Social Capital, Trust, and Adaptation to Climate Change: Evidence from Rural Ethiopia

Christopher Paul[1], Erika Weinthal[2], Marc Bellemare[3], Marc Jeuland[4]
[1]Corresponding Author: cjp2@duke.edu; Phone: +1-919-260-0638; Fax: +919-681-7748
Nicholas School of the Environment, Duke University, Box 90328, Durham, NC 27708 USA
[2] Nicholas School of the Environment, Duke University, Box 90328, Durham, NC 27708 USA; weinthal@duke.edu
[3]Department of Applied Economics, University of Minnesota, 1994 Buford Avenue, St. Paul, MN 55108 USA; mbellema@umn.edu
[4]Sanford School of Public Policy, Duke University, Box 90239, Durham, NC 27708 USA, and Institute of Water Policy, Lee Kwan Yew School of Public Policy, National University of Singapore; marc.jeuland@duke.edu

Abstract

Climate change is expected to have particularly severe effects on poor agrarian populations. Rural households in developing countries adapt to the risks and impacts of climate change both individually and collectively. Empirical research has shown that access to capital—financial, human, physical, and social—is critical for building resilience and fostering adaptation to environmental stresses. Little attention, however, has been paid to how social capital generally might facilitate adaptation through trust and cooperation, particularly among rural households and communities. This paper addresses the question of how social capital affects adaptation to climate change by rural households by focusing on the relationship of household and collective adaptation behaviors. A mixed-methods approach allows us to better account for the complexity of social institutions—at the household, community and government levels—which drive climate adaptation outcomes. We use data from interviews, household surveys, and field experiments conducted in 20 communities with 400 households in the Rift Valley of Ethiopia aimed at eliciting trust and risk preferences. Our results suggest that qualitative measures of trust predict contributions to public goods, a result that is consistent with the theorized role of social capital in collective action. Yet qualitative trust is negatively related to private household-level adaptation behaviors, which raises the possibility that social capital may, paradoxically, be detrimental to private adaptation. Policymakers should account for the potential difference in public and private adaptation behaviors in relation to trust and social capital when designing interventions for climate adaptation.

Keywords: Climate Change; Trust; Social Capital; Adaptation; Ethiopia

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1. Introduction

Climate change is expected to have a profound impact on livelihoods around the world by causing more severe weather events, rising sea levels, and higher average temperatures (IPCC, 2014). Building resilience to climate change depends upon improving existing options for adaptation, especially among vulnerable populations, such as poor rural households in developing countries. Those households adapt to the risks and impacts of climate change in many ways, both individually and collectively (Adger, 2003; Tompkins and Eakin, 2012). The ability of households and their communities to adapt, however, is conditioned by a myriad of factors that are often in short supply for rural households, including access to financial, human, physical, and social capital. While access to all types of capital is critical for building resilience and fostering adaptation to environmental stresses, little attention has been paid to the role of social capital which, following Ostrom and Ahn (2003), we define as the value of relationships that facilitates cooperation and collective action through trust. In the absence of other forms of capital, social capital is particularly important for promoting adaptation to new threats from climate change by furthering cooperation and collective action.

This paper addresses the question of how social capital affects adaptation at the household and community levels in poor rural communities in developing countries. Specifically, we (i) assess the role of social capital in poor, rural communities in the Ethiopian Rift Valley, (ii) test multiple survey and experimental measurements of social capital both qualitative

and quantitative, and (iii) evaluate the relationship of our various measures of social capital to individual household and collective community adaptation behaviors.

Although scholars have recognized the potential importance of social capital, most work on the role of social capital in adaptation to date has been theoretical or based on case studies or small samples (Adger, 2003; Pelling and High, 2005; Wolf et al., 2010). The gap in applied research on this relationship is evident in reports from the Intergovernmental Panel on Climate Change that state "the capacity for collective action is a critical determinant of the capacity to adapt to climate politics," yet only have evidence for the loss of social capital in conflict (Adger et al., 2014). Empirical work on this topic is particularly challenging because social capital and climate adaptation are both complex phenomena with a variety of potential mechanisms and effects (Adger et al., 2005; Ostrom and Ahn, 2003). Furthermore, there is limited work on how social capital relates to adaptation behaviors. Most of the empirical literature focuses on the positive benefits arising from social relationships and trust while ignoring the possibility that the complexity of mechanisms and scales of social capital may in some cases reveal a "dark side of social capital" (Bagnasco, 2008; Deth and Zmerli, 2010; Portes, 1998) which promotes negative outcomes for certain groups.

The levels and methods for measuring key variables may also have an influence on the relationships between trust, social capital, and outcomes. For example, trust can be measured using surveys (by asking about trust in general or about trust in the context of specific transactions) and experimental approaches (by simulating trust-based

transactions and rewarding subjects accordingly). The measurements obtained using these different methods may not be consistent with one another, and may be differentially influenced by a variety of other characteristics that also affect adaptation (Bouma et al., 2008; Naef and Schupp, 2009; Ostrom, 2005). In addition, alternative measures may only be relevant to one or more specific levels—individual, household, and community—of social capital and adaptation (Smit and Wandel, 2006; Tompkins and Eakin, 2012).

In order to better test empirically the relationship between social capital and trust at the household and community levels, and climate change adaptation, we combine multiple methods of data collection, including semi-structured interviews, surveys, and field experiments. This mixed-methods approach allows us to better account for the complexity and scales at which alternative institutions influence climate adaptation behaviors (Adger et al., 2005; Poteete et al., 2010; Vaccaro et al., 2010), and to consider the relevance of different measures of trust and social capital.

Our analysis suggests that these different measures may be indicative of different constructs, and it reveals that survey measures of trust are more strongly related to observed behaviors. We also find evidence of a mixed effect of social capital in climate adaptation: social capital is associated with increased cooperative outcomes, but also with reduced private household-level adaptation.[1] Though our analysis can obviously not

[1] Throughout the paper, we use the term "private adaptation" to refer to household-level adaptation, noting that some of these household-level behaviors do involve limited cooperation with other households (e.g., sharing of tools). Community-level or "public

identify causal relationships between various measures of social capital and adaptation to climate change, our results raise the possibility that social capital may, paradoxically, be detrimental to private adaptation, depending on which effect dominates in household behavior.

The remainder of this paper is organized as follows. We begin in section 2 by describing climate adaptation and defining the phenomenon of social capital and its mechanisms in the next section. In section 3, we describe our study site in the rural Rift Valley of Ethiopia, and the specific methods used to evaluate social capital and adaptation. Next, we provide a description of the data in section 4 and, in section 5, we discuss our results in testing of each of the hypotheses, showing that while social capital is important in collective adaptation activities, it is negatively related to private household adaptation. We then conclude in section 6 with potential policy implications and directions for future research.

2. Climate adaptation, social capital, and collective action

Climate adaptation, "the process of adjustment to actual or expected climate and its effects" (IPCC, 2014), is a process that is both bio-physical and human. While humans have always needed to respond to a changing environment, the current period of global climate change strains human capacity for adaptation because of the combined rapidity and severity of the changes it entails. Individuals must make complex decisions about adaptation that determine the consequences of climate change for livelihoods under increasing

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adaptation" behaviors represent contribution or participation in the provision of community-level public goods.

uncertainty, for example that arising from water availability, variability in crop yields and greater extremes of natural disasters. By definition, constraints on adaptation, which are a function of financial, human, and other forms of capital, would appear highest for disadvantaged communities.

Adaptation occurs at individual, household, community, and larger institutional scales (Adger et al., 2005). In this paper, we consider three potential levels of adaptation: household, community, and government. At the private household level, adaptation takes forms such as technology adoption, migration, or changes in livelihoods. Community level adaptation may occur through collective action, the ability of a group to achieve a common interest, and the provision of public goods (Olson, 1971; Poteete et al., 2010; Tompkins and Eakin, 2012). Collective action facilitates the pooling of resources, knowledge, and efforts for community responses. We treat collective action as a broad description of cooperative interaction. External interventions such as government programs and interventions can affect adaptation, with or without the input of households and communities, but do not always benefit rural areas because of the lack of infrastructure or state reach, the ability of governments to implement programming and exert power (e.g., Herbst, 2000). The degree of cooperation in rural areas is thus potentially more important in determining outcomes.

Explanations for the emergence of collective action have focused on factors such as group size, leadership, and incentives (Olson, 1971), but the value of cooperative social relations and how precisely they emerge remains critical and unclear (Ostrom, 1994; Ostrom and Ahn, 2003). Theories of social capital arose out of work such as that of Pierre Bourdieu

investigating the resources of social networks and the function of social structures by James Coleman (Bourdieu, 1986; Coleman, 1988; Portes, 1998). These theories have been further developed and applied to diverse fields including economic activities, sustainable development, and natural resource management (Dale and Newman, 2010; Dale and Onyx, 2010; Fukuyama, 1995; Pretty and Ward, 2001). Ostrom and Ahn (2003), moreover, specify three components of social capital: institutions, social networks, and trustworthiness. Institutions are the social, economic, and political "rules of the game" that govern interactions (North, 1990); they mediate relationships, and thus influence the outcomes of individual and collective behavior (Agrawal, 2009). Opportunities for cooperation thus arise from the web of relationships that make up social networks (Ostrom and Ahn, 2003). The relationships in these networks are commonly classified as: bonding, the close ties within a group; bridging, the ties between groups; and linking, the vertical relationships across hierarchies (Szreter and Woolcock, 2004; Woolcock, 2001). Dense and stable networks facilitate generalized reciprocity and "trustworthiness," which are all characteristics that facilitate trust (Putnam et al., 1993).

Trust, the confidence that others will act on commitments reliably and with reciprocity, is a core mechanism of social capital for collective action (Ostrom and Ahn, 2003; Putnam, 2001). Trust is dependent upon characteristics of individuals and their setting, including institutions, the nature and extent of social networks, and individual characteristics. Trust may also be related to an individual's tolerance for risk, since trusting another individual may in many cases carry risks (Schechter, 2007). In the face of threats from climate change, trust affects households' confidence that they can rely on others for resource sharing,

conflict resolution, and sustained cooperation. As a result, higher trust may enhance opportunities for adaptation (Adger, 2003).

As an example, the sharing of farm equipment can help illustrate the nature of relationships between trust and social capital. In many situations, farmers may have short-term demand for more physical capital than they personally own. Individuals who are well endowed with such physical capital must decide whether to loan or lease farming equipment to their neighbors, a decision that is influenced by multiple aspects of social capital, including bonding social capital and trust. Bonding social capital helps groups leverage their resources more effectively by sharing risk and cost (Woolcock and Narayan, 2000). Here, trust functions to aid the lender or lessor to make a decision based on a history of past interactions with the potential borrower (i.e., his or her trustworthiness) (Fafchamps, 2004; Platteau, 2000, 1994a, 1994b), on his own perceptions, or on other community members' perceptions of the borrower's trustworthiness. Thus, social networks may contribute information about agents' trustworthiness, and may provide recourse in the event that the terms of the transaction are violated. Meanwhile, existing institutions structure transactions, for example by specifying the time over which a loan is allowed, the conditions of enforcement of the agreement (e.g. returning the equipment on time), or the terms of reciprocity.

When faced with environmental threats, such as worsening growing conditions, farmers must draw upon social capital, among other forms of capital, to cope. For example, if additional labor and tools are needed for terracing a field to cope with stronger rainstorms,

a farmer must determine information about best practices and find other people to contribute, by hiring them or leveraging social relationships. In the example, these network relationships mediate opportunities for information, such as new or best practices. Bridging social capital allows information to be shared between groups. Confidence in information can be determined by linking social capital across vertical levels to government or outside agencies. Ultimately, groups of high bonding social capital can act upon this knowledge. The sharing of information promotes adaptation by combining the human capital of knowledge with the social capital of networks (Falco and Veronesi, 2013a). Trust is, moreover, essential for assessing and acting upon shared information (Creech and Willard, 2001). Finally, adaptation occurs through cooperation and collective action supported by social capital. Community-level adaptation may also depend upon external factors, such as government institutions and programming, which could complement or offset the effect of social capital.

Social networks specifically serve multiple types of functions for adaptation and collective action, as networks can be horizontal between peers within a community, or vertical across hierarchies (Putnam et al., 1993). Particularly when higher-level (e.g. state-level) institutions are absent, the networking function of social capital supports local institutions and collective action responses that are needed for addressing community challenges, including those arising from shocks or crises (Adger, 2003; Bratton, 1989; Platteau, 1994a, 1994b). Thus, the value of social networks is in both facilitating trustworthiness and contributing to the possibility of accessing different (and perhaps collective) resources through multiple venues (Woolcock and Narayan, 2000).

Social capital does not necessarily have universally positive effects or serve as insurance mechanisms against adverse shocks. Social capital may be ineffective if there is a general lack of resources or knowledge of effective solutions. In this sense, the community may be the inappropriate scale of action necessary to adapt; rather, adaptation could depend primarily on choices made by the individual household (e.g., migration) or by the state (e.g., aid programming). Trust may not be enough to overcome the transaction costs for collective action. There also may be a "dark side of social capital" (Deth and Zmerli, 2010), in which strong social institutions can generate negative outcomes or overpower formal legal institutions, as in the case of the mafia (Gambetta, 1988). Groups may be isolated and made less diverse by a process of homophily, the tendency of groups to become more similar, reducing valuable bridging social capital between groups (Newman and Dale, 2007). Decisions involving trust and social capital may also be governed by other decision-making characteristics such as risk preferences (Schechter, 2007). In other words, an individual's propensity to trust may be partially governed by her willingness to take risks.

Finally, it is important to distinguish between social capital of households within communities, and bridging (vertical linking) of social ties beyond communities. Bridging social capital can help link individuals and households to new ideas and resources beyond their community, by either substituting or complementing the role of the state (Adger, 2003). In adaptation, communities that organize and cooperate can better access external support (Karlsson and Hovelsrud, 2015). These types of links can enhance connection with outside organizations and government officials, generating better provision of resources.

We hypothesize that social capital influences the ability of households to respond to change. This is because the constituent parts of social capital, and access to collective action processes, influence the quality and set of options (or constraints) that households face when threatened by climate change. Specifically, trust should be associated with collective action and increased adaptation behaviors, perhaps due to information sharing, knowledge mobilization, and resource coordination. Households with higher levels of trust are likely to possess more social capital and are hypothesized to undertake more adaptation activities.

3. Study Site and Methods

3.1 Study Location

Ethiopia is one of the fastest growing economies in the world, averaging over 10% annual growth in gross domestic product since 2004. Yet, Ethiopia remains a predominantly poor and rural country, with a national average per capita income of $470 and a population that is 84% rural (The World Bank, 2014a, 2014b). Throughout rural Ethiopia, farmers typically use labor-intensive agricultural methods and practice subsistence farming, as most farms are rain-fed and yields are accordingly low (Mengistu, 2006). These factors, coupled with extreme and increasing climate variability, suggest a high degree of potential vulnerability to climate change, especially in drought-prone rural areas such as the Rift Valley (*Notre Dame Global Adaptation Index*, 2014). The effect of climate change on water supplies in this region could be quite significant (Legesse et al., 2003). The 13 million people living in this

region are primarily smallholder and herder households, and have minimal access to financial capital and outside resources for coping with such disruptions.

This study spans 20 villages located in four *woredas* (i.e., districts) of the Ziway-Shala lake basin; communities in this zone share common hydrological and agricultural conditions. The study communities are small and relatively isolated, and mostly homogenous in religious and ethnic make-up. The final sample consists of 20 randomly selected households from each of these communities, for a total of 400 households.

We chose the Ethiopian Rift Valley to study adaptation because the region's rural population is already experiencing (and responding to) significant stresses due to extreme climate variability, the effects of which are likely to become more pronounced in the future (Kassie et al., 2013). In rural Ethiopia, climate change has been linked to reduced income; in the absence of adaptation, further decline in household income is likely to occur (Deressa and Hassan, 2009). Moreover, the semi-arid lowlands of the Rift Valley are similar to many other sub-Saharan locations that are facing or expected to face new threats from climate change (Niang et al., 2014).

3.2 Data Collection Strategy

The villages in our sample were selected using a stratified method. Half of the villages were selected from all 5936 villages within the study area, and half were randomly selected from a list of 50 sites with known poor water quality. This sampling process comports with a separate study on water quality and health in this region and builds upon prior research

(Kravchenko et al., 2014; Rango et al., 2012). Within each sample community, we used a structured field counting randomization method to select 20 households within a two-kilometer radius of the community center. In each selected household, we interviewed both the male and female household head whenever possible. Data collection occurred primarily during the month of February, which is immediately post-harvest for teff and maize, the primary crops in the area.

The first element of the data collection was semi-structured interviews, which establish the institutional conditions for adaptation and resource management and also provide context for understanding the survey and experimental data. Specifically, we interviewed community representatives in each of our 20 villages, as well as regional government officials located at the *woreda*-level, with a set of guiding questions and allowing open-ended responses. Local interviews were complemented by interviews with officials from the central government, foreign donors, and nongovernmental organizations (NGOs). The second data collection component comprises surveys conducted with the 400 selected households. The third component of data collection consisted of field experiments. Specifically, following Schechter (2007) and Tanaka et al. (2010), we played investment and risk games developed to measure individual trust and risk preferences with a male and female member of each household in our sample. These are described in more detail in the following section.

The Duke University Institutional Review Board approved the study and experimental game protocols. All respondents provided informed consent prior to participation in the study. The confidentiality and anonymity of survey respondents has been maintained.

3.3 Measures of Social Capital, Trust, Collective Action, and Adaptation

The multiple data collection activities provide us with a rich set of empirical measures of trust and social capital constructs, and of collective action and agricultural adaptation outcomes. Survey questions corresponding to our key variables are listed in Table 1.

3.3.1 Trust

We measure trust through surveys and experimental games. In the survey, we use standardized questions from the General Social Survey (Smith, Marsden, Hout, & Kim, 2011). The specific wording of our survey questions is listed in Table 1. Previous research has indicated that this survey measure of trust, albeit imperfect, is relatively stable and comparable with real world behavior (Glaeser et al., 2000).

The experimental games' measure of trust relies on the investment game, a tool that has been widely used and tested in field experiments (Berg et al., 1995; Ostrom and Walker, 2003). Our design closely follows the model of Schechter (2007), combining a risk game with a trust game in which participants invest and entrust a sum of actual money with another participant. A key advantage of this field experimental methodology is that participants have the potential to earn real money, which is thought to induce truthful revelation of preferences and beliefs as compared to hypothetical payoffs.

The trust experimental game is played in a group with household heads who participated in the survey. Approximately three quarters of household heads participated in the game. As described further below, there were no systematic demographic differences between those who participated and those who did not. Each participant is randomly assigned to an anonymous partner, and both partners play the role of sender and receiver. Groups for the trust game were separated by gender because small-scale financial transactions in the study communities, such as interpersonal loans, are often segregated by gender. To play the first role (sender), each participant is given an initial endowment of 10 Birr (approximately 0.50 USD, or 25% of a day's wage in this region). The sender is then told that she can choose to anonymously send none, some, or all of the initial endowment to another anonymous receiver in the group. She is also told that any amount sent will be tripled, and that some of the money sent could then be returned, depending on what the receiver decides to do with it. The sent amount is placed in an envelope with a facilitator, who triples the sum in view of the sender. In the second stage, these envelopes are randomly mixed, and each participant is given a different envelope (not her own). At this point, each individual plays the receiver role, and decides what proportion to return to the original sender. Envelopes with the returned sum are then given back to the original sender.

We also implemented an experimental procedure following Schechter (2007) and Tanaka et al., (2010) to elicit risk preferences with the same individuals who participated in the trust games. In the risk experiment, respondents choose between binary lotteries (of

known probability and outcomes) to measure parameters establishing the shape and concavity of the individual's value function, and the degree of loss aversion (Liu, 2013; Tanaka et al., 2010). By including these risk measures in our analyses, we can ensure that behavior we ascribe to trust is not the result of underlying risk preferences.

3.3.2 Community Adaptation

We evaluate community adaptation activities by asking households in the surveys about their participation and contribution to community improvements and public goods, such as water source maintenance and construction of community water harvesting. In interviews, we also asked about communal activities and organization. In our regression analysis, the dependent variable "community participation" is a binary variable from the survey question "Do you or any members of your household participate in any activities for improving your community (outside the immediate limits of your house)?" The dependent variable "community contribution" is a binary variable from the survey question "Does your household contribute to village activities or services with money or other donations in the past year?"

3.3.3 Private Adaptation

Private adaptation behaviors were measured directly and indirectly in the survey. We asked households detailed questions about specific changes made to agricultural practices and crops in recent years. Adaptation across multiple behaviors is likely critical for success (Falco and Veronesi, 2013b). Given that there are a variety of different adaptation behaviors reported by households, we constructed indices of these, using a simple count method and principal component analysis (PCA) on polychoric correlations (Kolenikov and

Angeles, 2004). In the main regression analysis on private adaptation, we use two specifications of the dependent variable. The "adaptation index" is a simple count (sum) index of twelve adaptation behavior categories, including: Proportion of different crops; Type of seed (traditional vs. improved); Timing of planting; Timing of harvest; Method of farming; Number of livestock; Amount of crops; Farm equipment/assets; Work for income outside the farm; Change total area harvested; Fertilizer use; and, Other. The "adaptation PCA index" is a principal component analysis index of these twelve adaptation behavior categories. The result of the principal component analysis is also presented in the appendix (Tables A7-A8).

3.3.4 Control Variables

A number of socioeconomic and demographic characteristics are likely to be important in adaptation behaviors, namely wealth in the form of assets, animals (i.e. livestock), and land; income; household size and the ratio of dependents; and individual characteristics of the household head, including gender, age, education, and marital status. We thus control for these variables in our regressions.

3.4 Hypotheses and analytical methods

We make the following hypotheses:

> H1. If communities and households have limited access to and support from government institutions, then there should be more household and community-level adaptation than government-led adaptation.
>
> H2. There is a positive association between survey and experimental game measures of trust.

H3. There is a positive association between trust and adaptation for households because trust increases exposure to new and tested adaptation options, and for communities because it facilitates collective action.

We analyze H1 using qualitative data from local interviews with community representatives of the institutions relevant to social capital and climate adaptation. This analysis provides context for the household-level and community-level adaptation hypotheses. We evaluate transcribed interviews for dominant themes, which include community concerns, climate change awareness, conflict related to environmental factors, and a particular focus on water. We also study the village interviews to deepen insights on the types of changes from year to year within and between villages.

We analyze H2 and H3 using linear regression using household survey and field-experimental data. We control for individual characteristics, socioeconomic covariates at the household level and cluster the standard errors of all estimates at the village level. Village fixed effects control for unobserved heterogeneity among villages. In the trust experiment analyses, we additionally control for the risk preference parameters.

To test H2, i.e., that there is a positive association between experimental measures of trust—in terms of proportion of money sent by individual i (A_i)—and the binary survey measures of individual trust ($X_{1,i}$), we estimate the model in equation (1), where the other controls include individual risk preferences ($X_{2,i}$), individual characteristics ($X_{3,i}$), a vector of controls for household j (W_j), and fixed effects for each distinct village k (Z_k):

$$A_i = \alpha + \beta_1 X_{1,i} + \beta_2 X_{2,i} + \beta_3 X_{3,i} + \delta W_j + \gamma Z_k + \varepsilon_i \quad (1)$$

For H3, i.e., that there is a positive association between adaptation at both the community and household levels (Y) and trust ($X_{1,i}$), we evaluate the model shown in equation (2), where we again control for individual risk preferences ($X_{2,i}$), individual characteristics ($X_{3,i}$), household level characteristics (W_j), and include village fixed effects (Z_k):

$$Y_i = \alpha + \theta_1 X_{1,i} + \theta_2 X_{2,i} + \theta_3 X_{3,i} + \zeta W_j + \upsilon Z_k + \eta_i \varepsilon_i \quad (2)$$

We reiterate, however, that our analysis of observational and field-experimental data can only estimate partial correlations between these parameters and adaptation outcomes. In other words, the usual sources of statistical endogeneity, viz. reverse causality or simultaneity, measurement error, and unobserved heterogeneity, are all likely to compromise the causal identification of the parameters of interest in equations 1 and 2.

4. Data

For our regression analysis, we use household survey data from 400 households, and risk and trust experiments with 614 male and female household heads from households who participated. The qualitative data used in this paper includes interviews with local representatives in each of the 20 villages across the three waves (2012, 2013, 2014), for a total of 51 interviews (nine villages are missing one of the waves because a representative was unable to be contacted; but all villages have at least two waves of interviews).

Villages in our study had an average population of approximately 2000 people. Households had on average of 6.3 members (adults and children), with a mean per capita income of 2623 Birr (USD 137), far below the Ethiopian average of 8995 Birr (USD470) (The World Bank, 2014b). Eighty-nine percent of study households are Oromo, the most populous language group in Ethiopia, and 51 percent of households are Muslim (as compared to 34% nation-wide (CIA, 2015)). Households cultivate on average 3.4 hectares of land. The primary crops were maize, wheat, and teff. A summary of key statistics is reported in Table 2.

As described above, we use a variety of survey questions to assess social capital characteristics. Respondents indicated high levels of community participation, especially in collective activities: 93% of households said they regularly participated in activities to improve the community. Nearly 80% of households reported participating in a community meeting within the two weeks preceding the survey. Fourteen percent of households indicated being active members of religious groups, with about equal participation among Christians and Muslims. Another measure for assessing cooperative behavior is the sharing of resources or labor. Just over half (52%) of households share farming equipment. About 78% of respondents indicate that they expect a loan to be repaid when it is given to others.

Regarding trust, 40% of all individual male and female respondents reported that most people in their village can be trusted, while 23% reported that people cannot be trusted (and the remaining proportion indicate that "it depends"). This level of trust is higher than a 2007 World Values Survey in Ethiopia, which found 21% of respondents stating that most

people can be trusted, as well as a global meta-analysis estimate of 32% (Johnson and Mislin, 2012; WVS, 2014). In our sample, as with the World Values Survey results, males were slightly more likely than females to report trusting others in their village (44% vs. 37%, t-test $p<0.05$). In addition, most respondents (61%) said that it was not at all likely that a neighbor would return lost money (e.g. 100 Birr), but only 40% said it was not at all likely a neighbor would return a lost hen (an animal having similar value), which may indicate varying norms for different items, or may reflect challenges in monitoring ownership of less identifiable assets such as money. These rates did not vary substantially by religion. The sizable group of respondents reporting low trust of others may indicate a significant challenge to collective action and social insurance in these communities.

Our field-experimental approach allows for a different way to evaluate trust among study participants. The main results from the investment game are presented in Figure 1. The average proportion of the initial endowment that was sent by players in the first stage was 0.43. This was somewhat higher than the average proportion returned, 0.34, though the average cash amount returned was similar due to the tripling of the amount sent. Men, on average, sent and returned slightly higher amounts than women ($p<0.01$). The average proportion initially sent was 0.47 for males and 0.39 for females, while the average proportion returned was 0.37 for males and 0.31 for women ($p<0.01$). Senders in the first round also showed a strong tendency to send half of the sum, a common anchor identified in these types of games. The correlation of the proportion sent in the first round to the proportion returned in the second round is 0.38. These results are similar to those found by Schechter (2007) in Paraguay. We would expect there to be a relationship between the

"trust" behavior in sending the initial investment, and the "trustworthy" behavior of the altruistic return, but should not expect these parameters to be fully correlated.

4.1 Construction of the final analytical sample

To avoid analyzing outcomes across different samples, our final analytical sample for regression includes 360 household heads of the 400 households in the original study for whom we have the full set of experimental measures of trust and all other covariates (as described above and listed in table 2). We estimated a regression with all households, including those with missing data for experimental measures (n=400), to see if these households are systematically different on other covariates from those with full experimental data, and no covariates were significant at the $p<.05$ level. Regressions were also tested for sensitivity to variables with outliers, and there was no significant change in the regression results.

5. Results

5.1 Community-Level Social Capital

To evaluate the importance of community-level social capital, we test H1, i.e., that the communities in our study have limited access to government or outside institutions and, in the example of water, depend primarily on local mobilization of resources to respond to hardship. Our interview data suggest that a large proportion (45%) of the communities have limited access to government officials (visits by officials once a month or rarer). Yet, agricultural and health extension, however, are prominent institutions in Ethiopia including in these communities, with significant expansion in reach over the prior decade

(Banteyerga, 2011; Spielman et al., 2011). Forty percent of communities in the study have a full time agricultural extension agent (known as a development agent), but even villages without an agent are visited at least once per week. Village representatives reported that development agents may distribute or sell subsidized inputs if they have them available, provide guidance on government recommendations or instructions, and provide training on agricultural topics. Forty-five percent of study communities have a full-time community health worker, and only two (10%) receive less than weekly health worker visits.

In the interviews with community representatives, they most frequently complained about poor attention from the water bureau. Only three villages (15%) received even monthly visits from water bureau representatives, and one stated that while "the water bureau comes to teach skills … there hasn't been a meeting this year" (Authors' Interview, December 2011). One village representative noted that though the water "bureau takes samples, but they do not report" the results to the community" (Authors' Interview, January 2012). Another said "we have communicated [our concerns] with the woreda water bureau meeting in Ziway, but the bureau does not give any response, so we have had no further communication. We don't expect a positive response" (Authors' Interview, February 2014). The lack of communication is important because the water bureau representatives both perform maintenance activities and determine priorities or allocation of government resources for water source development and improvement. Some communities reported that they were successful in reporting problems to the water bureau, but that repairs took multiple months, as there are not enough technicians (Authors' Interviews, January 2012). Yet, many community representatives complained in

interviews about not receiving any support or communication from the water bureau, even when the community initiated an inquiry. One community leader said, "the government does not assist them, and the water bureau 'knows nothing.' The water bureau doesn't matter; it is just a symbolic organization" (Authors' Interview, January 2012). Another community said they were told to stop drinking the water due to poor quality, "but were not offered an alternative" (Authors' Interview, February 2013). Another community, whose well had not been working for eight months asked "the water bureau for help, but they have not," and so the community representatives also "talked to an NGO seven months back, which said they would help, but the NGO has not come" (Authors' Interview, February 2013).

With regards to water supply (a primary concern of these communities), of the 12 communities that had a well, four had service interruptions during the three years of the study period, and of those, two reported having trouble getting assistance from the relevant agency (either the water bureau or an NGO) to restore water supplies. Seven of the 20 communities reported having trouble getting assistance from the Water Bureau more generally. Many communities reported that they must raise all of the funds needed for repairs locally; such repairs are often costly and thus require strong collective action. One community said they had "reported the problem to the Water Bureau, and someone has come twice, but has not fixed it. The community will try to gather money to fix ourselves: this is our personal problem" (Authors' Interview, February 2013).

Some communities mentioned getting occasional help from NGOs when faced with water supply problems, but most were heavily reliant on their own savings, which typically resulted in delayed repairs and consequent water shortages. In one community, villagers experiencing months of water shortage due to a broken pump would have to travel for three hours for drinking water and nine hours for livestock to get water (Authors' Interview, January 2012). Representatives from communities who sought help from the water bureau described having to wait for days in the *woreda* seat for the water bureau to respond, and then have to compensate the technician for his travel and per diem. One community "sent 2 people to the water bureau office for 6 days to petition for help" (Authors' Interview, February 2013). Another water manager described that when a technician comes, "we have to pay the per diem he asks for. If the technician asks for 500B, we pay it as we can't argue" (Authors' Interview, December 2011). Notably, the water bureau officials also emphasized their extremely limited resources for responding to community needs, including a problem of insufficient vehicles (motorbikes) and money for fuel needed to reach remote villages.

Another measurement of engagement with government institutions is how the community deals with conflict. For less serious violations, communities rely on elders and social ostracizing to punish those held responsible for a conflict. If a conflict was too serious or unable to be resolved, then community leaders said that they would seek the assistance of the police and formal justice system. Across the twenty communities, 15 (75%) had community elders who were noted as an authority for resolving conflict, as compared to only 11 (55%) mentioning official government (*kebele* and *woreda*) leaders.

The household-level survey data are consistent with the village-level data indicating low levels of government involvement. When confronted with worsening conditions, such as water and food supply, less than 10% of individual households surveyed said they sought help from the local or national government, and mostly endured greater hardship. Notably, few households indicated seeking help from the community when affected by poor environmental conditions, and mostly indicated self-reliance and hardship. Only 29% of households had direct interaction with government officials apart from health and development agents, yet sixty percent of households reported having received some form of government assistance, however, primarily healthcare, education, and food assistance. Fifteen percent of households had received food and nutrition aid, and 17% had received government training. These results suggest that government is neither absent nor prominent in the lives of the study households. Overall, our qualitative results from the interviews and surveys support the hypothesis that communities in our study have limited access and support from government institutions for climate-related adaptation, especially as it relates to management of water resources, and therefore must draw on internal resources to meet many of their needs.

5.2 Trust Measurement Results (Hypothesis 2)

For H2, we test the null hypothesis of no association between survey and experimental measures of trust (Table 3). In this case, a rejection of the null due to a positive coefficient would provide evidence in favor of H2. The coefficient of experimental trust regressed on survey trust is positive, as expected, but it is modest in size and not statistically significant.

The lack of a statistically significant relationship between the experimental and survey measures of trust may indicate that the experiment was not well understood, that the experimental results primarily reflect risk preferences (given that respondents may consider the investment sent to an anonymous community member to be risky), or that the survey and experimental trust variables relate to different constructs. For example, the experimental measure may be specific to shared financial investments, whereas the survey measures may measure more general trust in other people. Alternatively, the lack of relationship may indicate that the survey questions do not yield reliable measures of trust, given that they are filtered through subjective perceptions and are possibly influenced by respondent-enumerator interactions or differing relative conceptions of what the word "trust" actually means. The division between private and community benefits of social capital may also affect the results. The survey questions are about generalized trust and community activities, whereas the experimental game outcome results in a private gain from trusting behavior, these tools may measure somewhat different characteristics. Interestingly, neither survey nor experimental measures of trust appear significantly related to risk preferences.

5.3 Trust and Adaptation Results (Hypothesis 3)

For hypothesis 3, we test whether there is a positive association between trust and both communal and private adaptation activities. Our main results for communal adaptation are displayed in Table 4. These results suggest that observational measures of trust significantly predict contribution to public goods, and collective action that may support adaptation, both in terms of participation and contributions of money. This is consistent

with the hypothesized role of social capital in collective action. We do not find evidence of a similar relationship between our experimental measure of trust and participation in community adaptation or monetary contributions to public goods. In the appendix (Tables A1-A3), we present additional results that test the robustness of the relationships identified in Table 4 using alternative measures of community participation from different survey years, or based on an index of participation, and alternative measures of contributions (from different survey years). We also test whether results are sensitive to the inclusion of controls and village fixed effects. Generally speaking, we find that the results are insensitive to the inclusion of the latter variables, but that survey trust from 2013 is only weakly related to participation and contributions in 2014. Moreover, survey trust has a weak *negative* relationship with the participation index, which is largely driven by a relatively small number of households who report both participation in many activities and low trust. The experimental trust measures remain insignificant across all of these additional analyses. Also noteworthy is the fact that the R-squared values are low; this is not uncommon in cross-sectional analyses of heterogeneous socio-economic variables, but it nevertheless suggests that our models explain relatively little of the variance in our outcome variables. This is consistent with the idea that there remain unobserved factors, such as confidence in information about adaptation, that inform decisions to undertake adaptation behaviors besides the social capital and other control variables included in our model specifications. The qualitative interviews suggest that a variety of sources of information, from government, traditional knowledge, and peers influence adaptation decision making by individual households.

Despite the positive link between survey trust and participation and contributions, survey trust is negatively related to private adaptation behaviors as measured through the two indices of these behaviors (Table 5). This result suggests that social capital may be detrimental to private adaptation. The experimental trust measures are again not significantly related to these outcomes, but also have negative signs for both private and communal adaptation activities. In additional robustness checks (Appendix Tables A4-A6), we find some consistency with the patterns described above for community participation and contributions, in that the results do not appear sensitive to inclusion of controls. Yet the relationships are weakly *positive* between longer term measures of adaptation and survey trust. This suggests the need for additional longitudinal work to better understand the relationships between these variables over time.

Finally, we note that in the analyses, the risk loss parameter (lambda in Table 5 and in Tables A4-A6) is consistently and significantly related to different measures of private adaptation: the higher the loss aversion, the greater the engagement in private adaptation behaviors. Socioeconomic factors such as education and wealth are positively, if insignificantly, associated with both forms of adaptation. Land area, however, is negatively associated with private adaptation, which may reflect the high implementation cost of adaptation, or may indicate that larger land ownership provides greater intrinsic diversification or buffer against shocks.

6. Conclusions

We investigated the relationship between social capital and climate adaptation-relevant behaviors using survey and experimental measures of trust. In so doing, we found that a survey measure of trust is positively and significantly related to engagement in community-improving activities, but negatively and significantly related to private household-level adaptation activities. This may stem from the fact that people who can rely on community members are less likely to try new activities as individuals, or that individuals who engage in individual adaptation are less likely to engage with the community, even when controlling for wealth. A negative relationship between household adaptation and trust is surprising, as it suggests the possibility that social capital is unhelpful or even detrimental to adaptation. Conversely, trust and social capital could be considered to substitute for private adaptation.

As a third alternative, and because our study cannot establish causal relationships, the negative relationship of household adaptation and trust may reflect an erosion of trust due to private adaptation, or the influence of other omitted variables that are positively correlated with trust that also impede adaptation. Our interviews with community representatives suggest that government programs and instructions are considered important when they occur, though they do not occur at a high frequency. If government instructions dictate activities related to climate adaptation, this might alter patterns of private adaptation. With regards to measurement of household behavior and characteristics, we found a statistically insignificant relationship between survey and

experimental measures of trust, suggesting that further development of theory linking social capital and trust, and additional empirical tools to measure these constructs, may be necessary. Simulations and interactive activities similar to the trust experiment may have the dual effect of indicating the level of social capital and providing an opportunity to enhance cooperation.

An alternative possible critique of the underlying theoretical link between social capital and adaptation arises from concerns over the effectiveness of social capital for achieving better outcomes at the household level. It is useful to consider social capital as a form of value, because the ability to share knowledge, cooperate, and share other forms of capital remains useful, even if all households are negatively affected by a climate-related stresses. Another possibility is that social capital presents an analytical paradox if smaller and more homogenous groups have greater social capital or possibility of collective action. The effect of heterogeneity within a group is complex, however, and inconsistent (Olson, 1971; Poteete and Ostrom, 2004). Social capital may have value for explaining adaptive capacity, but a true test of the causal impact of social capital requires exogenous modification of social relationships, which is difficult to do in any setting.

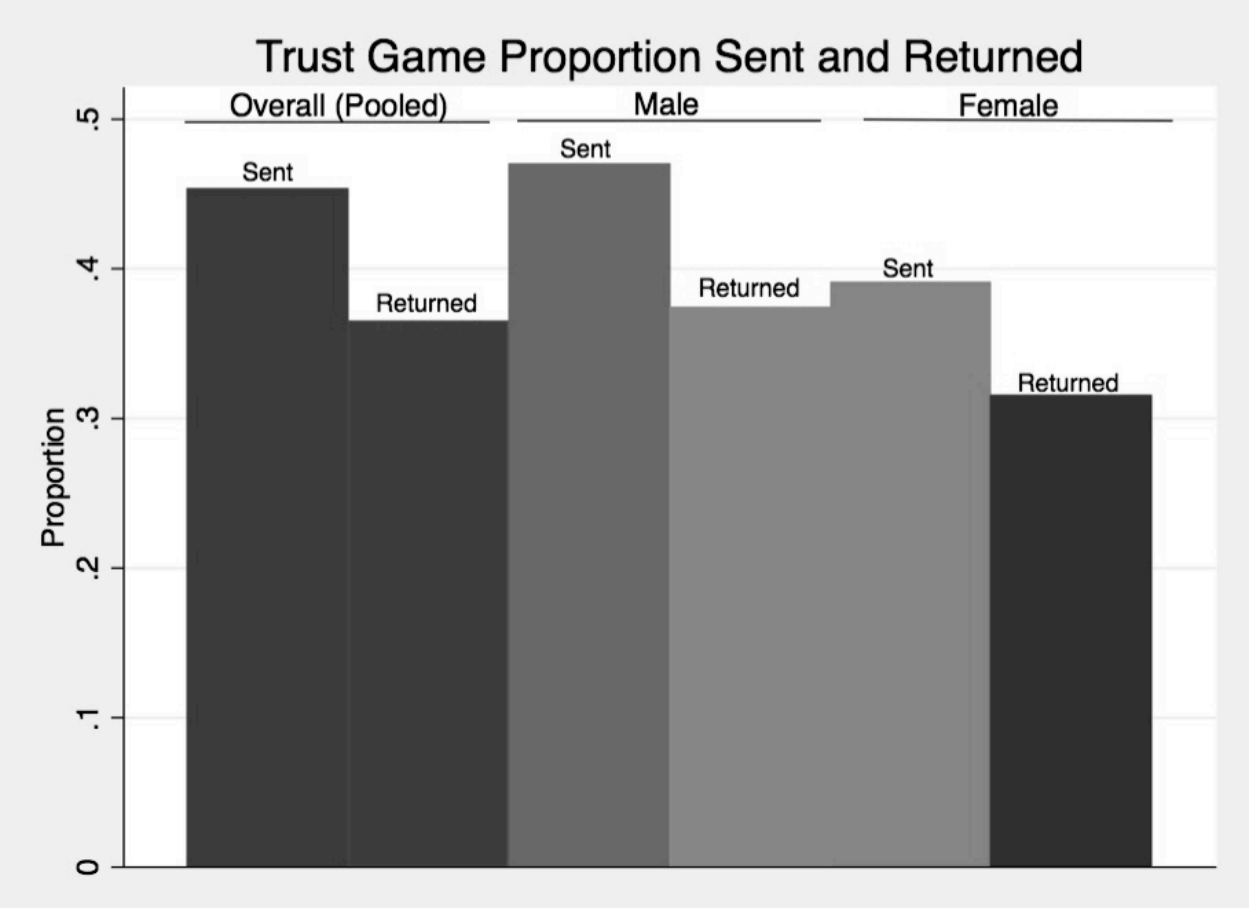
An empirical implication of this work for the Ethiopian context is that policy makers should be aware of the potential heterogeneity in social capital and its effects: social capital is not necessarily uniformly good, yet neither is it unimportant. Social capital may be useful in some settings, but not useful or even detrimental in others. From the interview and survey data, it is clear that rural Ethiopians in communities similar to those in this study still have

limited support from the state, particularly as documented in the case of water supplies. Given our main finding that suggests a difference between those engaged in household adaptation and those engaged in community adaptation, Ethiopian policymakers should be aware of the impacts of different forms of adaptation being promoted.

While it is unclear if policy should or can be used to increase social capital with regards to adaptation, some research suggests useful interventions in this arena, such as institutional design for participation and community building activities (Aldrich, 2012; Ostrom, 1992; Putnam, 2001). Future research involving multiple qualitative and quantitative methods, as used this in this paper, can better identify the relevant variables influencing climate adaptation behavior. Further, using mixed methods at multiple scales, though intensive in time and resources, generates more relevant policy prescriptions. Local-level policymaking is the appropriate scale at which to integrate social capital into climate adaptation, yet it is important to draw upon a comparative perspective of experiences of adaptation in other locations and at different policy scales (Vogel and Henstra, 2015). Policymakers may need to account for multiple scales and forms of adaptation, for the individual, household, and community, when designing interventions.

Figures

Figure 1. Trust Game Proportion Sent and Returned



Note: Pooled sample is driven by male results, as 82% of household heads were male.

Tables

Table 1. Survey Questions for Key Variables

Key Independent Variables	**Variable/Question Text**
General trust (survey)	"In general, would you say that most people in your village can be trusted or that you cannot trust people in your village?"
Community Participation	"Do you or any members of your household participate in any activities for improving your community (outside the immediate limits of your house)?"
Total adaptation changes	An index of responses to "In the last 10 years, if you have changed [PRACTICE], for what reason did you do so? (Mark all that apply)"
Covariates	
Player Male	What is your gender?
Player Age	What is your age?
Player Education Level	What is your highest level of schooling?
Player Married	Are you married?
Household Size	Number of members listed on detailed roster
Total Land Area (Ha)	Sum of "What is the area of [each] plot you own or rent?"
Dependency Ratio	Ratio of number of dependents under 16 on roster to household size
Number of Bovine Owned	How many cows, bulls, oxen, and calves do you own?
Income	"Please estimate the total amount of money your household receives in an average year"
HH Assets	The sum of total value of ten key asset types (e.g. furniture, technology, transportation)

Table 2. Descriptive Statistics of Household Survey Data

Variable	Obs	Mean	Std. Dev.	Min	Max
Key Independent Variables					
General trust (survey)	360	0.42	0.49	0	1
Experimental Trust (Proportion Sent)	360	0.45	0.24	0	1
Community Participation	360	0.94	0.27	0	1
Community Contribution	360	0.43	0.50	0	1
Household adaptation changes (simple index)	360	4.50	3.26	0	12
Household adaptation changes (PCA index)	360	-0.20	1.54	-2.32	3.43
Covariates					
Risk alpha parameter	360	0.70	0.19	0.05	1.45
Risk sigma parameter	360	1.23	0.34	0.05	1.5
Risk lambda parameter	360	1.53	1.93	0.12	7.85
Player Male	360	0.82	0.38	0	1
Player Age	360	40.84	16.75	14	101
Player Education Level	360	1.60	1.57	0	6
Player Married	360	0.84	0.36	0	1
Household Size	360	6.37	2.36	1	15
Total Land Area (Ha)	360	3.49	12.13	0	201.5
Dependency Ratio	360	0.46	0.23	0	1.5
Number of Bovine Owned	360	4.77	6.79	0	81
Income Per Capita (Birr)	360	2645	18289	0	345015
Log of Income Per Capita	360	7.0	1.06	2.01	12.75
Household Asset Per Capita	360	278.43	762.599	0	11576.7
Log of Household Asset Per Capita	360	4.39	1.84	-2.30	9.36

Table 3. Survey and Experimental Trust Measures

VARIABLES	(1) Experimental trust	(2) Survey trust	(3) Experimental trust	(4) Experimental trust
Risk alpha		-0.173	0.0245	0.0298
		(0.183)	(0.0573)	(0.0570)
Risk sigma		-0.00369	-0.00665	-0.00654
		(0.0977)	(0.0389)	(0.0402)
Risk lambda		-0.00258	0.00840	0.00848
		(0.0146)	(0.00638)	(0.00641)
Survey trust	0.0279			0.0304
	(0.0259)			(0.0251)
Constant	0.330***	0.425*	0.345***	0.332***
	(0.0109)	(0.224)	(0.107)	(0.109)
Observations	360	360	360	360
R-squared	0.211	0.118	0.254	0.257
Controls	No	Yes	Yes	Yes
Village Fixed Effects	Yes	Yes	Yes	Yes
Village Clustered Standard Error	Yes	Yes	Yes	Yes

Notes: *** p<0.01, ** p<0.05, * p<0.1 Robust standard errors in parentheses. Ordinary Least Squares (OLS) Model. Controls: Male, Age, Education, Marital Status, Household Size, Log Land Area, Dependency Ratio, Livestock, Log Income Per Capita, Log Household Assets.

Table 4. Trust and Community Adaptation

VARIABLES	(1) Community Participation	(2) Community Participation	(3) Community Participation	(4) Community Contribution	(5) Community Contribution	(6) Community Contribution
Survey trust	0.0482**		0.0499**	0.161**		0.156**
	(0.0187)		(0.0189)	(0.0678)		(0.0678)
Experimental trust		-0.0492	-0.0568		0.187	0.163
		(0.0404)	(0.0429)		(0.124)	(0.135)
Risk alpha	-0.0828	-0.0899	-0.0811	-0.0425	-0.0749	-0.0474
	(0.0795)	(0.0847)	(0.0810)	(0.131)	(0.140)	(0.130)
Risk sigma	0.0628	0.0623	0.0624	0.0654	0.0660	0.0665
	(0.0633)	(0.0621)	(0.0630)	(0.108)	(0.106)	(0.105)
Risk lambda	0.00875	0.00904	0.00923	0.0245*	0.0225	0.0231
	(0.00614)	(0.00626)	(0.00625)	(0.0136)	(0.0141)	(0.0135)
Constant	0.720***	0.758***	0.739***	-0.433	-0.429	-0.487*
	(0.196)	(0.187)	(0.193)	(0.258)	(0.254)	(0.253)
Observations	360	360	360	360	360	360
R-squared	0.220	0.213	0.222	0.170	0.154	0.175
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Village Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Village Clustered Standard Error	Yes	Yes	Yes	Yes	Yes	Yes

Notes: *** p<0.01, ** p<0.05, * p<0.1 Robust standard errors in parentheses. Ordinary Least Squares (OLS) Model. Controls: Male, Age, Education, Marital Status, Household Size, Log Land Area, Dependency Ratio, Livestock, Log Income Per Capita, Log Household Assets.

Table 5. Trust and Private Adaptation

VARIABLES	(1) Adaptation Index	(2) Adaptation Index	(3) Adaptation Index	(4) Adaptation PCA Index	(5) Adaptation PCA Index	(6) Adaptation PCA Index
Survey trust	-0.973**		-0.956**	-0.456**		-0.448**
	(0.377)		(0.369)	(0.179)		(0.175)
Experimental trust		-0.687	-0.542		-0.315	-0.247
		(0.752)	(0.758)		(0.358)	(0.358)
Risk alpha	0.0154	0.200	0.0315	0.00729	0.0937	0.0146
	(0.996)	(0.984)	(0.983)	(0.476)	(0.471)	(0.469)
Risk sigma	0.493	0.492	0.489	0.229	0.228	0.227
	(0.598)	(0.592)	(0.599)	(0.278)	(0.275)	(0.279)
Risk lambda	0.187**	0.196**	0.192**	0.0850**	0.0888**	0.0871**
	(0.0721)	(0.0718)	(0.0708)	(0.0340)	(0.0339)	(0.0334)
Constant	0.672	0.495	0.852	-1.948	-2.033	-1.866
	(2.519)	(2.578)	(2.639)	(1.181)	(1.210)	(1.239)
Observations	360	360	360	360	360	360
R-squared	0.182	0.164	0.183	0.177	0.160	0.178
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Village Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Village Clustered Standard Error	Yes	Yes	Yes	Yes	Yes	Yes

Notes: *** p<0.01, ** p<0.05, * p<0.1 Robust standard errors in parentheses. Ordinary Least Squares (OLS) Model. Controls: Male, Age, Education, Marital Status, Household Size, Log Land Area, Dependency Ratio, Livestock, Log Income Per Capita, Log Household Assets.

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Appendix: Additional robustness checks

Table A1. Community Participation

VARIABLES	(1) Community Participation	(2) Community Participation	(3) Community Participation	(4) Community Participation	(5) Community Participation 2014	(6) Community Participation 2014
Survey trust	0.0709***	0.0499**	0.0482**		0.0584*	0.0338
	(0.0219)	(0.0189)	(0.0187)		(0.0304)	(0.0291)
Experimental trust	-0.0102	-0.0568		-0.0492	0.0122	-0.0397
	(0.0424)	(0.0429)		(0.0404)	(0.0836)	(0.0723)
Risk alpha		-0.0811	-0.0828	-0.0899		-0.0630
		(0.0810)	(0.0795)	(0.0847)		(0.0582)
Risk sigma		0.0624	0.0628	0.0623		-0.0206
		(0.0630)	(0.0633)	(0.0621)		(0.0521)
Risk lambda		0.00923	0.00875	0.00904		0.00613
		(0.00625)	(0.00614)	(0.00626)		(0.0116)
Constant	0.974***	0.739***	0.720***	0.758***	0.914***	0.624***
	(0.0175)	(0.193)	(0.196)	(0.187)	(0.0317)	(0.156)
Observations	360	360	360	360	347	347
R-squared	0.070	0.222	0.220	0.213	0.109	0.238
Controls	No	Yes	Yes	Yes	No	Yes
Village Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Village Clustered Standard Error	Yes	Yes	Yes	Yes	Yes	Yes

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
Ordinary Least Squares (OLS) Model
Controls: Male, Age, Education, Marital Status, Household Size, Log Land Area, Dependency Ratio, Livestock, Log Income Per Capita, Log Household Assets

The dependent variable "community participation" is a binary variable from the survey question "Do you or any members of your household

Table A2. Community Participation Index

VARIABLES	(1) Participation Index	(2) Participation Index	(3) Participation Index	(4) Participation Index	(5) Participation PCA Index	(6) Participation PCA Index
Survey trust	-0.133	-0.315*	-0.341*		-0.0221	-0.114
	(0.157)	(0.169)	(0.182)		(0.0837)	(0.102)
Experimental trust	-0.540	-0.859		-0.907	-0.431	-0.521
	(0.509)	(0.597)		(0.602)	(0.311)	(0.344)
Risk alpha		-0.196	-0.221	-0.140		-0.119
		(0.537)	(0.552)	(0.552)		(0.372)
Risk sigma		-0.240	-0.235	-0.239		-0.0738
		(0.531)	(0.523)	(0.537)		(0.289)
Risk lambda		0.0136	0.00631	0.0148		0.0280
		(0.0985)	(0.0979)	(0.0983)		(0.0555)
Constant	5.715***	-0.715	-1.000	-0.832	0.556***	-1.965**
	(0.199)	(1.624)	(1.537)	(1.661)	(0.117)	(0.797)
Observations	360	360	360	360	360	360
R-squared	0.056	0.209	0.204	0.205	0.059	0.157
Controls	No	Yes	Yes	Yes	Yes	Yes
Village Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Village Clustered Standard Error	Yes	Yes	Yes	Yes	Yes	Yes

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
Ordinary Least Squares (OLS) Model
Controls: Male, Age, Education, Marital Status, Household Size, Log Land Area, Dependency Ratio, Livestock, Log Income Per Capita, Log Household Assets

The dependent variable "participation index" is a simple count (sum) index of twelve adaptation behavior categories, including: Sweeping public streets; Cleaning drains; Cleaning water sources; Cleaning school area; Removing garbage; Planting trees; Cleaning community latrines; Well maintenance; Security patrols; Terracing; Bridge or road maintenance; Water Conservation; Construct water harvesting. "Participation PCA index" is a polychoric component analysis (PCA) index of these categories.

Table A3. Community Contribution

VARIABLES	(1) Community Contribution	(2) Community Contribution	(3) Community Contribution	(4) Community Contribution	(5) Community Contribution 2014	(6) Community Contribution 2014
Survey trust	0.181***	0.156**	0.161**		0.00926	0.00340
	(0.0625)	(0.0678)	(0.0678)		(0.0434)	(0.0425)
Experimental trust	0.185	0.163		0.187	0.126	0.0755
	(0.124)	(0.135)		(0.124)	(0.101)	(0.0976)
Risk alpha		-0.0474	-0.0425	-0.0749		
		(0.130)	(0.131)	(0.140)		
Risk sigma		0.0665	0.0654	0.0660		
		(0.105)	(0.108)	(0.106)		
Risk lambda		0.0231	0.0245*	0.0225		
		(0.0135)	(0.0136)	(0.0141)		
Constant	0.123***	-0.487*	-0.433	-0.429	0.397***	0.0847
	(0.0419)	(0.253)	(0.258)	(0.254)	(0.0392)	(0.313)
Observations	360	360	360	360	347	347
R-squared	0.113	0.175	0.170	0.154	0.033	0.079
Controls	No	Yes	Yes	Yes	No	Yes
Village Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Village Clustered Standard Error	Yes	Yes	Yes	Yes	Yes	Yes

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
Ordinary Least Squares (OLS) Model
Controls: Male, Age, Education, Marital Status, Household Size, Log Land Area, Dependency Ratio, Livestock, Log Income Per Capita, Log Household Assets

The dependent variable "community contribution" is a binary variable from the survey question "Does your household contribute to village activities or services with money or other donations in the past year? Regressions 1-4 use the 2013 survey, regressions 5-6 use the 2014 survey question regressed on the 2013 covariates.

Table A4. Household Adaptation Simple Index

VARIABLES	(1) Adaptation Index	(2) Adaptation Index	(3) Adaptation Index	(4) Adaptation Index	(5) Adaptation 2014 Index	(6) Adaptation 2014 Index
Survey trust	-0.851**	-0.956**	-0.973**		0.0649	0.0413
	(0.352)	(0.369)	(0.377)		(0.115)	(0.116)
Experimental trust	-0.758	-0.542		-0.687	0.108	0.0586
	(0.844)	(0.758)		(0.752)	(0.189)	(0.156)
Risk alpha		0.0315	0.0154	0.200		0.00142
		(0.983)	(0.996)	(0.984)		(0.255)
Risk sigma		0.489	0.493	0.492		0.325**
		(0.599)	(0.598)	(0.592)		(0.132)
Risk lambda		0.192**	0.187**	0.196**		0.0269
		(0.0708)	(0.0721)	(0.0718)		(0.0322)
Constant	4.828***	0.852	0.672	0.495	0.304***	-1.072**
	(0.339)	(2.639)	(2.519)	(2.578)	(0.0839)	(0.483)
Observations	360	360	360	360	360	360
R-squared	0.123	0.183	0.182	0.164	0.069	0.124
Controls	No	Yes	Yes	Yes	No	Yes
Village Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Village Clustered Standard Error	Yes	Yes	Yes	Yes	Yes	Yes

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
Ordinary Least Squares (OLS) Model
Controls: Male, Age, Education, Marital Status, Household Size, Log Land Area, Dependency Ratio, Livestock, Log Income Per Capita, Log Household Assets

The dependent variable "adaptation index" is a simple count (sum) index of twelve adaptation behavior categories, including: Proportion of different crops; Type of seed (traditional vs. improved); Timing of planting; Timing of harvest; Method of farming; Number of livestock; Amount of crops; Farm equipment/assets; Work for income outside the farm; Change total area harvested; Fertilizer use; and, Other. For regressions 1-4, this index was generated from the 2013 survey data for adaptations done over the prior 10 years. For regression 5-6, the index was generated from 2014 survey data for adaptations over the prior 5 years.

Table A5. Household Adaptation PCA Index

VARIABLES	(1) Adaptation PCA Index	(2) Adaptation PCA Index	(3) Adaptation PCA Index	(4) Adaptation PCA Index
Survey trust	-0.401**	-0.448**	-0.456**	
	(0.166)	(0.175)	(0.179)	
Experimental trust	-0.354	-0.247		-0.315
	(0.397)	(0.358)		(0.358)
Risk alpha		0.0146	0.00729	0.0937
		(0.469)	(0.476)	(0.471)
Risk sigma		0.227	0.229	0.228
		(0.279)	(0.278)	(0.275)
Risk lambda		0.0871**	0.0850**	0.0888**
		(0.0334)	(0.0340)	(0.0339)
Constant	-0.0722	-1.866	-1.948	-2.033
	(0.161)	(1.239)	(1.181)	(1.210)
Observations	360	360	360	360
R-squared	0.120	0.178	0.177	0.160
Controls	No	Yes	Yes	Yes
Village Fixed Effects	Yes	Yes	Yes	Yes
Village Clustered Standard Error	Yes	Yes	Yes	Yes

Robust standard errors in parentheses

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

Ordinary Least Squares (OLS) Model

Controls: Male, Age, Education, Marital Status, Household Size, Log Land Area, Dependency Ratio, Livestock, Log Income Per Capita, Log Household Assets

The dependent variable "adaptation PCA index" is a polychoric component analysis (PCA) index of twelve adaptation behavior categories, including: Proportion of different crops; Type of seed (traditional vs. improved); Timing of planting; Timing of harvest; Method of farming; Number of livestock; Amount of crops; Farm equipment/assets; Work for income outside the farm; Change total area harvested; Fertilizer use; and, Other. This index was generated from the 2013 survey data for adaptations done over the prior 10 years.

Table A6. Household Adaptation Binary

VARIABLES	(1) Adaptation 10yr binary	(2) Adaptation 10yr binary	(3) Adaptation 10yr binary	(4) Adaptation 10yr binary	(5) Adaptation 2014 5yr Binary	(6) Adaptation 2014 5yr Binary	(7) Adaptation 1yr 2014 Binary	(8) Adaptation 1yr 2014 Binary
Survey trust	0.0205	0.00159	0.00224		0.124**	0.0963*	0.0842*	0.0614
	(0.0502)	(0.0510)	(0.0501)		(0.0537)	(0.0480)	(0.0447)	(0.0418)
Experimental trust	0.0558	0.0214		0.0216	0.209	0.185	0.133*	0.0875
	(0.0897)	(0.0923)		(0.0900)	(0.122)	(0.116)	(0.0724)	(0.0868)
Risk alpha		0.134	0.135	0.134		0.0132		-0.0319
		(0.0961)	(0.0971)	(0.0989)		(0.162)		(0.133)
Risk sigma		0.120*	0.120*	0.120*		0.189**		0.158***
		(0.0654)	(0.0649)	(0.0654)		(0.0793)		(0.0517)
Risk lambda		0.0317***	0.0319***	0.0317***		0.0207		0.0188
		(0.00924)	(0.00924)	(0.00929)		(0.0215)		(0.0133)
Constant	0.709***	0.228	0.235	0.228	0.350***	-0.444	0.182***	-0.286
	(0.0314)	(0.249)	(0.248)	(0.249)	(0.0483)	(0.281)	(0.0326)	(0.223)
Observations	360	360	360	360	360	360	360	360
R-squared	0.069	0.137	0.137	0.137	0.100	0.187	0.076	0.147
Controls	No	Yes	Yes	Yes	No	Yes	No	Yes
Village Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Village Clustered Standard Error	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
Ordinary Least Squares (OLS) Model
Controls: Male, Age, Education, Marital Status, Household Size, Log Land Area, Dependency Ratio, Livestock, Log Income Per Capita, Log Household Assets

The dependent variable "adaptation binary" is a binary variable indicating action of at least one of twelve adaptation behavior categories, including: Proportion of different crops; Type of seed (traditional vs. improved); Timing of planting; Timing of harvest; Method of farming; Number of livestock; Amount of crops; Farm equipment/assets; Work for income outside the farm; Change total area harvested; Fertilizer use; and, Other. For regressions 1-4, this index was generated from the 2013 survey data for adaptations done over the prior 10 years.

Table A7. Household Adaptation Polychoric Correlation Matrix

Adaptation Changes	Area farmed	Farm equipment/assets	Proportion of different crops	Fertilizer Use	Timing of Harvest	Work for income outside of the farm	Number of livestock	Method of farming	Other changes	Proportion of different crops	Type of seed (traditional vs. improved)	Timing of Planting
Area farmed	1											
Farm equipment/assets	0.771	1										
Amount of crops	0.557	0.502	1									
Fertilizer Use	0.853	0.699	0.549	1								
Timing of Harvest	0.837	0.640	0.697	0.843	1							
Work for income outside of the farm	0.724	0.731	0.324	0.467	0.484	1						
Number of livestock	0.131	0.561	0.547	0.572	0.695	0.116	1					
Method of farming	-0.004	0.531	0.302	0.401	0.530	0.150	0.697	1				
Other changes	0.706	0.893	0.606	0.691	0.982	0.781	0.651	0.741	1			
Proportion of different crops	0.766	0.535	0.742	0.605	0.697	0.345	0.328	0.340	0.969	1		
Type of seed (traditional vs. improved)	0.668	0.486	0.568	0.622	0.583	0.409	0.330	0.359	0.973	0.763	1	
Timing of Planting	0.638	0.595	0.631	0.718	0.942	0.365	0.563	0.681	0.965	0.725	0.734	1

Table A8. Household Adaptation Principal Component Analysis

k	Eigenvalues	Proportion explained	Cumulative explained
1	7.796	0.650	0.650
2	1.604	0.134	0.783
3	0.999	0.083	0.867
4	0.747	0.062	0.929
5	0.514	0.043	0.972
6	0.325	0.027	0.999
7	0.260	0.022	1.020
8	0.174	0.014	1.035
9	0.091	0.008	1.043
10	-0.028	-0.002	1.040
11	-0.141	-0.012	1.028
12	-0.342	-0.028	1.000