

# RURAL HOUSEHOLDS COPING MECHANISMS IN RESPONSE TO THE 1998 FLOOD IN BANGLADESH

Amineh Kamranzadeh

## Abstract

In this paper, the immediate effects of the 1998 flood in Bangladesh on the well-being of rural households are studied using the International Food Policy Research Institute panel data. Furthermore, the coping mechanisms employed by households in response to the crisis are identified. During this period, households managed to reallocate labor supply within household to smooth out consumption. Number of household members engaged in self-employment increased in response to the weakened formal sector. In addition, households postponed their expenditures on semidurables to mitigate fluctuations in their food consumption. Finally, wealth was found to be the most effective smoothing mechanism. Particularly, jewelry was found to play a significant role in consumption-smoothing.

## Introduction

The 1998 flood in Bangladesh is considered as one of the most severe national crisis of the country. The magnitude of the flood is stunning when compared with other seasonal floods of the country and is expected to have significant impacts on the well-being of the individuals exposed. Since the magnitude of the crisis was to a large extent unanticipated, we consider the 1998 flood as an *unanticipated adverse shock*. The panel data used in this study provides a unique opportunity to capture the immediate effects of the shock on the well-being of rural households in Bangladesh.

The coping mechanism employed by households to smooth out the effects of such adverse shocks can take many forms. In this study we focus on asset-based coping mechanisms, paying special attention to the value and type of assets used in the adaptation process. We also consider other coping mechanisms such as reallocation of labor supply, and reallocation of expenditures on semidurables. Finally, we seek to identify the characteristics of household that are correlated with the capacity of consumption smoothing. Prior to examining households' capacity to smooth consumption, we control for shock exposure heterogeneity across households. Based on the community-level data, we use percentage of land affected by flood across villages to measure the magnitude of shock experienced across households. Furthermore, given the big advantage of having panel data, we control for time-invariant unobserved heterogeneity across households by including household fixed effects.

The next section provides a background of the 1998 flood in Bangladesh and is followed by a description of our dataset and literature review. The last section reports our main findings from this study and conclude the paper.

## Bangladesh Context

Bangladesh is prone to coastal flooding and bursting of river banks due to its extensive sea coastline and being situated on the Ganges Delta. Annually, about 18% of Bangladesh is flooded during the monsoon season from June to September. The 1998 flood is marked as one of the most severe floods in Bangladesh with more than 75% of the country land and 30 million people affected by the flood (Shah 1999).

Given that seasonal flooding is nothing new in Bangladesh, the people and economy of Bangladesh have adapted over years to the consequences of seasonal flooding. However, the severity of the 1998 flood was unanticipated. This flood lasted for an unprecedented eleven weeks – in comparison to the previous severe flood in 1988 that lasted only two weeks - and

caused one of the most catastrophic devastation in the nation in terms of death toll, crop damage and financial loss. The eleven-week flood led to the death of 1050 people, 4.5 million tons of damaged crops, and 142,160 million Taka in financial loss (Shah 1999).

### **Data**

The survey panel data used in this paper was conducted by International Food Policy Research Institute (IFPRI) in collaboration with the Food Management and Research Support Project (FMRSP), Ministry of Food, Government of the People's Republic of Bangladesh. The data collected covers 754 households in seven flood-affected rural areas at three points in time over a period of a year between August 1998 and April 1999. The main objective of the survey was to address concerns about food security and calorie intake in the rural areas in the period following the flood. However, the survey covers many other topics in the household and community level.

Topics in the household survey include household composition, education, employment and training, agricultural activity, fishing and livestock activity, allocation of family labor, household assets, and food and nonfood spending. Topics in the community survey include the level of agricultural production, employment, prices, economic activity, and information about the flood at the thana, union, and village level.

Since two rounds of the data collection was conducted in the period following the crisis and includes detailed information about household's composition, assets, and expenditures, we are able to capture the difference in the consumption due to the crisis and study households coping mechanisms to smooth out the effects of the unanticipated shock.

### **Literature Review**

The coping mechanism employed by individuals to smooth out the effects of adverse shocks can take many forms. The literature on coping mechanism revolves around the *lifecycle hypothesis*, which states that individuals seek to smooth out consumption in order to keep the marginal utility of consumption constant across periods. In other words, they tend to save when income is high and dissave when income is low (Frankenberg et al 2003).

Moreover, individuals try to avoid concentration of declining consumption in a single or relatively few time periods. The extent to which they can smooth out consumption depends on the markets with which they interact. "Additional resources are required to finance current consumption at levels above the now "shock" depleted levels of current income" (Frankenberg et al 2003). In the absence of liquidity constraints, we assume households will borrow capital and pay back when conditions have improved (Townsend 1993; Platteau 1991). In the case of Bangladesh, however, we assume that liquidity constraints were binding. Although the crisis did not lead to the collapse of the banking system, we expect that the formal financial sector was weakened.

Deaton (1992) also emphasizes on the incompleteness of formal financial markets and the ubiquity of credit and liquidity constraints in low-income economies. Given the absence of insurance contracts and in the presence of borrowing constraints in developing countries, households have lower capacity to manage risk and spending down assets serves as the main mechanism to smooth fluctuations in per capita expenditure. Deaton's (1992) intertemporal model of risk coping under borrowing constraints assumes that households have access to a single buffer asset (such as grain), and that income levels are independent of asset holdings. Therefore, "for impatient agents whose discount rate exceeds the rate of return on the buffer asset, the only cost of such savings is postponed consumption." However, the costs associated with savings become considerably more complex if the savings asset is either a productive asset or if agents have an opportunity to choose among multiple assets. Rosenzweig and Wolpin (1993) discuss that selling productive assets such as land or farm has powerful implications for future consumption and the decisions regarding selling productive assets highly depend on the intertemporal substitution.

In addition to the productivity of the asset, liquidity is another important dimension. Assets that are relatively more liquid are used more to smooth out consumption in time of crisis. Housing, land, and durables are the least liquid; Moreover, their prices tend to fall at the onset of the crisis. Financial assets, including cash and stocks, are the most liquid assets, however, the values of these assets also drop significantly. Frankenberg et al (2003) find that gold was the most used asset in Indonesia in response to the Asian financial crisis. This is due to the fact that gold held its price at the prevailing world price. Similarly, using a ten-year panel data, Quisumbing (2011) finds that jewelry remains the most important storage of value in Bangladesh. Since the market for gold is very active and is a relatively liquid asset, and more importantly due to its capital appreciation in contrast to the depreciation of the national currency in times of crisis, jewelry is considered an important tool for smoothing consumption (Rakib and Matz 2014, Quisumbing 2011, Frankenberg et al 2003).

Furthermore, Zimmerman and Carter (2002) find that asset-based risk coping is highly correlated with initial wealth and portfolio rate of return, implying that initial asset inequality reproduces and deepens itself over time. They find that poor individuals, in contrast to wealthier individuals, respond to shocks by destabilizing consumption in order to defend or smooth their asset base. The role of initial wealth and asset-smoothing versus consumption-smoothing among poor individuals has received little attention in the literature. Nonetheless, Lipton (1993) also discusses that risk management is not only more expensive for the poor, but also creates a poverty trap. His model finds a “Micawber Threshold”, below which the agent selects a defensive portfolio strategy and is never able to improve his living standards.

Besides asset-based smoothing, there are other mechanisms that individuals might employ to smooth fluctuations in the marginal utility of consumption. Households may seek to share risk among people within a community (Townsend 1993; Platteau 1991); or across communities through public or private transfers (Rosenzweig and Stark 1986). Households may also reallocate their spending on durables and semidurables. While some parts of the consumption bundle (such as food) cannot be altered due to the crisis, some parts such as durables and semidurables are more likely to be substitutable. For example it is reasonable to assume that postponing expenditures on clothes will not have a significant effect on life-time utility, whereas postponing expenditures on staples surely does (Frankenberg et al 2003).

Another coping mechanism discussed in the literature is changes in household living arrangements. This may include taking advantage of economies of scale (Frankenberg et al 2003) or reallocation of different types of members of extended families across different households (Rosenzweig 1988, 1996). The former “involves a tradeoff between taking advantage of economies of scale in consumption and the utility derived from individual or subfamily privacy” and the latter is based on the idea of relocating the net consumers in the household to live with relatives who are not suffering from lower consumption due to the crisis.

Some studies also find changes in work effort and type of work undertaken by household members, which may also lead to migration, as a coping mechanism (Davis and Ali 2014). Also, since real wages tend to decline after a crisis, one would expect substitution away from time at work, so leisure would increase and work hours fall. “While there will presumably be a countervailing income effect that would encourage additional work effort, there is no reason to expect the income effects would offset substitution effects in this context (Frankenberg et al 2003).” Changes in type of work is also attributed to the fact that self-employment offers more flexibility in choosing hours of work, and the self-employed are better able to exploit new opportunities. “Even if jobs in the formal wage sector are difficult to find because of the crisis, opportunities may exist for expanded work effort in family businesses and farms (Frankenberg et al 2003).”

A study by Rakib and Matz (2014) specifically focuses on asset-based coping in Bangladesh. They investigate changes in assets owned by the household head, his/her spouse, or jointly by both of them. They find that jointly owned assets are not sold in response to shocks, “either due to

these assets being actively protected or due to the difficulty of agreeing on this coping strategy (Rakib and Matz 2014).” Another study by Davis and Ali (2014) explores adaptation to climate change in rural Bangladesh. They find that adaptation and coping mechanisms varied according to location, livelihood, and the assets and endowments people have at their disposal. Furthermore, respondents long-run coping mechanisms were changing cropping patterns, and changes in occupation and migration, as many move into small nonagricultural businesses or migrate to urban centers or even internationally for work. Finally, the paper by Frankenberg et al (2003) focuses on the immediate effects of the Asian crisis on the livelihood of Indonesians. They find that although the average level of consumption severely declines after the crisis, for some households, the crisis brought new opportunities. The study also finds distinct range of coping mechanism such as exploiting benefits of economics of scale, increase in labor supply, and decrease in spending on semidurables while maintaining expenditures on foods.

## **Results**

This section reviews our findings regarding the rural households’ capacity to smooth out the effects of the adverse shock. We begin by discussing our findings regarding the immediate effects of the flood on the household’s well-being. In line with what is standard in the literature, we interpret level of consumption as indicative of household’s well-being.

Second, we present our findings on coping mechanisms employed by the households in response to the shock. We focus on the mechanisms that seem to have significantly helped households to mitigate the effects of the shock. First, we discuss our evidence on reallocation of expenditures on semidurables, and present our findings on changes in labor supply and types of work. Next, we focus on asset-based coping mechanisms and discuss changes in asset holdings and types of assets in the period following the crisis. Lastly, we examine the correlation between changes in consumption and asset holdings along with other household characteristics that are likely to be associated with consumption smoothing.

### **A. Changes in Household Consumption**

The first round of the panel data was largely collected before the crisis – the indefinite overlap between data collection and crisis is discussed in the limitation section of the paper. The next two rounds of data were collected four months and eight months after the crisis. As a result, we have a unique opportunity to investigate the immediate effect of the crisis on households in terms of changes in their level of consumption.

Mean levels of total household consumption are reported in the first row of Table 1 along with changes in consumption between the three time periods. Total household consumption drops by 28% in the period between August 1998 and January 1999. This is the immediate period following the crisis and best captures the immediate changes in consumption due to the crisis. Total household consumption reduces remarkably less (8%) in the subsequent period (between January 1999 and April 1999). The last column in Table 1 reflects the overall changes in consumption between the first and last round of panel data. Overall, total household consumption was reduced by 34% between August 1998 and April 1999. (Throughout the paper, we will refer to August 1998 as period 1, January 1999 as period 2, and April 1999 as period 3).

Using the data on household size, we have also estimated changes in per capita consumption. Second row in Table 1 reports changes in per capita consumption between the three different periods. Per capita consumption drops by 32% between the first and second period, and by stunning 40% between first and third period. We find that the magnitude of reduction in consumption is larger for per capita consumption. This implies that households with more members suffered more from fluctuations in consumption. We will further examine the implied relation between household size and changes in consumption in our regression model.

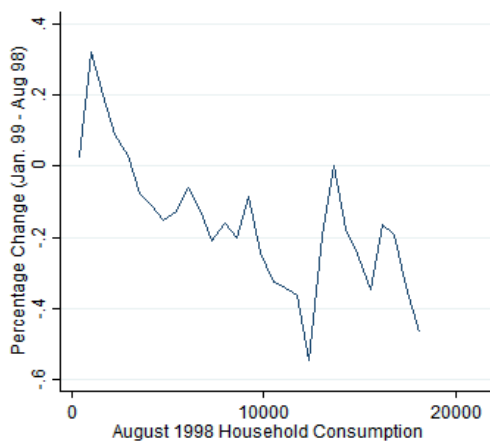
**Table 1**  
**Household Consumption and Changes; Means (standard errors in parentheses)**

	<b>August 1998(t1)</b>	<b>January 1999 (t2)</b>	<b>April 1999 (t3)</b>	<b>Percent Change (t2-t1)</b>	<b>Percent Change (t3-t2)</b>	<b>Percent Change (t3-t1)</b>
<b>Total Household Consumption</b>	4054 (243)	2900 (185)	2662 (191)	-28% (60)	-8% (67)	-34% (54)
<b>Per Capita HH Consumption</b>	779 (29)	529 (17)	470 (13)	-32% (8)	-11% (4.7)	-40% (11)
<b>Per Adult Household Consumption</b>	1126 (49)	779 (23)	735 (24)	-31% (13)	-6% (11)	-35% (16)
<b>Composition of Household Consumption</b>						
<b>Food</b>	1876 (123)	1708 (126)	1444 (217)	-9% (4)	-15% (6)	-23% (3)
<b>Nonfoods</b>	2178 (128)	1190 (67)	1216 (78)	-45% (57)	2% (48)	-44% (53)

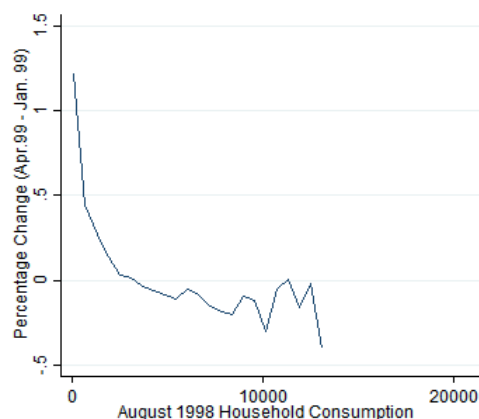
Note: Consumption measured in 1998 Bangladesh Taka

As we cannot assume that adults and children have equivalent level of consumption, we report per adult consumption and changes between three periods in the third row of Table 1. We find that, on average, changes in per adult consumption is less than changes in per capita consumption, which implies that children's well-being was more severely affected by the crisis.

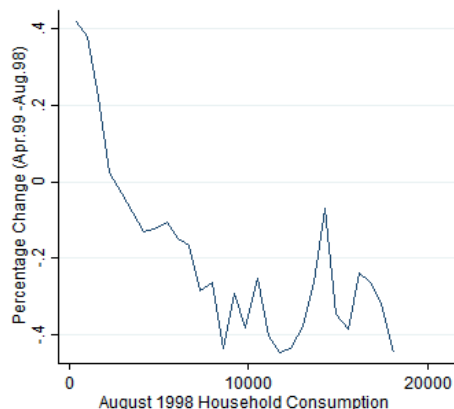
Finally, we break consumption into food and nonfood consumption to better understand the immediate effects of the crisis on the household well-being. As one would expect, food is a part of consumption bundle that can barely be altered. As a result, the decrease in consumption of food is significantly lower than the decrease in nonfood expenditures. Nevertheless, on average, household consumption of food drops by 9 percent in the period following the crisis- between first and second period. Interestingly, food expenditures are reduced more in the next period – between second and third period. This implies that initially household had relatively higher capacity to mitigate the effects of the shock on their food consumption, but their easing capacity eventually weakened after a few months. Overall –between first and third period, food consumption was reduced by 23% on average. Nonfood expenditures reflect a stunning 45% decline in the immediate period following the crisis. However, nonfood expenditures increased by 2% between January and April 1999.



(a)



(b)



(c)

Figure 1

The distribution of the changes in household consumption is presented in Figure 1, which demonstrates nonparametric estimates of the percentage change in household consumption between any two periods across the distribution of the prior consumption. The stunning finding that emerges from the distributions is that changes in consumption varies significantly across households. More specifically, households with initially better level of consumption experience showed much larger reduction in their consumption. Interestingly, it is also shown that households with the lowest initial level of consumption experienced a growth in their consumption after the crisis. For example, in Figure 1.a, where the distribution of changes in consumption between the first and second period is depicted, we see that while the upper quartile undergo a fall in consumption by 40% or more, the lowest part of bottom quartile sees a rise in their consumption by 30%. Table 2 lists the distribution of changes in household consumption ( $\Delta\text{HHC}$ ) for different quartiles.

**Table 2**  
**Distribution of Change in Household Total Consumption**

	Percentile of Change in Consumption				
	10	25	50	75	90
Changes between Aug. 98 - Jan. 99	-112	-106	-106	-402	-591
Changes between Jan. 99 - Apr. 99	-19	-91	-163	-186	-212
Changes between Aug. 98 - Apr. 99	-131	-349	-269	-587	-803

The nonparametric estimates presented in Figure 1 are driven using local polynomial regression and consumption level in the first period is used as the baseline level of consumption on the  $X$  axis. Because of the limitation of the panel data, we could not construct the distribution of changes across a more robust prior distribution as their baseline level of consumption. Meaning that we were not able to avoid biases due to correlated measurement error that will arise from regressing ( $\text{HHC}_{i1} - \text{HHC}_{i2}$ ) on  $\text{HHC}_{i1}$ . We could have avoided measurement error biases that arise from the mentioned regression, if we could regress the percentage change in consumption on a different preceding distribution of consumption. In other words, if the panel data had provided us with level of consumption from an earlier period we could have used that level as the households' baseline level of consumption on the  $X$  axis to avoid bias.

#### B. Smoothing Mechanism: Reallocation of Expenditures on Semidurables across Time

Our findings regarding reallocation of expenditures on semidurables is consistent with the literature. Literature suggests that the nonfood part of consumption bundle can be very responsive to income shocks, while food is poorly substitutable over time. We also find that the rural households in Bangladesh made drastic changes in allocation of their nonfood expenditures across time. As can be seen in Table 3, expenditure on goods such as housing investment, clothing, semidurables, and family events fall by more than 30%. This implies that households' investments on these goods are readily substituted over time and easily postponable.

For some items, however, we find mixed effects. For example, mean values of health expenditures is reported in row five, where it can be seen that health expenses drop by 56% between first and second period, but it increase by 51% between second and third period. We hypothesize that because of the magnitude of the crisis, postponement of health expenses was not feasible anymore between the second and third period. It may also be that delaying health expenditures in the period following the crisis has had severe consequences for some households and has caused them higher costs of health expenses in the subsequent period. Furthermore, our findings regarding education and personal care expenses are unexpected. While we anticipated that postponement of expenditures on education and personal care to not have a large effect on

lifetime utility and therefore be substituted over time, we find that investments on education and personal care were not postponed by the average household in Bangladesh.

Fuel and travel and transportation are also considered as a part of consumption bundle that is poorly substitutable over time. Furthermore, in times of crisis, we consider changes in household living arrangements as a coping mechanism, which include relocation of net consumers and migration of family members in search of better job opportunities. These assumptions can explain the increase in expenditures on transportation and fuel.

**Table 3**  
**Household Nonfood Consumption and Changes; Means (standard errors in parentheses)**

	<b>Aug. 98 (t1)</b>	<b>Jan.99 (t2)</b>	<b>Apr.99 (t3)</b>	<b>Percent Change (t2-t1)</b>	<b>Percent Change (t3-t2)</b>	<b>Percent Change (t3-t1)</b>
<b>Total Household Nonfood Consumption</b>	2217 (323)	1190 (406)	1216 (567)	-46% (141)	2% (62)	-45% (89)
<b>Housing (Rent and Repairs)</b>	1127 (872)	485 (365)	495 (371)	-56% (208)	0.1% (11)	-56% (53)
<b>Clothing</b>	212 (183)	144 (79)	127 (173)	-32% (28)	-11% (16)	-40% (35)
<b>Semidurable Goods</b>	71 (20)	19 (21)	20 (8)	-73% (16)	4% (6)	-71% (42)
<b>Health Expenses</b>	223 (208)	97 (46)	147 (129)	-56% (33)	51% (62)	-34% (98)
<b>Family Events</b>	825 (652)	210 (68)	534 (236)	-75% (302)	154% (205)	-35% (160)
<b>Education</b>	78 (68)	104 (82)	108 (77)	33% (20)	3% (12)	38% (53)
<b>Personal Care</b>	54 (13)	74 (32)	82 (41)	36% (28)	10% (51)	50% (44)
<b>Travel and Transportation</b>	96 (75)	133 (79)	159 (130)	38% (16)	20% (59)	65% (65)
<b>Fuel</b>	83 (14)	71 (23)	79 (57)	-15% (8)	11% (5)	-5% (14)

Note: Consumption measured in 1998 Bangladesh Taka

### C. Smoothing Mechanism: Reallocation of Labor Supply and Changes in Types of Work

A coping mechanism employed by households in times of crisis is modifying the labor supply of family members. In the formal wage sector, many of household members may experience losing their jobs or a decline in their real wage. On the other hand, literature suggests that household members may increase their contribution to household work, either by working on the farm or in the businesses owned by the household. Given the expected mixed effect on the reallocation of family supply, we examine different aspects of family labor supply by distinguishing number of workers and number of hours in different labor sectors. Table 4 lists composition of household



labor supply and changes over the time periods. Total number of workers in the household decline by 4% in the period following the crisis, and by 6% overall as shown in the first row of Table 4. This may be due to a major layoff and decline in real wages in the formal sector. Our assumption is validated once we find the fall in number of formal sector workers reported in second row of Table 4. Number of workers in the market sector drops by 24 percent in the period following the crisis.

**Table 4**  
**Household Labor Supply and Changes; Means (standard errors in parentheses)**

	<b>August 1998 (t1)</b>	<b>January 1999 (t2)</b>	<b>April 1999 (t3)</b>	<b>Percent Change (t2-t1)</b>	<b>Percent Change (t3-t2)</b>	<b>Percent Change (t3-t1)</b>
<b>Number of workers in household</b>	1.614 (0.8)	1.555 (0.67)	1.518 (0.71)	-4% (0.32)	-2% (0.12)	-6% (0.43)
<b>Number of market sector workers in household</b>	0.263 (0.02)	0.200 (0.01)	0.232 (0.01)	-24% (0.66)	16% (0.49)	-12% (0.08)
<b>Number of daily laborer and casual laborer</b>	0.536 (0.11)	0.621 (0.40)	0.473 (0.38)	16% (0.34)	-24% (0.07)	-12% (0.07)
<b>Number of self-employed workers in household (Own business)</b>	0.339 (0.06)	0.375 (0.03)	0.505 (0.02)	11% (0.01)	35% (0.04)	49% (0.11)
<b>Number of self-employed workers in household (Own farm)</b>	0.323 (0.09)	0.284 (0.12)	0.250 (0.18)	-12% (0.05)	-12% (0.10)	-23% (0.0.6)
<b>Number of unpaid family workers in household</b>	0.153 (0.08)	0.075 (0.04)	0.059 (0.03)	-51% (0.08)	-22% (0.01)	-62% (0.05)
<b>Number of hours worked per day</b>						
<b>Daily Laborer and Casual Laborer</b>	8.32 (2.11)	8.96 (1.79)	8.67 (2.45)	8% (0.04)	-3% (0.01)	4% (0.01)
<b>Self Employed (Own Business)</b>	7.34 (1.89)	7.73 (1.53)	8.07 (1.69)	5% (0.03)	4% (0.02)	10% (0.11)
<b>Self-employed (own farm)</b>	2.9 (0.56)	3.17 (0.17)	2.66 (0.18)	9% (0.10)	-16% (0.09)	-8% (0.05)

Literature suggests that self-employment increases as a coping mechanism in response to crisis as self-employed have higher flexibility in adapting working hours and are more capable of exploiting new opportunities. Our findings regarding self-employment is consistent with the literature as we also find that number of family members who own their own business increases by 35% between January 1999 and April 1999, and by 45% overall –between August 1998 and April 1999. Our finding on number of unpaid family workers is, however, puzzling. As discussed earlier, we expected higher contribution in the household work (farm or own business), but we find that number of unpaid family workers significantly falls. This might however, be due to the higher tendency of family members toward self-employment given the new opportunities.

The last three rows of Table 4 lists number of hours worked per day in different sectors. Daily laborer and casual laborer show mixed and insignificant changes in their hours of work. Row eight in Table 4 reports that number of hours in self-employment (in own business) increases by 10% overall. Finally, row nine reports that number of hours worked on own farm increases by 9% in the immediate period after the crisis, which is consistent with the fact that land in Bangladesh becomes more fertile after each flooding and more labor hours is required on the field to benefit from higher productivity of land. On the other hand, we see that number of labor hours on land decreases in the subsequent period, when the productive season of the land is over.

#### D. Smoothing Mechanism: Spending Down Wealth

In low-income countries, given the absence of insurance contracts and the presence of borrowing constraints, selling assets serves as the main consumption-smoothing mechanism by the households. It is expected that household with higher value of assets experience less fluctuations in their consumption. Beside the total value of asset holdings, it is expected that type of assets play an important role in mitigating the effects of the crisis. Literature suggests that households are mostly reluctant to sell their productive assets such as land and agricultural tools since selling these assets will have long-term negative consequences on the income of household. Furthermore, assets such as land and durables are relatively less liquid, which makes them specifically harder to sell in times of crisis. Finally, literature suggests that gold is the most used asset in asset-based smoothing mechanism given its liquidity and value appreciation in contrast to the depreciation of national currency. In this section, we study the changes in the value and type of household assets and further discuss the role assets play in helping household to mitigate fluctuations in consumption.

**Table 5**  
**Household Asset Holdings and Changes; Means (standard errors in parentheses)**

	<b>August 1998 (t1)</b>	<b>January 1999 (t2)</b>	<b>April 1999 (t3)</b>	<b>Percent Change (t2-t1)</b>	<b>Percent Change (t3-t2)</b>	<b>Percent Change (t3-t1)</b>
<b>Total Household Wealth</b>	26055 (4159)	23112 (9442)	20664 (4526)	-11%	-11%	-21%
<b>Land</b>	13064 (812)	11150 (567)	12110 (959)	-15%	9%	-7%
<b>Grain</b>	962 (972)	3974 (693)	1359 (778)	313%	-66%	41%
<b>Livestock</b>	1551 (862)	907 (709)	720 (207)	-42%	-21%	-54%
<b>Jewelry</b>	2823 (957)	1834 (800)	1516 (998)	-35%	-17%	-46%
<b>Consumer Durables</b>	956 (399)	650 (385)	726 (449)	-32%	12%	-24%
<b>Agriculture Tools</b>	3662 (712)	3187 (849)	2509 (724)	-13%	-21%	-31%
<b>Other Valuable Assets</b>	3034 (704)	1407 (906)	1722 (659)	-54%	22%	-43%

Note: Values measured in 1998 Bangladesh Taka

Table 5 demonstrates asset holdings and changes over the three time periods in 1998 Bangladesh Taka. Row 1 shows that on average households lost about 21% of their assets after the crisis. The only type of asset that increases is grain. As discussed earlier, there is evidence that flooding has a tremendous effect on making land more fertile in Bangladesh, therefore grain wealth increases by more than 300% in the period following the flood. However, grain also experiences a decline of 66% in the subsequent period following the heavy harvest.

As expected, since land is a productive and non-liquid asset, it does not undergo a severe fall. However, in the immediate period following the crisis, land wealth drops by 15%. It is not clear, however, that how much of the loss in land is due to being destroyed and washed away by the flood. Nonetheless, we suspect that a large part of loss in land may be associated with land being destroyed during the flood. Moreover, we provide percentile of change in wealth distribution in Table 6, and find evidence that the upper percentile experienced severe loss in land between January 1999 and April 1999, which is unlikely to be for consumption-smoothing purposes.

**Table 6**  
**Distribution of Change in Household Wealth**

	Percentile of Change in Wealth Distribution				
	10	25	50	75	90
<b>Changes between Aug. 98 - Jan. 99</b>					
<b>Land and housing</b>	-1100	-1950	-1125	10000	19750
<b>Grain wealth</b>	134	375	998	3107	6540
<b>Livestock wealth</b>	-50	-115	-694	-1525	-1992
<b>Jewelry</b>	-80	-400	-50	0	-3000
<b>Agriculture tools</b>	-135	-305	-750	3150	16975
<b>Durables</b>	-85	-150	-330	-75	-500
<b>Other valuable assets</b>	-200	-148	-350	-750	0
<b>Changes between Jan. 99 - Apr. 99</b>					
<b>Land and housing</b>	100	400	-875	-13000	-5000
<b>Grain wealth</b>	-110	-321	-800	-3034	-5291
<b>Livestock wealth</b>	10	20	25	75	335
<b>Jewelry</b>	-90	-150	-725	-200	500
<b>Agriculture tools</b>	-5	-55	50	2350	2000
<b>Durables</b>	-2	-10	-70	-275	500
<b>Other valuable assets</b>	200	198	250	500	1000
<b>Changes between Aug. 98 - Apr. 99</b>					
<b>Land and housing</b>	-1000	-1550	-2000	-3000	14750
<b>Grain wealth</b>	24	54	198	73	1249
<b>Livestock wealth</b>	-40	-95	-669	-1450	-1657
<b>Jewelry</b>	-170	-250	-675	200	-2500
<b>Agriculture tools</b>	-140	-360	-700	800	3525
<b>Durables</b>	-87	-160	-400	-350	0
<b>Other valuable assets</b>	0	50	-100	-250	1000

There is severe decline in livestock, durables, and agriculture tools as well. Again, we are not certain about how much of the decline in livestock is attributed to loss during the flood. Our percentile estimates in Table 6 regarding livestock implicate that even the upper percentile faced severe loss in livestock, which is most probably not due to being forced to sell the asset for consumption-smoothing but is due to losing the asset on the onset of the crisis.

Nonetheless, we assume consumer durables and agriculture tools were less affected at the time of crisis and the fall in their holdings is more related to being sold as a smoothing mechanism. Our findings regarding changes in jewelry is consistent with literature. Jewelry falls by 35%

between the first and second period, and falls by another 17% between the second and third period.

Since household at the top of consumption distribution are more likely to own assets and are also less likely to be hit severely by the crisis and sell assets, we estimate the impact of the crisis on asset holdings by percentile of changes in wealth distribution in Table 6. Interestingly, we find that jewelry was employed as a smoothing mechanism by all households in the immediate period after the crisis, even by the upper quantile. In the subsequent period, there is a decline in holdings of jewelry between all percentiles except for the upper 90 percentile.

#### E. Regression Models of Characteristics Associated with Smoothing Consumption

In this section, we intend to identify the characteristics of households that are correlated with higher consumption-smoothing capacity. We build two panel models. First panel includes our baseline model that examines the direct effect of the independent variables. Second panel includes the interaction between the shock magnitude and household characteristics. In each case, the dependent variable is changes in household consumption ( $\Delta \ln HHC$ ) over three different time periods. Our independent variables are the household characteristics that are likely to reduce fluctuations in  $\ln HHC$ . Meaning that if the characteristic is associated with greater consumption-smoothing (and therefore less fluctuations in consumption), the coefficient will be negative and vice versa. For example, we expect shock magnitude to increase fluctuations in consumption and therefore has a positive coefficient, while we expect wealth to be associated with higher smoothing capacity and therefore has a negative coefficient.

Prior to examining households' capacity to smooth consumption, we need to control for shock exposure heterogeneity across households. In other words, it is critical to measure the intensity of shock experienced across households to be able to compare their consumption-smoothing capacity. Based on community-level data, we use percentage of land affected by flood across villages to measure the magnitude of shock experienced across households.

Panel A, OLS:

$$\Delta \ln HHC_{it} = \beta_0 + \beta_1 S_i + \beta_2 X_{it} + \epsilon_{it}$$

In each panel, we include two models: ordinary least square model and fixed effects. The regression model above is the ordinary least square model, where  $\Delta \ln HHC$  denotes changes in consumption of household  $i$  at time  $t$ .  $S$  denotes the magnitude of shock experienced by household  $i$ .  $X$  is a vector of households' characteristics including age of the household head, education of the household head, size of household, adult ratio (number of adult members over total members), and household's wealth. However, it may also be that there are unobserved characteristics of households that go hand in hand with both the exposure to shock and consumption level. The big advantage of having panel data is that we are able to control for this time-invariant unobserved heterogeneity across households by including household fixed effects, which yields our next model in Panel A.

Panel A, FE:

$$\Delta \ln HHC_{it} = \beta_0 + \beta_1 S_i + \beta_2 X_{it} + \theta_i + \epsilon_{it}$$

$\theta$  represents the inclusion of household fixed effects which take account of everything specific to a household that does not change over time, i.e. we investigate changes within households over time, rather than computing average effects generated by differences between households.

Panel B, OLS and FE:

$$\Delta \ln HHC_{it} = \beta_0 + \beta_1 S_i + \beta_2 X_{it} + \beta_3 S_i * X_{it} + \epsilon_{it}$$

$$\Delta \ln HHC_{it} = \beta_0 + \beta_1 S_i + \beta_2 X_{it} + \beta_3 S_i * X_{it} + \theta_i + \epsilon_{it}$$

In panel B, tests of consumption-smoothing capacity are based on the interaction between our measure of shock intensity and household characteristics. If the characteristic leads to higher smoothing capacity, the interaction will be negative.

**Table 7**  
**Regression Models of Characteristics Associated with Changes in Household Consumption ( $\Delta \ln HHC$ )**

	Panel A		Panel B	
	OLS	FE	OLS	FE
Covariates	(1)	(2)	(3)	(4)
<b>Shock Magnitude</b>	0.028 (0.019)	0.064*** (0.021)	-0.081 (0.132)	0.170** (0.014)
<b>Wealth</b>	0.037*** (0.007)	0.013 (0.008)	0.033*** (0.008)	-0.013** (0.009)
<b>Household Size</b>	0.059*** (0.011)	0.027 (0.030)	0.058*** (0.012)	0.022 (0.031)
<b>Adult Ratio</b>	0.112*** (0.015)	0.082*** (0.020)	0.129*** (0.017)	0.097*** (0.021)
<b>Head of HH Education</b>	0.036*** (0.004)	0.011 (0.032)	0.039*** (0.004)	0.012 (0.032)
<b>Head of HH Age</b>	0.003** (0.001)	0.016 0.019	0.004 (0.001)	0.016 (0.019)
<b>Shock*Wealth</b>			0.042 (0.018)	-0.010** (0.020)
<b>Shock*HH Size</b>			-0.011 (0.021)	-0.021 (0.023)
<b>Shock*Adult Ratio</b>			0.011 (0.029)	-0.036 (0.032)
<b>Shock*Education</b>			-0.009 (0.004)	-0.013** (0.005)
<b>Shock*Age</b>			-0.004 (0.001)	-0.002 (0.001)
<b>N</b>	1517	1517	1517	1517
<b>R-Sq.</b>	0.58	0.73	0.57	0.73

Note: standard errors in parenthesis. \*p< .10. \*\*p< .05. \*\*\*p< .01

Table 7 lists our regression estimates. The OLS model in Panel A indicates that households that experienced more intense shock may have suffered from greater fluctuations in their consumption. However, the effect of shock magnitude is not statistically significant. The OLS model also finds that all of the included household characteristics are correlated with higher fluctuations in consumption and are statistically significant. This model finds that households with more

educated and older head of household experience greater fluctuations in their consumption, which is indicative of biased estimates in this model. We suspect that the OLS estimates suffer from bias that arises from unobserved heterogeneity across households. Comparing the results with the FE model validates our concern regarding unobserved heterogeneity.

The FE model in Panel A indicates that shock magnitude is positively correlated with fluctuations in consumption, i.e. households who experience more shock intensity have lower smoothing capacity and the effect is statistically significant. The estimates regarding household characteristics is not significant except for adult ratio. Households that had more adult members suffer from greater fluctuations in their consumption.

The OLS estimates in Panel B seems to be suffering from unobserved heterogeneity as well, since the estimates are significantly inconsistent with FE estimates. The FE model in Panel B indicates that the shock magnitude effect is statistically significant and is positively correlated with fluctuations in consumption. The adult ratio effect is also statistically significant and indicates that household with more adult members have lower capacity to smooth consumption. This model also suggests that as the magnitude of shock increased, households with higher human capital (more educated head of household) were better able to smooth their consumption, since the effect of the interaction between shock magnitude and education is negative and significant. Furthermore we find that the direct effect of household wealth is significant and negative, suggesting that wealthier household experienced lower fluctuations in their consumption. Finally, the effect of the interaction between shock magnitude and wealth is also statistically significant, implying that as the intensity of shock increased, wealthier households had higher consumption-smoothing capacity.

**Table 8**  
**Regression Model of Asset Types Associated with Changes in Consumption**

Model	Direct effect of wealth (1)					
	Land	Grain	Livestock	Jewelry	Durable Goods	Agriculture Tools
FE	-0.069** (1.27)	-0.091 (1.61)	0.03 (0.026)	-0.326** (0.007)	0.002 (1.09)	0.041 (1.13)
	Wealth * Shock interaction (2)					
	Land	Grain	Livestock	Jewelry	Durable Goods	Agriculture Tools
	-0.022** (2.91)	-0.056** (0.43)	0.013 (1.66)	-0.743*** (1.05)	-0.024 (1.87)	-0.056** (1.40)
N	1517					
R-Sq.	0.63					

Note: standard errors in parenthesis. \*p< .10. \*\*p< .05. \*\*\*p< .01

As we discussed in the previous section, we expect the impact of the crisis on wealth to differ considerably across asset types. We discussed that productive and relatively less liquid assets such as land and durables are likely to be less affected by the crisis, while assets such as jewelry are expected to play a significant role in consumption smoothing. To test our assumptions, we have re-estimated the FE model in Panel B, keeping the same set of household characteristics and interaction terms, but also included distinguished asset types. The results are listed in Table 8. Since the estimates for household characteristics beside wealth did not differ from our results in Column 4 of Table 7, we do not report them in Table 8. First row in Table 8 reports the direct effect of distinguished asset types and second row reports the estimates of their interaction with shock magnitude.

The results in Table 8 indicate that land and jewelry have significant direct effect on consumption smoothing. Household with higher ownership of land and jewelry seemed to have undergone less fluctuation in their consumption. Moreover, the estimates of the interaction terms suggest that as the magnitude of shock increases, households with more land, jewelry, grain, and agriculture tools smooth their consumption better. Our finding is consistent with literature suggesting that jewelry serve as the main coping mechanism in developing countries. The coefficient of the interaction between jewelry and shock is much larger in magnitude than the rest of the asset types and clearly indicates that jewelry is strongly associated with consumption smoothing in times of crisis.

### **Limitations**

The panel data used in this paper partially captures the consumption levels before the crisis. First round of the survey panel data was conducted in August 1998 and the length of data collection is not clear to us. Since the flood occurred in September 1998, we suspect that there might have been an overlap between the data collection and the devastating flood that lasted for eleven weeks.

In addition, because of the limitation of the panel data, we could not construct the distribution of consumption changes across an unbiased prior level of consumption. Meaning that we were not able to avoid biases due to correlated measurement error that will arise from regressing  $(HHC_{t1} - HHC_{t2})$  on  $HHC_{t1}$ . We could have avoided measurement errors biases if we could regress the difference in consumption on a level of consumption from earlier time periods.

Moreover, the distribution of changes in consumption suggests that those in the upper quantile of the distribution experienced higher fluctuations. Thus, we suspect that our impact estimates in this study might suffer from selection bias. To address the plausible selection bias, for future studies, we suggest estimating the effect of the shock magnitude on the upper quantiles of the distribution.

### **Conclusions**

Considering the limitations mentioned above, we believe that the panel data used in this study provides a unique opportunity to capture the immediate effects of the 1998 flood on the well-being of rural households in Bangladesh. Despite a wide range of smoothing mechanisms employed by households, we found that, on average, total household consumption and food consumption plummeted by 34% and 23%, respectively, due to the crisis. Such significant decline in consumption, specifically food consumption, can have severe long-term consequences on the well-being of individuals. Therefore, it is important to distinguish households who were better able to mitigate the negative effect of the crisis on their well-being.

Rural households in Bangladesh employed different coping mechanisms in response to the crisis. Households managed to reallocate labor supply within household to smooth consumption. More specifically, number of household members engaged in self-employment increased in response to the weakened formal sector and in order to exploit new opportunities. In addition, household postponed their expenditures on semidurables to maintain their food consumption at a relatively constant level.

Finally, spending down assets was found to be the most effective mechanism to smooth consumption. In contrast with developed countries where household spend down their financial assets in times of crisis, rural households in Bangladesh spent down their real asset to smooth consumption. We found evidence that rural households with more land and jewelry were better able to cope with the crisis. Particularly, jewelry was found to play a significant role in consumption smoothing.

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