	0.0979	0.1048	0.0788	0.0993

p-values in parentheses

*** p<0.01, ** p<0.05, * p<0.10

Table 7. Linear regression estimates of the effect of rainfall on individual decisions

	Percent Sent				
VARIABLES	Trust Game - Sender				
	Oct 1998	Oct 1988	Oct 1978	Oct 1968	Oct 1958
Rain in Oct (cm×10)	2.754***	-0.075	0.136	0.595	0.415***
	(0.006)	(0.525)	(0.372)	(0.210)	(0.002)
Rain in Oct. squared (cm×10)	-0.184***	0.011	-0.032	-0.085	-0.059***
	(0.007)	(0.768)	(0.283)	(0.356)	(0.003)
Average monthly rain (cm×10)	0.825	7.356*	2.165	0.675	-3.160
	(0.864)	(0.085)	(0.682)	(0.879)	(0.401)
Average monthly rain sq. (cm×10)	-0.102	-2.331*	-0.722	-0.207	1.065
	(0.946)	(0.079)	(0.657)	(0.881)	(0.362)
Amount Received					
Constant	-10.338**	-4.850	-0.851	-0.672	2.513
	(0.018)	(0.148)	(0.839)	(0.849)	(0.383)
Observations	351	351	351	351	351
R-squared	0.181	0.173	0.173	0.181	0.197

Clustered errors at the community level, p-values in parentheses.

All regression include the same controls as in Table 5.

*** p<0.01, ** p<0.05, * p<0.10

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Table 7. Linear regression estimates of the effect of rainfall on individual decisions

VARIABLES	Percent Returned Trust Game - Receiver				
	Oct 1998	Oct 1988	Oct 1978	Oct 1968	Oct 1958
Rain in Oct (cm×10)	2.474**	-0.005	0.438*	0.037	0.069
	(0.044)	(0.971)	(0.053)	(0.958)	(0.628)
Rain in Oct. squared (cm×10)	-0.163*	0.008	-0.087*	0.007	-0.006
	(0.051)	(0.861)	(0.056)	(0.960)	(0.773)
Average monthly rain (cm×10)	-9.268	-1.584	-6.806	-2.654	-4.970
	(0.170)	(0.791)	(0.238)	(0.612)	(0.397)
Average monthly rain sq. (cm×10)	3.005	0.432	2.021	0.782	1.504
	(0.151)	(0.812)	(0.256)	(0.628)	(0.407)
Amount Received	-0.002***	-0.002***	-0.002***	-0.002***	-0.002***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Constant	-1.777	1.732	5.478	2.423	4.306
	(0.795)	(0.730)	(0.240)	(0.575)	(0.375)
Observations	331	331	331	331	331
R-squared	0.135	0.124	0.130	0.126	0.127

Clustered errors at the community level, p-values in parentheses.

All regression include the same controls as in Table 5.

*** p<0.01, ** p<0.05, * p<0.10

(continuation)

Table 8. Linear regression estimates of the effect of rainfall on survey questions

	Trust others...		Organizations		Informal relationships		
VARIABLES	much money	little money	All	Local government*	Number of close friends	Help contacts	Relative help contacts
Rain in Oct 98 (cm×10)	3.917	6.366**	-18.090**	-5.372*	20.648	12.327*	11.730**
	(0.186)	(0.027)	(0.018)	(0.086)	(0.163)	(0.085)	(0.019)
Rain in Oct 98 sq. (cm×10)	-0.266	-0.434**	1.218**	0.366*	-1.423	-0.803*	-0.789**
	(0.187)	(0.026)	(0.016)	(0.079)	(0.153)	(0.097)	(0.018)
Other controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	-4.132	-22.637*	52.592**	14.744	-182.371***	18.339	-24.593
	(0.683)	(0.063)	(0.044)	(0.218)	(0.001)	(0.461)	(0.171)
Observations	683	681	578	578	668	531	531
R-squared	0.178	0.178	0.162	0.192	0.061	0.107	0.131

Clustered errors at the community level, p-values in parentheses. All regression include the same controls as in Table 5.

Number of observations varies due to item non-response.

* Local government and producers' associations.

*** $p<0.01$, ** $p<0.05$, * $p<0.10$