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**"Household-Level Recovery after Floods in a Tribal and Conflict-Ridden Society"**

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# Household-Level Recovery after Floods in a Tribal and Conflict-Ridden Society

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Abstract:

Based on a panel survey conducted in Khyber Pakhtunkhwa, Pakistan, this study analyzes the extent to which households recovered from damage due to floods that hit the country in 2010. With regard to the initial recovery of productive assets, households that experienced heavier damage to their assets had recovered to a lesser extent. After one year, recovery had continued, but traditional leaders and those whose houses were damaged by the floods experienced a deceleration in the recovery speed. The recovery of productive assets was affected by concerns for house reconstruction, reflecting the tribal value of preserving honor in conflict-ridden situations.

Keywords: natural disaster, recovery, house reconstruction, tribal codes, Asia, Pakistan.
JEL classification codes: O12, D12, D91.

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## 1. INTRODUCTION

Households throughout the world face a wide variety of risks arising from natural disasters, such as floods, droughts, and earthquakes. For instance, Pakistan, from which the household data analyzed in this study were taken, experienced in 2010 the worst floods in its history, which affected 84 districts out of a total 121 districts, killing more than 1,700 people (United Nations, 2010). Households in low-income developing countries are particularly vulnerable, since their initial welfare levels are already close to the poverty line, institutional arrangements used to cope with disasters are lacking, and early warning systems are absent. To compound issues, the number of natural disasters reported appears to be increasing globally—from fewer than 100 per year in the mid-1970s to approximately 400 per year during the 2000s, according to the emergency events database (EM-DAT).[1]

As summarized by Cavallo & Noy (2011) and Sawada (2007), much research in both the social and natural sciences has been devoted to enhancing our ability to predict disasters, while economic research on natural disasters and their consequences, including the recovery process, has been fairly limited. In the limited economics literature, several authors have investigated macroeconomic impacts, both direct and indirect. For instance, using cross-country panel data, Noy (2009) shows that developing countries face much larger declines in output following disasters of similar relative magnitude than do developed countries or bigger economies, suggesting the importance of a greater ability to mobilize resources for reconstruction. Using similar cross-country panel data, Sawada et al. (2011) demonstrate that natural disasters positively impact welfare (measured by per-capita GDP) in the long run, although they exert a substantial negative impact on welfare in the short run. Coffman & Noy (2012) use a synthetic control methodology to estimate the long-term impacts of a 1992 hurricane on the island economy of Kauai, Hawaii, showing that Kauai's economy was yet to recover after 18 years of the event. These macroeconomic studies have tended to treat disasters as economy-wide covariant shocks, not focusing on within-country or within-village heterogeneity.

However, in terms of the microeconomic impacts of exogenous shocks, there has been an accumulation of theoretical and empirical studies in development economics focusing on households' ability to cope with such shocks. These studies have shown that poor households are likely to suffer not only from low levels of welfare on average but also from fluctuations in their welfare due to their limited coping ability (Fafchamps, 2003; Dercon, 2005). The inability to avoid declines in welfare when hit by exogenous shocks can be called vulnerability; regarding the measurement of vulnerability, a substantial literature has developed (Ligon & Schechter, 2003; Dercon, 2005; Kurosaki, 2006; Dutta et al., 2011). These studies tend to focus on how idiosyncratic shocks impact welfare. This is unsatisfactory, as Ligon & Schechter (2003) demonstrate that aggregate risk is much more important than idiosyncratic sources of risk. Furthermore, the influence of aggregate shocks on the welfare of households is growing in the process of globalization and with global warming.

To respond to the need for further research, recent years have seen an increasing number of more micro-level studies on the impact of natural disasters. For instance, Carter et al. (2007) analyze the asset dynamics associated with post-disaster recovery at the household level in Honduras (after Hurricane Mitch) and Ethiopia (after prolonged droughts). They show that the poorest households struggled most with shocks and had to adopt costly strategies such as asset smoothing. Mogues (2011) expands the analysis of Ethiopian droughts to demonstrate the importance of precautionary motives for holding wealth. Regarding the impact of droughts on asset dynamics in Africa, Giesbert & Schindler (2012) add evidence from Mozambique. They show that even food-insecure households are able to sustain productive assets when they have unproductive, liquidatable assets and better access to income-generating opportunities. These studies are motivated by the asset poverty trap hypothesis (Carter & Barrett, 2006), regarding which the empirical evidence is mixed (McKay & Perge, 2013; Kraay & McKenzie, 2014). Other studies that have assessed the impact of disasters include de Mel et al. (2012), who examine the business recovery of microenterprises in Sri Lanka, and Rodriguez-Oreggia et al. (2013), who investigate the effects of floods and droughts on municipality-level poverty and human development indicators.

Nevertheless, empirical studies on household-level asset recovery from natural disasters remain limited. Regional studies on South Asian economies have been few, although poverty and exposure to natural disasters are serious problems in the region. In terms of characteristics of the economy, mixed farming economies under tribal codes are not studied in detail. Economies facing conflicts such as civil war or insurgencies are rarely analyzed. Finally, the interaction of productive assets and unproductive, non-liquidatable assets has not been analyzed in the literature.

This study attempts to fill these gaps in the literature by investigating household-level asset recovery from floods in a tribal and conflict-ridden society with a focus on unproductive, non-liquidatable assets. Which types of households are quicker to recover from nation-wide flood damage? Is there any heterogeneity in recovery attributable to the variation in damage extent and social status? Do recovery patterns differ between the period immediately after floods and a year after? How are the dynamic recovery patterns related with the social structure in such an economy? To examine these questions, I employ a panel dataset collected in the province of Khyber Pakhtunkhwa,[2] Pakistan, in December 2010–February 2011 and one year after. The survey area was severely hit by nation-wide, unprecedented floods in Pakistan that occurred in July–August 2010. The province of Khyber Pakhtunkhwa is populated by the Pakhtuns whose social behavior is governed by tribal codes known as *Pakhtunwali* (Ahmed, 1980). One of the key elements of *Pakhtunwali* is the preservation of the honor of the family, especially of women members. In the 2000s, law and order in the region deteriorated, making the region difficult for outside researchers to conduct detailed surveys.

Since the recovery process is dynamic in nature, a single “snapshot” survey after a disaster cannot comprehensively provide detailed information. Utilizing the panel dataset, I show that households that initially had fewer assets and were hit by greater flood damage had more difficulty in recovering; after one year, their recovery had improved, but there remained substantial variation across households regarding the extent of recovery; and households headed by traditional leaders and households whose houses were damaged by the floods experienced a deceleration in the speed of recovery. The recovery of productive assets was affected by concerns regarding the reconstruction of houses, which are unproductive and non-liquidatable in the survey area. I interpret the results as a reflection of the tribal value placed on honor preservation in conflict-ridden situations. Given the scarcity of such an analysis in the literature, the evidence shown in this study is expected to shed light on the recovery process after natural disasters, despite the small sample size involved.

The remainder of this paper is organized as follows. Following this introductory section, Section 2 puts forward a conceptual framework for the empirical analysis. Section 3 describes the study area, survey design, and the dataset. Section 4 explains the empirical strategy, followed by regression results in Section 5. Section 6 concludes the paper.

## 2. ASSET RECOVERY FROM NATURAL DISASTERS

The empirical models in this paper are motivated by the literature on consumption smoothing (Fafchamps, 2003; Dercon, 2005), which refers to the use of assets as a buffer to smooth consumption, and the literature on asset poverty traps, which indicates that there are situations in which assets are smoothed and consumption sacrificed to avoid poverty traps (Carter & Barrett, 2006; Carter et al., 2007). In this section, I briefly explain the conceptual framework underlying the empirical investigation.

A household makes a living using its productive, liquidatable assets, whose value is denoted by a scaler $A_t$. Its expected value in the next period, $A_{t+1}$, is an increasing function of $A_t$, i.e., $E_t[A_{t+1}] = f(A_t)$ with $f'(.)>0$. If $f(.)$ is S-shaped with three intersections with a 45-degree line, there could be multiple equilibriums with the lower one corresponding to the asset poverty trap.

Now assume that a shock due to a natural disaster occurs, which destroys the productive asset. Let $Z_p$ be the amount of damage that occurs between period $t$ and $t$+1. By definition, the productive asset value is reduced by $Z_p$ immediately after the shock.

However, the expected value of $A_{t+1}$ given the productive asset shock may not equal $f(A_t) – Z_p$ for two reasons. First, the household may rebuild the asset to compensate for the damage caused by the natural disaster. The household can use its own savings, mutual help inside the community, or aid from outside[3] to replenish the asset. How much of $Z_p$ is transferred to the realized value of $A_{t+1}$ is thus a measure of resilience of the productive asset against the natural disaster.

Second, the household may sell productive assets to cope with other shocks that occur between period $t$ and $t$+1. When a natural disaster occurs, not only productive assets but also unproductive assets (such as houses, household durables, etc.) may be damaged. Household income may also be reduced (for example, standing crops may be destroyed). Let $Z_n$ be the amount of damage to unproductive, non-liquidatable assets and $Z_y$ be the unexpected reduction in income. Even when the household does not sell productive assets to cope with these shocks, these shocks constrain the household's liquidity positions so that it becomes difficult for the household to replenish productive assets. As a net effect, it is expected that the realized value of the productive assets in period $t$+1 is a non-increasing function of $Z_n$ and $Z_y$.

Assuming the absence of natural disasters between $t$+1 and $t$+2, the recovery process is expected to continue. It may be a reversion to the initial path of $f(.)$ or permanent divergence from the initial path. If a sufficiently long panel dataset with a large number of observations is available, we may be able to distinguish the two different dynamics. However, as the dataset available for this study is a small-size panel dataset with two post-disaster periods, this is not attempted. Instead, I propose several hypothesis tests using the following model for $g_i$, the asset change for household $i$. The model is similar to the one adopted by Carter et al. (2007):

$$g_i \equiv A_{i,t+1} - A_{it} = h(A_{it}) + \gamma_{1i} Z_{pi} + \gamma_{2i} Z_{ni} + \gamma_{3i} Z_{yi} + X_i \beta + u_i, \qquad (1)$$

where $h(A_{it}) \equiv f(A_{it}) - A_{it}$, $\gamma_{1i}$, $\gamma_{2i}$, and $\gamma_{3i}$ are parameters to be estimated, $X_i$ is a vector of household and village characteristics, $\beta$ is a vector of parameters to be estimated, and $u_i$ is an error term. Parameters $\gamma_{1i}$, $\gamma_{2i}$, and $\gamma_{3i}$ may shift depending on the characteristics of household $i$, which are associated with the household's self-insurance ability and social and market access conditions (Carter et al., 2007). As a key variable for $X_i$ and a shifter of $\gamma$ parameters, household characteristics related to tribal codes are included. An equation analogous to equation (1) is estimated using the data from one year after:

$$g'_i \equiv A_{i,t+2} - A_{it} = k(A_{it}) + \gamma'_{1i} Z_{pi} + \gamma'_{2i} Z_{ni} + \gamma'_{3i} Z_{yi} + X_i \beta' + u'_i, \qquad (2)$$

where the error term, $u'_i$, incorporates shocks that occur between $t$+1 and $t$+2 as well.

A null hypothesis of $H_0$: $\gamma_{1i} = -1$ corresponds to the complete absence of recovery. This is because a coefficient of –1 on the asset shock variable would mean that the household had not recovered at all from the shock (e.g., a $100 loss of assets would reduce the asset level in period

$t$+1 by the same amount). Another null hypothesis of $H_0$: $\gamma_{1i} = 0$ corresponds to complete recovery. If both hypotheses are rejected in favor of $-1 < \gamma_{1i} < 0$, partial recovery is suggested. Similar tests are conducted a year later using the coefficient estimate for $\gamma'_{1i}$. The test of $H_0$: $\gamma_{1i} = \gamma'_{1i}$ corresponds to no change in the recovery status between period $t$+1 and $t$+2. If it is rejected in favor of $-1 < \gamma_{1i} < \gamma'_{1i} \leq 0$, it is suggested that recovery continued between the two periods. Furthermore, a null hypothesis of $H_0$: $\gamma_{1m} = \gamma_{1n}$ is tested, where $\gamma_{1m}$ is $\gamma_{1i}$ for all $i$ belonging to category $m$ based on $X_i$ and $\gamma_{1n}$ is $\gamma_{1i}$ for other households. By testing this, we can determine which types of household are quicker to recover from damage caused by natural disasters.

## 3. DATA

### (a) 2010 floods in Pakistan

In July–August 2010, heavy torrential rains and flash floods severely affected human lives, livestock, infrastructure, crops, and livelihoods all over Pakistan. The Government of Pakistan assessed that more than 20 million Pakistanis had been affected, approximately 1.88 million houses damaged, 1,767 persons killed or missing, and 2,865 persons injured (Government of Pakistan, 2010). The province of Khyber Pakhtunkhwa was affected most; the main reason for this was the fact that the province was affected directly by rains and no flood warning had been issued as the flash floods had occurred at night.

In response to the disaster, relief activities were quickly organized by international and domestic nongovernmental organizations (NGOs) and government agencies. The Pakistani government also initiated the Watan Card program, to assist the flood-affected population in the reconstruction of damaged houses. Flood-affected families were registered for the program by the government authority and were issued ATM cards that were keyed to accounts to which a total of Rs. 100,000[4] was to be paid in five equal installments. These cards were distributed in

December 2010, and the first installment was paid between December 2010 and April 2011. In July–October 2011, the government issued Watan Cards in areas in which initial allotments had not been assigned. The second installment was delayed in most of Pakistan, due to the government's failure to secure related budgetary funding. Compared with the intensity of the damage, these aid inflows did not appear to be sufficient.

### (b) Panel survey

To assess the vulnerability and resilience of rural economies against this unexpected natural disaster, my research team implemented a two-period panel survey of village economies in Khyber Pakhtunkhwa, Pakistan; this was designed to be a pilot study for a larger survey to follow. We chose the district of Peshawar because it was one of the worst hit districts in the province and it was the district where we conducted a survey of three villages in the 1990s (Kurosaki & Hussain, 1999; Kurosaki & Khan, 2001).

As it was designed as a pilot survey, the sample was small and not strictly a random one. We chose 10 sample villages and 100 sample households (i.e., 10 from each sample village). We tried to include the three villages surveyed in the 1990s but failed in resurveying one of them due to security reasons. We chose the 10 villages so that they would be similar in terms of ethnicity and culture but different in two measures of economic development: geographical access to markets and the percentage of agricultural land under irrigation. In rural Khyber Pakhtunkhwa, unirrigated villages and villages farther away from main roads are poorer than others. After village selection and village-level surveys were undertaken, we indeed found that in such villages, other development indicators were also poor. In finalizing the list of study villages, we also made sure that there was variation regarding the number of damaged houses and the number of persons killed or severely injured across the study villages. The characteristics of the sample villages are illustrated in Appendix Table 1.

We conducted the first round of the survey between December 2010 and February 2011. In the survey, we collected village-level information from knowledgeable villagers[5] via a structured questionnaire. Using a structured questionnaire for households, we surveyed 10 households in each village. We chose these households such that both relatively rich and poor households, as well as households both severely and mildly affected by flood damage, would be included. Judging from the within-village variation in the dataset, this was successfully achieved. Kurosaki & Khan (2011) provide details about the first round survey and the characteristics of the surveyed villages and households.

Important findings from the first round of the panel survey include the followings (Kurosaki & Khan, 2011). (1) There were both between-village and within-village variations in flood damage. (2) Different types of damage were not highly correlated. (3) Aid distribution across villages appeared to be well targeted toward severely affected villages. (4) Aid allocation within villages was targeted toward households whose houses had sustained greater damage, but not toward households with greater damage to land, crops, or other assets. (5) Aid recipients did not show higher or lower levels of recovery than did non-recipients.

To collect information on changes since the first round of the survey, we conducted the second round survey approximately 12 months after the first round, between December 2011 and January 2012. The second survey successfully covered all 10 sample villages and 100 sample households. We thus compiled a balanced panel of 100 household observations. In the re survey, we collected detailed information on changes in household demography, labor force, physical and monetary assets, aid received, and so on.

Soon after the two rounds of the panel survey, we tried to arrange for the main survey but failed as law and order in the area under study had worsened due to terrorist attacks and armed sectarian conflicts.[6] As a result, we were left with a small panel dataset of 100 households.

### (c) Tribal society

All 10 villages are populated by the Pakhtuns, who are famous for their tribal codes known as *Pakhtunwali* (Ahmed, 1980). Under *Pakhtunwali*, actions contributing to the preservation of the honor of the family and clan are highly valued. Such actions include showing hospitality and providing shelter to visitors in need; seeking justice and taking revenge against wrongdoers; respecting equality among adult males; and defending property, the weak, and women. In Pakhtun villages, most farmers are engaged in mixed farming; single farms engage both in raising livestock and cultivating crops. Land and livestock are important assets but the Pakhtuns regard them as mere means for the maintenance of *Pakhtunwali*.

As demonstrated by Ahmed (1980), *Pakhtunwali* rules everyday life more strictly in the Federally Administered Tribal Areas than in settled areas of Khyber Pakhtunkhwa, which includes Peshawar District. However, villages in Peshawar District are still clearly different from villages in the Punjab or Sindh Provinces of Pakistan. The first difference is with regard to house structure. Most village houses have walls to conceal women from passers-by. Richer households maintain a guest space called *Hujra*, which may be a separate room or an outdoor sitting area. Second, most villages have an institution called *Jirga*. A *Jirga* is an informal group of traditional leaders and functions as an informal dispute-solving institution. The *Jirga* makes decisions by consensus and according to the teachings of Islam. For a man to become a *Jirga* member means that he is a respected leader practicing *Pakhtunwali*.

Therefore, house structure and the institution of *Jirga* symbolize *Pakhtunwali* in villages in Peshawar District. All 10 villages under study shared these two characteristics.

### (d) Characteristics of sample households

Table 1 summarizes the household-level data.[7] On average, household heads (all of whom were males) were 47 years old and had received 6.9 years of schooling. In the sample, 16% were traditional leaders—village heads, *Jirga* heads, or *Jirga* members. These positions are not inherited. The percentage of traditional leaders in the dataset appears higher than in the population. As we expected the role of those leaders to be critically important in understanding post-disaster recovery, we included them in the survey. How different their asset dynamics are from others is indeed one of the main questions addressed in this paper. If a household is headed by such a traditional leader, it is likely that the household preserves *Pakhtunwali* well, operates large landholdings, and has a better network of personal support.

<Table 1 here>

The average household size increased by 0.35 persons over the previous year. Most of this increase was attributable to new births—another indicator of recovery. The average number of working household members increased by 0.23 persons over the previous year (not shown in the table). Most of the new jobs were in the private sector, in which low-paid, daily wage labor predominates. This indicates that after the floods, reconstruction activities increased the demand for such labor. The increase in the working population may have resulted from the pressure to generate more income to reconstruct houses and other properties.

As shown in Table 1, prior to the floods, households had average landholdings of 3.7 acres. These figures are smaller than the national average but similar to average landholding acreage in Peshawar District. The average value of land assets was Rs. 4.6 million; the median value was Rs. 1.0 million. Regarding land distribution, the average figure may be misleading since as many as 42% of the sample households did not own any land. Owing to this skewed distribution, the median acreage for landholdings was only 1.0 acre. Livestock was another physical asset of importance for the sample households. About 58% of the sample households owned large livestock animals such as cattle and buffalo; 78% of them owned some kind of livestock animals, including goats and poultry. Livestock assets are thus more equally distributed than land assets; nonetheless, their distribution is not completely egalitarian, resulting in a large difference between the mean (Rs. 74,000) and median (Rs. 34,000). Adding other business assets such as poultry sheds, apiculture facilities, etc. to land and livestock, I compiled the empirical variable for productive assets, corresponding to $A_t$ in Section 2; I obtained a mean of Rs. 4.7 million and a median of Rs. 1.1 million. The distribution of $A_t$ was thus characterized by a large mass of households at or around the poverty line and a small pool of middle-class households. Each of the large mass holds a small lot of assets, whereas the asset levels of the small middle class are comparatively and distinctively higher. This pre-flood distribution is similar to that seen in the panel data from 1996/97–1999/2000 (Kurosaki & Hussain, 1999; Kurosaki & Khan, 2001), where the welfare levels of the former group were at around the income poverty line while those of the latter group were above the poverty line.

These households sustained substantial damage in the 2010 floods (see Panel 4, Table 1). The extent of house damage was based on the estimated cost of reconstruction or repairs. In the study area, people do not use houses as liquid assets. Sales transactions are extremely rare and mortgaging houses is unknown in the villages. Standing crops were damaged heavily as well.

Panel 5, Table 1, summarizes information on aid received. Slightly less than one-half of the sample households received emergency aid from NGOs, emergency aid from the government, and Watan Cards. The total aid received was only 5% of the estimated value of the flood damage. Therefore, on average, aid received was not large relative to the flood damage. Nevertheless, for those households whose initial wealth level was not high and which had suffered substantial losses to houses, the percentage was much higher (20–30% of the flood damage).

**(e) Asset dynamics**

Panel 6, Table 1, shows changes in productive assets from the pre-flood level. Changes that had occurred by the first survey correspond to $g_i$ in equation (1) and changes that had occurred by the resurvey correspond to $g'_i$ in equation (2). The mean of $g_i$ and $g'_i$ is negative but its absolute value is smaller than the direct loss due to floods, suggesting partial recovery as a whole. By the time of the resurvey, 10% of the sample households experienced an increase in their assets in comparison with the pre-flood level.

I calculated the value of productive assets as a percentage of the pre-flood level for the entire sample. The 2010 floods reduced asset levels to 98.2% of pre-flood levels. Subsequently, asset levels recovered to 98.7% by the end of 2010 and to 99.5% one year after. The magnitudes of the shock may appear small, but this is due to the predominance of land in the total value of productive assets. Only a small portion of land owners experienced capital losses to their land (erosion, destruction of irrigation facilities, etc.). Flood damage as the percentage of annual income was much higher, roughly on the order of 10–30% on average.[8]

<Figure 1 here>

Figure 1 plots these percentages, distinguishing different types of household. In Panel (a), the dotted line represents the asset dynamics of villagers who did not suffer any damage to their productive assets, while the solid line represents those of villagers who suffered. By definition, asset levels did not change immediately after the floods among the former (dotted line). At the time of the first survey, however, their asset levels slightly declined and further declined a year after. These declines were mostly due to reduced numbers of livestock animals. The asset dynamics of the latter (solid line) resemble the pattern for the whole sample.

In Panel (b) of Figure 1, the dotted line represents the asset dynamics of villagers whose initial productive assets were larger than the median, while the solid line represents those of other villagers. Because livestock were more important than land in the asset portfolios of households that were initially poorer, the solid line (small initial assets) shows a larger decline in assets due to floods than does the dotted line (large initial assets). Recovery from the flood damage was quick among the initially rich but then decelerated.

There is heterogeneity between those who suffered substantial house damage and those who did not (Panel (c)) and between those households headed by a traditional leader and others (Panel (d)). The speed of recovery declined between the first survey and resurvey among those who suffered from substantial house damage and those headed by a traditional leader. These types of household had recovered more quickly at the time of the first survey than other households had. The reason for this deceleration is investigated further in the next section.

In the survey, we also collected information on the level of recovery, taking one of 11 percentage-point categories from 0 (no recovery) to 100 (complete recovery). The level of recovery was self-assessed; respondents were directly asked "How would you express the level of recovery of your house as a percentage (0 as no recovery, 100 as complete recovery to the pre-flood level) today?" The underlined "house" was changed to land, livestock, etc. to obtain a full picture. When respondents had difficulty giving a percentage, investigators helped using graphical representations. Although about one-third of our respondents did not complete primary education, they appeared to understand the question well, as the resulting numbers were mostly consistent with the information on current assets (in terms of quantity) obtained in interviews that took place prior to asking respondents the self-assessment question.

<Table 2 here>

The recovery rates at the ends of 2010 and 2011 are summarized in Table 2. At the end of 2010, recovery rates were higher for crops than for houses, land, or livestock; at the end of 2011, recovery rates were improved with respect to all kinds of damage. The average overall recovery rate was 86%, compared to 69% one year earlier. Especially with regard to crops and livestock, recovery was quick, and the average was close to 100%. On the other hand, recovery rates for land and houses were not very high. A substantial portion of the sample households reported that their recovery rates with regard to their land and houses were less than 50% at the end of 2011. In addition to their own resources, informal credit transactions played an important role in helping affected households rehabilitate their livelihoods and reconstruct their asset bases —47 respondents borrowed from informal sources and only 2 borrowed from institutional sources (resurvey data).

## 4. EMPIRICAL STRATEGY

As shown in the previous section, at the time of the resurvey, most of the affected households were in the process of recovering from flood damage. The recovery dynamics were heterogeneous and dependent on pre-flood household characteristics. In this section, I describe how to quantify the asset dynamics, based on the conceptual framework discussed in Section 2.

As the number of observations is small, I cannot estimate a model featuring many explanatory variables. To maintain degrees of freedom in the regression analysis, I ignore the potential non-linearity in asset growth. More concretely, I approximate $h(A_t)$ in equation (1) and $k(A_t)$ in equation (2) linearly. The first reason for this simplification is that the focus of this paper is not on testing the asset poverty trap hypothesis. The second reason is that non-parametric and parametric estimation of the function using data from the same district collected in the 1990s show that the function is approximately linear.[9] I also employ only three variables for $X_i$ in equation (1) and (2) to maintain degrees of freedom: household size (quantity of human capital), the household head's education (quality of human capital in the modern context), and the household head's traditional leader dummy (quality of human capital in the traditional context including the *Pakhtunwali* factor).[10]

With the parsimony in choosing explanatory variables, omitted variable bias is a concern, as is measurement error as the sample is not strictly random. To partially address these concerns, I include village fixed effects to control for unobservable village-level factors. With village fixed effects, I depend on within-village, between-household variation in flood damage to identify the γ parameters in equations (1) and (2). Thus, the basic specification I estimate is:

$$g_i = \gamma_0 A_{it} + \gamma_1 Z_{pi} + \gamma_2 Z_{ni} + \gamma_3 Z_{yi} + \beta_1 X_{1i} + \beta_2 X_{2i} + \beta_3 X_{3i} + \alpha_v + u_i, \quad (3)$$

where $\alpha_v$ is a village fixed effect. Using the resurvey data, a similar equation is estimated using $g'_i$ as the dependent variable.

To identify which group was more resilient, I extend equation (3) with interaction terms involving $Z_{pi}$:

$$g_i = \gamma_0 A_{it} + \gamma_{11} Z_{pi} D_i + \gamma_{12} Z_{pi} (1 - D_i) + \gamma_2 Z_{ni} + \gamma_3 Z_{yi} + \beta_1 X_{1i} + \beta_2 X_{2i} + \beta_3 X_{3i} + \alpha_v + u_i, \quad (4)$$

where $D_i$ is a dummy variable showing household *i* belonging to category *m*. To maintain degrees of freedom, I do not employ multiple categories simultaneously. Instead, I include one category in equation (4), one by one.

To supplement the estimation results based on equations (3) and (4), I estimate a different empirical model using the subjective percentage recovery in Table 2 as the dependent variable. Let $R_i$ be the recovery percentage of productive assets until period $t$+1. Note that

$$R_i / 100 = \{A_{i,t+1} - (A_{it} - Z_{pi})\} / Z_{pi} = 1 + g_i / Z_{pi}, \quad (5)$$

which indicates that by regressing $R_i$ on $X_i$, we can enrich our understanding of how $\gamma_{1i}$ in equation (1) varies with household characteristics $X_i$. To minimize potential omitted variable bias, I estimate a model with $R_i$ as the dependent variable and the same set of explanatory variables as equation (3), inclusive of the village fixed effect. An advantage of this approach is that I can estimate the model for house recovery. As houses are non-liquidatable in the study villages, no information is available regarding their pre-flood values in monetary terms. For this reason, I cannot estimate equation (3) or (4) using changes in house values as the dependent variable. Because houses occupy an important role in the tribal society under study, it is of great interest to analyze the house recovery dynamics quantitatively. Therefore, I estimate a model with $R_i$ for houses as the dependent variable.

One problem of using $R_i$ as the dependent variable is that it is not defined for households with $Z_{pi} = 0$. As shown in Tables 1 and 2, the number of households that suffered from flood damage to their land or livestock is much smaller than 100. Furthermore, the recovery rate for livestock reached 100% by the resurvey time, with no variation. For these reasons, I estimate the supplementary model for "overall" recovery and house recovery only.

In all regression analyses, flood damage variables are treated as exogenous. If they are endogenous to the household's asset decision-making, their coefficients may suffer from endogeneity bias. Although this is a valid concern, I cannot correct for it econometrically because of the small size of the dataset and the lack of appropriate instrumental variables. As the variation in flood damage is explained well by the household initial characteristics and village fixed effects (see Kurosaki & Khan, 2011), I hope that the inclusion of these variables as explanatory variables minimizes the endogeneity bias, if any.

## 5. CORRELATES OF THE RECOVERY PROCESS

### (a) Changes in productive assets

Table 3 reports the regression results for equation (3). The main parameter of interest, $\gamma_1$, is estimated at -0.68, which is different from both 0 and –1 at the statistical significance level of 1%. Therefore, partial recovery is suggested regarding the productive assets. A year after, $\gamma'_1$ is estimated at -0.27, again significantly different from both 0 and –1. $\gamma'_1$ is also significantly different from $\gamma_1$ at the 1% level. Thus the recovery process was continuing.

<Table 3 here>

In period *t*+1, neither house damage nor crop income damage affected the recovery of productive assets. However, in period *t*+2, house damage had a significantly negative coefficient. This appears to suggest that productive assets were not used to replenish reductions in income due to floods but used to reconstruct damaged houses. Looking at the coefficients on the three human capital variables, all of them are positive in period *t*+1 and the one on the education is statistically significant. In period *t*+2, in contrast, two of them have negative coefficients and the one on the traditional leader dummy is statistically significant. The significant coefficient implies that if a non-leader household had been headed by a traditional leader, the household's productive asset would have been lower by Rs. 89,500. Although this appears large (the mean asset reduction was Rs. 24,500), the amount is reasonable considering that the major portion of the liquidated assets was used for house reconstruction (the mean house damage was Rs. 139,000). The patterns shown in Table 3 appear to suggest that the undesirable impact of house damage on the recovery of productive assets was realized with a time lag and that the initial superiority in recovery among households with better human capital was lost over time.

Table 4 reports the regression results for equation (4) using four categories. First, as in Carter et al. (2007), I use the initial size of productive assets to divide the sample households. Second, I introduce, one-by-one, each of the three variables that have significant coefficients in Table 3 (flood damage to house, years of education, and traditional leadership status). As shown in Panel 1, Table 4, households with initially smaller productive assets recovered more slowly than did households with initially larger productive assets, similar to the findings in Cater et al. (2007) for Honduras. In this case, among the initially poor households, initial recovery was not different from zero (the null hypothesis of $\gamma_{11} = -1$ was not rejected). However, the difference between the two types of households was statistically insignificant.

<Table 4 here>

The interaction term with flood damage to houses shows an interesting contrast (Panel 2, Table 4). In period *t*+1, the difference was small and statistically insignificant. After a year, those whose houses had sustained substantial damage were still in the recovery process while those whose houses had sustained little damage had already completed recovery. The difference between the two types of household was statistically significant. Households headed by less educated heads had more difficulty in recovery in period *t*+1 (Panel 3). The null hypothesis of $\gamma_{11} = -1$ was not rejected. By contrast, households headed by more educated heads recovered with statistical significance. This contrast was reversed in period *t*+2. Households headed by less educated heads achieved full recovery by that time while more educated households were still in the recovery process. Although not statistically significant, a similar reversal can be seen in comparing households headed by traditional leaders and other households (Panel 4). Those with higher levels of human capital (both modern and traditional) enjoyed a quicker recovery a few months after the natural disasters; however, this superiority disappeared one year after. I speculate that the patterns shown in Panels 2-4 reflect concerns for house reconstruction, as discussed below.

**(b) Overall and house recovery**

Table 5 reports the regression results using recovery percentage points as the dependent variable. Regarding initial overall recovery, coefficients on household size and head's education are positive and significant. The coefficient on education indicates that if an uneducated household head had had 10 years of schooling, his household's overall recovery percentage would have been higher by 7.7 percentage points. Looking at the flood damage variables, coefficients on crop damage are insignificant, confirming the results in Table 3. Coefficients on productive asset damage and house damage are negative, as expected, but only the coefficient on house damage in the house recovery regression is statistically significant. The coefficient indicates that if the damage to a house had been Rs.100,000 greater, the household's house recovery percentage would have been lower by 5.7 percentage points. The coefficient on house damage is also negative with regard to overall recovery but statistically insignificant (*p*=0.197).

<Table 5 here>

After one year, the heterogeneity in recovery due to different levels of damage became more substantial. All four coefficients on productive asset damage and house damage are negative and statistically significant. An interesting finding is the positive and significant coefficient on the traditional leader dummy when the house recovery is the dependent variable. The coefficient indicates that if a non-leader household had been headed by a traditional leader, the household's house recovery percentage would have been higher by 12.9 percentage points. In contrast, the traditional leader dummy has a negative but statistically insignificant coefficient when the dependent variable is the overall recovery. The results in Table 5, when combined with those in Tables 3 and 4, suggest that compared with non-leader households, households headed by a traditional leader shifted their efforts to house reconstruction and repairs in period $t$+2, resulting in quicker house recovery but slower recovery with regard to productive assets.

**(c) Interpretations of the results**

The results in Tables 3–5 were found to be robust to various alterations.[11] These results can be summarized as two key findings. First, the recovery of productive assets was quite homogeneous in a few months after the floods excepting those that sustained more substantial damage to their productive assets and the superiority in recovery among more educated households. Second, the recovery of productive assets became more heterogeneous one year after. Those households that suffered from more substantial damage to their houses and were headed by a traditional leader experienced a deceleration in recovery speed. These findings show the importance of the traditional leadership within a village on the one hand and the interaction of productive and unproductive, non-liquidatable assets (i.e., houses) on the other.

I interpret this as a reflection of tribal codes prevalent in the study villages, known as *Pakhtunwali*. Within a context of increased terrorist attacks and violent conflicts, the 2010 floods damaged the houses of many villagers. In contrast, human casualties were relatively small and the field observations did not indicate that the floods had destroyed social capital or disrupted social norms. As a result of these factors, the sample households gave house reconstruction and repair high priority over productive asset recovery in order to preserve the honor of their families. This tendency became discernible after the immediate recovery phase was over, probably because flood victims were preoccupied with emergent relief during that phase.

As an anecdote to substantiate this interpretation, the dataset shows that 3 out of the 16 households headed by a traditional leader sold their cows between period $t$ +1 and $t$+2 and 2 out of the 16 sold a portion of their land. All five of these households spent the major portion of their revenues on their houses, employing fellow villagers for the reconstruction work. All five rated their house recovery at the time of the resurvey less than 100 percentage points.

Does the recovery process described so far indicate a recovery of the village economy to the initial asset distribution or a transition to a new regime with a different distribution of welfare levels and assets? The interaction terms in Table 4 indicate the tendency for initially asset-rich households to recover quickly. If this effect dominates, inequality in productive assets should be exacerbated as a result of turbulence due to the floods. On the other hand, those households with greater house damage had difficulty in recovering productive assets after a year. In addition, aid allocation was targeted towards those with lower initial assets, although weakly (Kurosaki & Khan, 2011). These tendencies work in the direction of reducing inequality in productive assets.

From the regression results alone, it is difficult to judge which effect dominates. However, as the floods did not destroy human capital and social capital (including the tribal codes), it appears to be safe to conclude that a drastic change in inequality in wealth cannot be the ultimate result of the 2010 floods. Thus, the tentative conclusion of this paper is that although damage stemming from the 2010 floods was massive, the resulting turbulence did not result in transition to a new regime with a completely different distribution of welfare levels and assets; instead, the rural economy seems to be recovering to the initial regime.[12]

## 6. CONCLUSION

This paper analyzed at the household level the process of recovering from damage caused by floods in Pakistan in 2010. The analysis was based on a panel survey of households conducted twice after floods in Peshawar District, Khyber Pakhtunkhwa, where tribal codes prevail and law and order are deteriorating. With regard to the initial recovery of productive assets from flood damage, it was found that households that initially had fewer assets and had sustained more extensive flood damage had greater difficulty in recovering. After one year, recovery was continuing, but with substantial heterogeneity across households. Those households that sustained more substantial damage to their houses and were headed by traditional leaders experienced a deceleration in recovery speed. My interpretation is that due to the tribal code of preserving the honor of the family, the sample households gave house reconstruction and repair high priority over productive asset recovery after the emergency phase was over. Because of the preservation of such social norms and human capital, I speculated that the village economy was gradually recovering towards the initial wealth distribution, which was characterized by a large mass of households whose welfare and asset levels were around the poverty line, together with a small grouping of middle-class households whose asset levels were sufficiently high to ensure them a welfare level above the poverty line.

The findings of this paper have several implications for policy-oriented research regarding household-level resilience against natural disasters in developing countries. First, the pattern of recovery dynamics is heterogeneous; thus, minute targeting is required. It is possible that without such a consideration, interventions for ameliorating the damage from natural disasters can be ineffective for certain households in affected areas. Second, the contrast found in this paper between the recovery process immediately after floods and the recovery process a year after appears to indicate that the recovery process at the household level is non-linear and time-varying. In such situations, a single "snapshot" survey after a disaster may not provide precise information on who needs to be supported. Additional knowledge gained from a resurvey could be substantial. Third, the recovery of productive assets should not be isolated from the need to replenish unproductive, non-liquidatable assets. The case studied in this paper is probably one where this need is strong, due to the conflict-ridden and tribal nature of the society.

Because of the small sample size and the limited information on returns on various types of assets therein, the conclusion of this paper is tentative and preliminary. Moreover, I cannot claim that the findings are generalizable to other settings. The provision of further support for this paper's findings and interpretations thereof is left to future research.

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**Notes**

[1] Available on http://www.emdat.be/natural-disasters-trends (accessed on October 25, 2011). In interpreting such data, attention must be paid to the possibility that the reported increase is partly due to an increased tendency to report, not necessarily an increase in the occurrence of disasters.

[2] Khyber Pakhtunkhwa is one of the four provinces that comprise Pakistan. The province was formerly known as the North-West Frontier Province.

[3] See Takasaki (2011) and references therein for further information regarding the allocation of aid after a natural disaster in developing countries.

[4] "Rs." stands for Pakistani rupees in 2010 prices. US$1.00 was approximately equal to Rs. 86.

[5] In each village, we interviewed a group comprising two to five villagers who knew the village well. Such knowledgeable villagers included social workers appointed by the government, union councilors, traditional village leaders such as *Jirga* members or village heads, and Islamic leaders.

[6] For instance, in 2012, 140 terrorist attacks occurred in Peshawar District, killing 170 and injuring 540 persons (Pak Institute for Peace Studies, 2013). All three figures were the highest among districts in Pakistan. All three figures were higher than the 2010 figures by 26 to 82%.

[7] As the number of households differ from village to village (Kurosaki & Khan, 2011), the 10 sample households represent a different number of fellow villagers. To control for the different sampling probabilities due to this reason, I could have used weighted statistics. Weighted statistics show qualitatively the same results (available on request). Because I do not have information to correct for the different sampling probabilities between leaders and non-leaders, I report unweighted statistics in Tables 1 and 2.

[8] Unfortunately, full information on household income or consumption was not available in the dataset. The percentage in the text was inferred from the partial information contained in Kurosaki & Khan (2011).

[9] See Kurosaki (2013), who shows that the dynamics are almost linear for livestock and land. The dataset used there is a panel dataset of approximately 300 households collected from three villages in 1996/97 and 1999/00. The absence of multiple equilibriums in the asset dynamics curve in Pakistan is also supported by Naschold (2013), who uses a dataset more representative of Pakistan than the one used by Kurosaki (2013).

[10] In addition to these variables, I also attempted a specification with aid received as an explanatory variable. As the added variable was insignificant robustly, I did not include it in specifications in this paper. The insignificance could probably be due to the mixing of the recovery-promoting effect of aid and the selection effect for aid toward households that

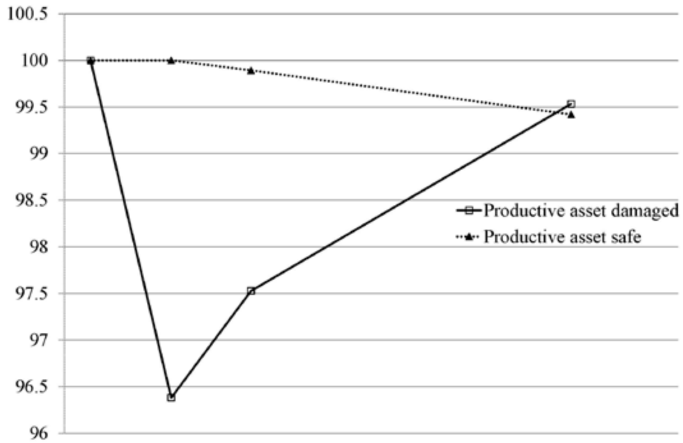
inherently have more difficulty in recovering.

[11] Namely, I tried different empirical definitions with respect to the pre-flood assets and adopted weighted least squares reflecting the difference in sampling probability instead of OLS, and Tobit specifications reflecting the limited range of the dependent variables. Details of these robustness checks are available on request.

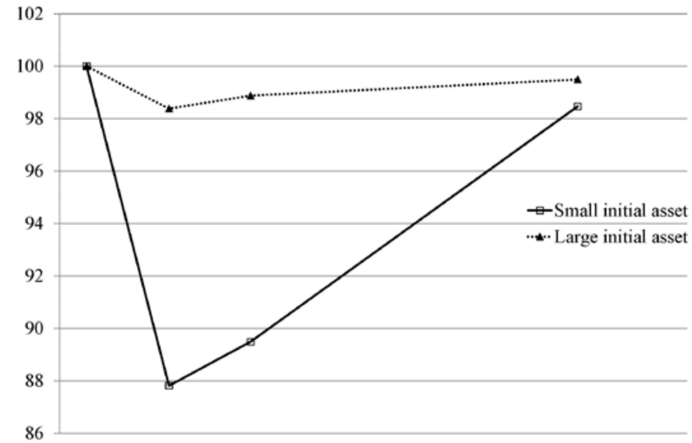
[12] This does not imply, however, that there were no individual households that suffered a sustained deterioration in their welfare levels. Public policies play an important role in supporting such households in the aftermath of devastating floods.

Figure 1. Productive assets as a percentage of the pre-flood level

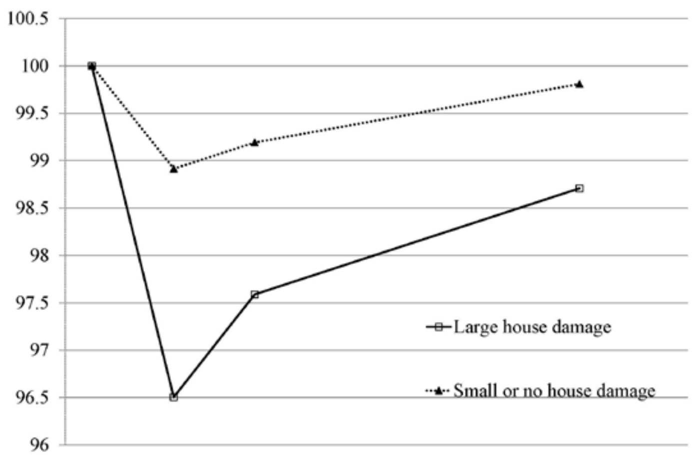
(a) Contrast by the size of flood damage to productive assets



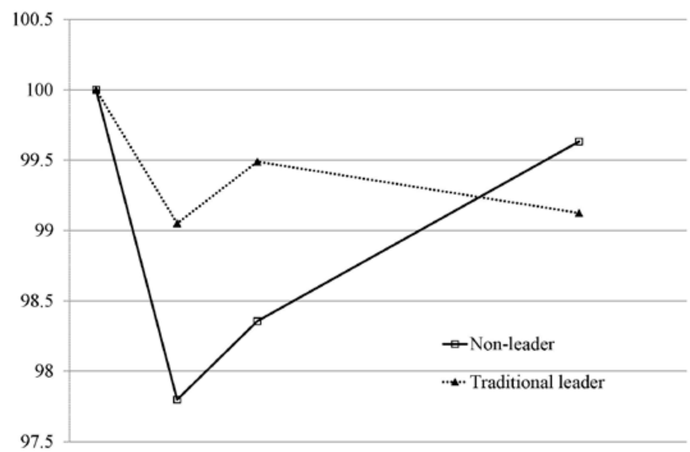

(b) Contrast by the size of initial productive assets




(c) Contrast by the size of flood damage to houses




(d) Contrast by the social status of the household head




Note: Four points correspond to the pre-flood level (reference), the level immediately after floods, the level at the first survey, and the level at the resurvey. (a) Out of 100 sample households, 48 suffered from flood damage to productive assets. (b)(c) 100 sample households were divided into 50 and 50 using the median as the threshold. (d) Out of 100, 16 were households headed by a traditional leader.

Table 1. Characteristics of the sample households, Khyber Pakhtunkhwa, Pakistan

| | Survey[a] | Mean | (Std.Dev.) | Median | Minimum | Maximum | Positive[b] |
|---|---|---|---|---|---|---|---|
| 1. Characteristics of household heads at the end of 2010 | | | | | | | |
| Age | 1 | 46.8 | (13.9) | 46.5 | 20 | 80 | 100 |
| Years of formal schooling | 1 | 6.88 | (6.03) | 8.00 | 0 | 16 | 62 |
| Village leader dummy[c] | 1 | 0.16 | (0.37) | 0.00 | 0 | 1 | 16 |
| 2. The number of household members | | | | | | | |
| End of 2010 | 1 | 9.45 | (5.01) | 9.00 | 2 | 38 | 100 |
| Change during 2011 | 2 | 0.35 | (0.98) | 0.00 | -2 | 3 | 37 |
| End of 2011 | 2 | 9.80 | (5.38) | 9.00 | 2 | 41 | 100 |
| 3. Productive assets before the 2010 floods | | | | | | | |
| Land ownership (acres) | 1 | 3.74 | (7.26) | 1.00 | 0 | 40 | 58 |
| Value of land owned (Rs.1,000) | 1 | 4553.0 | (9196.5) | 1025.0 | 0 | 60000 | 58 |
| Number of large animals[d] owned | 1 | 1.41 | (2.01) | 1.00 | 0 | 12 | 58 |
| Value of all livestock animals[d] owned (Rs.1,000) | 1 | 73.9 | (150.0) | 34.3 | 0 | 1250 | 78 |
| Value of all productive assets[e] owned (Rs.1,000) | 1 | 4668.2 | (9223.2) | 1097.6 | 0 | 60068 | 92 |
| 4. Damage due to the 2010 floods (Rs.1,000) | | | | | | | |
| House buildings | 1 | 139.1 | (139.8) | 127.6 | 0 | 650 | 87 |
| Agricultural land | 1 | 57.5 | (235.7) | 0.0 | 0 | 2000 | 19 |
| Standing crops | 1 | 417.1 | (1035.3) | 67.5 | 0 | 5250 | 75 |
| Livestock | 1 | 9.4 | (23.1) | 0.0 | 0 | 100 | 28 |
| Others | 1 | 17.9 | (108.9) | 0.0 | 0 | 1000 | 7 |
| Total | 1 | 641.0 | (1188.5) | 250.0 | 0 | 6770 | 99 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 5. Amount of aid received including the imputed value of in-kind transfers (Rs.1,000) | | | | | | | |
| Emergency aid from NGOs, 2010 | 1 | 6.1 | (8.6) | 5.0 | 0 | 40 | 46 |
| Emergency aid from the government, 2010 | 1 | 5.3 | (7.1) | 0.0 | 0 | 30 | 43 |
| Reconstruction aid from NGOs, 2011 | 2 | 2.6 | (12.2) | 0.0 | 0 | 100 | 7 |
| Reconstruction aid from the government, 2011 | 2 | 0.7 | (5.1) | 0.0 | 0 | 50 | 4 |
| Income transfer through Watan Cards | 2 | 9.8 | (12.6) | 0.0 | 0 | 40 | 42 |
| 6. Change in the sum of all productive assets[(e)] from the level before the 2010 floods (Rs.1,000) | | | | | | | |
| Change immediately after the floods | 1 | -84.7 | (275.2) | 0.0 | -2000 | 0 | 0 |
| Change by the first survey | 1 | -60.4 | (196.1) | 0.0 | -1401 | 0 | 0 |
| Change by the resurvey | 2 | -24.5 | (114.9) | 0.0 | -799 | 122 | 10 |

Notes: The number of observations is 100 (10 from each sample village). "Rs." stands for Pakistan rupees in 2010 prices.
(a) "Survey 1" corresponds to the first round (fiscal year 2010/11) and "Survey 2" corresponds to the second round (fiscal year 2011/12).
(b) This column indicates the number of sample households out of 100 that takes a positive value of the variable.
(c) When the household head is either a village head, *Jirga* leader, or *Jirga* member, the dummy takes the value of one. *Jirga* is a traditional dispute-solving institution in the Pakhtun society.
(d) "Large animals" include buffalo, cattle, horse, and mule. "All livestock animals" in addition include goat, sheep, and chicken.
(e) "All productive assets" include land, all livestock, and other business assets such as poultry sheds, apiculture facilities, etc.

Source: Two rounds of the panel survey data (same for the following tables and figure).

Table 2. The extent of recovery from the 2010 floods

| Type of recovery | Assessment period | Positive[a] | Frequency distribution of the recovery extent[a] | | | | | | | | | | | Summary statistics | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 0-9% | 10-19 % | 20-29 % | 30-39 % | 40-49 % | 50-59 % | 60-69 % | 70-79 % | 80-89 % | 90-99 % | 100% | Mean | (Std. Dev.) |
| Overall | End of 2010 | 99 | 3 | 2 | 0 | 3 | 3 | 24 | 4 | 12 | 21 | 6 | 21 | 69.0 | (25.3) |
| | End of 2011 | 99 | 0 | 0 | 1 | 1 | 3 | 4 | 3 | 10 | 8 | 17 | 52 | 87.3 | (18.8) |
| House | End of 2010 | 87 | 3 | 0 | 1 | 14 | 3 | 31 | 1 | 10 | 2 | 0 | 22 | 60.1 | (27.8) |
| | End of 2011 | 87 | 0 | 0 | 3 | 3 | 1 | 8 | 3 | 3 | 12 | 6 | 48 | 83.8 | (23.3) |
| Land | End of 2010 | 19 | 5 | 0 | 1 | 2 | 0 | 2 | 0 | 0 | 1 | 0 | 8 | 55.8 | (43.8) |
| | End of 2011 | 19 | 2 | 0 | 0 | 1 | 0 | 1 | 2 | 0 | 4 | 0 | 9 | 74.7 | (33.4) |
| Crops[b] | *Rabi* 2010/11 | 75 | 5 | 0 | 0 | 1 | 1 | 6 | 1 | 4 | 2 | 2 | 53 | 84.9 | (28.8) |
| | *Kharif* 2011 | 75 | 1 | 0 | 0 | 0 | 0 | 2 | 2 | 1 | 0 | 0 | 69 | 96.0 | (15.2) |
| | *Rabi* 2011/12 | 75 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 4 | 0 | 70 | 98.4 | (6.4) |
| Livestock | End of 2010 | 28 | 14 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 11 | 46.4 | (48.5) |
| | End of 2011 | 28 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 28 | 100.0 | n.a. |

Notes: (a) The recovery extent is a concept applicable only to those households with positive flood damage. Therefore, the sum of frequency distribution is the same as the number reported in the column named "Positive".
(b) *Kharif* is a monsoon season whose harvest comes on September-December (major crops: maize, rice, etc.) and *Rabi* is a dry season whose harvest comes in March-June (major crops: wheat).

Table 3. Recovery and growth of productive assets

| | Dependent variable: Change in the value of all productive assets from the pre-flood level | | | | | |
|---|---|---|---|---|---|---|
| | Change by the first survey | | | Change by the resurvey | | |
| | Coefficient | | (std.error) | Coefficient | | (std.error) |
| Pre-flood level of productive assets | -0.002 | | (0.001) | 0.001 | | (0.001) |
| Flood damage in monetary terms | | | | | | |
| Flood damage to productive assets: $\gamma_1$ | -0.683 | *** | (0.050) | -0.271 | *** | (0.081) |
| Flood damage to house | 0.008 | | (0.050) | -0.117 | * | (0.070) |
| Flood damage to crops | 0.013 | | (0.011) | -0.021 | | (0.014) |
| Household's pre-flood human capital indicators | | | | | | |
| Number of household members | 0.273 | | (1.310) | 2.616 | | (1.844) |
| Years of education of the hh head | 2.425 | ** | (0.941) | -0.556 | | (1.498) |
| Traditional leader dummy of the hh head | 22.08 | | (28.16) | -89.49 | ** | (45.07) |
| Village fixed effects | Yes | | | Yes | ** | |
| R-squared | 0.915 | | | 0.543 | | |
| F-statistics for zero slopes | 19.31 | *** | | 2.24 | *** | |
| F-statistics for $H_0$: $\gamma_1 = -1$ | 40.14 | *** | | 81.47 | *** | |
| F-statistics for $H_0$: $\gamma_1 = \gamma'_1$ (SUR estimation) | 138.06 | *** | | | | |

Notes: The number of observations is 100. Huber-White robust standard errors are shown in parenthesis. OLS regression with village fixed effects is employed. All monetary values are in Rs. 1,000 (2010 prices). The regression coefficient is significantly different from 0 at the 1% (***), 5% (**), and 10% (*) level.

Table 4. Heterogeneous recovery of productive assets

| Interaction term of "Flood damage to productive assets" | Change by the first survey: Coef. | | (std.error) | Change by the resurvey: Coef. | | (std.error) |
|---|---|---|---|---|---|---|
| | *Dependent variable: Change in the value of all productive assets from the pre-flood level* | | | | | |
| 1. Contrast by the initial productive assets | | | | | | |
| Damage*Dummy for "Small initial asset": $\gamma_{11}$ | -1.019 | ** | (0.452) | -0.681 | * | (0.374) |
| Damage*Dummy for "Large initial asset": $\gamma_{12}$ | -0.683 | *** | (0.050) | -0.271 | *** | (0.081) |
| F-statistics for $H_0$: $\gamma_{11} = \gamma_{12}$ | 0.54 | | | 1.26 | | |
| F-statistics for $H_0$: $\gamma_{11} = -1$ | 0.00 | | | 0.73 | | |
| F-statistics for $H_0$: $\gamma_{12} = -1$ | 41.00 | *** | | 81.81 | *** | |
| 2. Contrast by the size of flood damage to houses | | | | | | |
| Damage*Dummy for "Large house damage": $\gamma_{11}$ | -0.663 | *** | (0.054) | -0.305 | *** | (0.080) |
| Damage*Dummy for "Small or no house damage": $\gamma_{12}$ | -0.784 | *** | (0.166) | -0.065 | | (0.094) |
| F-statistics for $H_0$: $\gamma_{11} = \gamma_{12}$ | 0.43 | | | 4.13 | ** | |
| F-statistics for $H_0$: $\gamma_{11} = -1$ | 39.46 | *** | | 75.60 | *** | |
| F-statistics for $H_0$: $\gamma_{12} = -1$ | 1.71 | | | 99.26 | *** | |
| 3. Contrast by the schooling years of the household head | | | | | | |
| Damage*Dummy for "Lowly educated": $\gamma_{11}$ | -0.992 | *** | (0.073) | -0.014 | | (0.097) |
| Damage*Dummy for "Highly educated": $\gamma_{12}$ | -0.635 | *** | (0.050) | -0.303 | *** | (0.081) |
| F-statistics for $H_0$: $\gamma_{11} = \gamma_{12}$ | 13.21 | *** | | 4.88 | ** | |
| F-statistics for $H_0$: $\gamma_{11} = -1$ | 0.01 | | | 102.84 | *** | |
| F-statistics for $H_0$: $\gamma_{12} = -1$ | 52.50 | *** | | 73.98 | *** | |
| 4. Contrast by the social status of the household head | | | | | | |
| Damage*Dummy for "Non-leader": $\gamma_{11}$ | -0.694 | *** | (0.052) | -0.272 | *** | (0.083) |
| Damage*Dummy for "Traditional leader": $\gamma_{12}$ | -0.469 | | (0.333) | -0.252 | | (0.231) |
| F-statistics for $H_0$: $\gamma_{11} = \gamma_{12}$ | 0.44 | | | 0.01 | | |
| F-statistics for $H_0$: $\gamma_{11} = -1$ | 34.86 | *** | | 76.59 | *** | |
| F-statistics for $H_0$: $\gamma_{12} = -1$ | 2.54 | | | 10.53 | *** | |

Notes: Each panel corresponds to a regression model in which the full set of village fixed effects and 7 explanatory variables other than "Flood damage to productive assets" are included (full regression results are available on request from the author). Panels 1-3: 100 sample households were divided using the median as the threshold (Panels 1-2 with the 50-50 division, Panel 3 with the 51-49 division). Panel 4: Out of 100, 16 were households headed by a traditional leader. See Table 3 for further notes.

Table 5: Overall and house recovery status

| | Dependent variable: Recovery status in percentage points | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Recovery by the end of 2010 | | | | | | Recovery by the end of 2011 | | | | | |
| | Overall | | | House | | | Overall | | | House | | |
| Pre-flood level of productive assets | 0.046 | | (0.035) | 0.003 | | (0.035) | -0.012 | | (0.011) | 0.002 | | (0.034) |
| Flood damage in monetary terms | | | | | | | | | | | | |
| Flood damage to productive assets: $\gamma_1$ | -0.552 | | (0.565) | -0.429 | | (0.728) | -0.902 | ** | (0.360) | -1.573 | ** | (0.723) |
| Flood damage to house | -2.370 | | (1.824) | -5.664 | * | (2.856) | -2.058 | ** | (0.891) | -3.132 | * | (1.837) |
| Flood damage to crops | -0.025 | | (0.305) | 0.284 | | (0.358) | 0.091 | | (0.109) | 0.159 | | (0.296) |
| Household's pre-flood human capital indicators | | | | | | | | | | | | |
| Number of household members | 0.932 | ** | (0.465) | 0.828 | | (0.614) | 0.001 | | (0.180) | -0.220 | | (0.339) |
| Years of education of the hh head | 0.773 | * | (0.419) | 0.320 | | (0.628) | 0.137 | | (0.201) | 0.586 | | (0.385) |
| Traditional leader dummy of the head | 9.24 | | (7.20) | 11.54 | | (9.74) | -2.41 | | (4.10) | 12.90 | ** | (6.18) |
| Village fixed effects | Yes | *** | | Yes | | | Yes | *** | | Yes | *** | |
| R-squared | 0.337 | | | 0.324 | | | 0.716 | | | 0.441 | | |
| F-statistics for zero slopes | 3.69 | *** | | 3.39 | *** | | 10.88 | *** | | 5.68 | *** | |
| Number of observations | 99 | | | 85 | | | 99 | | | 85 | | |

Notes: Huber-White robust standard errors are shown in parenthesis. OLS regression with village fixed effects is employed. The regression coefficient is significantly different from 0 at the 1% (***), 5% (**), and 10% (*) level. The recovery status is defined only for the subsample that suffered from flood damage, resulting in a smaller number of observations than in Tables 3-4.

Appendix Table 1: Characteristics of the sample villages

| | Indicators of economic development | | | | Damage caused by the 2010 floods | | | |
|---|---|---|---|---|---|---|---|---|
| | Access to an arterial road | | Distance to the nearest market (km) | Irrigation ratio of agricultural land (%) | Percentage of households that suffered from: | | Number of persons who were: | |
| Village No. | Distance (km) | Status of the access road | | | Complete destruction of their house | Major damage to their house | Killed | Seriously injured |
| 1 | 2 | paved | 3 | 100 | 15 | 25 | 1 | 3 |
| 2 | 1 | paved | 3 | 94 | 13 | 42 | 0 | 4 |
| 3 | 10 | partially paved | 10 | 50 | 7 | 10 | 0 | 0 |
| 4 | 17 | unpaved | 5 | 10 | 15 | 17 | 1 | 20 |
| 5 | 8 | partially paved | 8 | 58 | 5 | 17 | 0 | 0 |
| 6 | 16 | partially paved | 16 | 64 | 7 | 33 | 1 | 0 |
| 7 | 6 | partially paved | 6 | 92 | 24 | 26 | 1 | 0 |
| 8 | 11 | unpaved | 11 | 78 | 2 | 3 | 0 | 0 |
| 9 | 10 | partially paved | 10 | 86 | 1 | 8 | 1 | 0 |
| 10 | 2 | partially paved | 10 | 75 | 10 | 17 | 0 | 0 |