Weather Shocks and the Religious Margin of Adaptation

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Abstract

In this paper, I study household's religious responses to types of weather shocks. I characterize two forms of climate exposure: (i) a persistent risk, which has slow onset and increases the probability of future hardship, and (ii) an immediate liquidity shock that induces liquidity constraints in the current period. Using panel data from Bangladesh, I exploit the plausibly exogenous within-household variation in monsoon rainfall over time to identify how exposure to these two types of weather shocks affect households' contributions toward religion. In the context of rural Bangladesh, I interpret monsoon droughts as persistent risk and excess rainfall as liquidity shocks. I find that drought exposure leads to contemporaneous increases in household contributions to religious infrastructure like mosques or temples while there is a positive lagged effect on other religious activities. I argue that droughts operate as a signal of elevated future risk, inducing households to reallocate from private devotional practices toward publicly observable contributions in the current period that may strengthen informal insurance networks and future access to informal credits. Once adverse income effects materialize, religion responds as a coping mechanism along with other coping channels like borrowing, remittances, etc.

1 Introduction

Religion is a fundamental aspect of human decision making. It is linked with several drivers of economic success including trust and cooperation (Iannaccone 1998; Iyer 2016). Moreover, it is quite common to turn to religion when faced with uncertainty. Various religious scripture urge the believers to abide by God's guidelines to alter outcomes of the current life. Individuals, therefore can use religion to gain a spiritual insurance against uncertainty (Auriol et al. 2020). Aside from divine protection, religion also provides psychological coping during shocks (Bentzen 2021; Pargament et al. 2001). Most religions have designated institutions like churches, temples, or mosques where individuals sharing similar beliefs gather. It is quite common to see the formation of religious groups within the institutions that function as semi-formal safety nets where members provide aid to one another during difficult times (Chen 2010; Dehejia et al. 2007). Since religious practices are costly, such insurance providing groups often use them to screen commitment to deter free-riding problems (Iannaccone 1992). Despite the advances in literature, there is still a lot we do not know about what drives individuals to engage in religion or how they decide between different forms of religious practice.

Recent studies have found similar religious responses to weather shocks. Using the dip in cellular call volumes during the evening prayer time as a measure of religiosity in Afghanistan, Dube et al. (2022) finds that people become more religious when economic conditions worsen after droughts. But will people remain religious even if conditions do not improve? In this regard, Espín-Sánchez et al. (2023) study rainmaking rituals and find that these traditions persist where they are successful, which selects environments with an increasing hazard during a drought.

While the existing literature establishes that religious beliefs and practices respond to shocks, several important questions remain unresolved. First, it is un-

clear whether religious responses vary systematically with the type and intensity of shocks. Second, different forms of religious activity such as private devotional practices, participation in communal worship, or contributions to religious institutions may respond differently to adverse events. If so, this raises the possibility that individuals engage in distinct religious behaviors for different reasons. For instance, charitable contributions to religious institutions may reflect strategic or social motivations, while private prayer may be driven primarily by personal belief or psychological coping. The timing of these responses may also matter, as individuals can adjust religious behavior differently before, during, or after shocks. In this paper, I attempt to answer these question by studying climate shocks in Bangladesh.

I exploit the plausibly exogenous variation in monsoon rainfall across three waves of the Bangladesh Integrated Household Survey (BIHS) data, which is nationally representative of rural Bangladesh. Bangladesh is one of the world's most climate vulnerable countries with high rainfall variability. Moreover, religion is an integral part of rural Bangladesh where institutions like community mosques are central to the village structure. Because of these two features, Bangladesh is a well suited setting for my study.

I calculate rainfall variability and define weather shocks using satellite based daily precipitation data and spatially match it to household locations. I define excess rainfall as monsoon precipitation above 1 standard deviation of the long run mean and drought as the monsoon precipitation being 1 standard deviation below the long run mean. I first find that drought shocks reduce income with a lag while excess rain has contemporaneous negative effects. Consequently, households immediately deplete savings to smooth consumption in response to excess rain whereas they increase savings during droughts anticipating future risks. This suggests that droughts operate like a persistent risk in Bangladesh, while excess rain is an immediate liquidity shock.

Then I study the effects of these two types of shocks on various religious activities. Since Bangladesh is a Muslim majority country, most of these activities broadly relate to Islam. I find that immediately after drought, households increase contributions to the construction or maintenance of religious infrastructure like mosques or temples. The probability that a household contributes to religious infrastructure increases by 9 percentage points following a contemporaneous drought shock, and this effect is statistically significant at the 1 percent level. Contributions also increase in the year following the drought, although the magnitude is smaller, with a 7.8 percentage point increase in the probability of contributing. Excess rain do not show similar short run effects possibly because of the liquidity crunch. Moreover, this response to drought is not accompanied by contemporaneous increases in other devotional activities such as time spent doing religious activities, giving religious charitable donation (sadaqa), giving zakat (a kind of wealth tax in Islam), etc. In particular, I do not find any contemporaneous effect of drought on the probability of giving sadaqa. It is striking to not see effects on sadaqa because contribution to mosque is an act of sadaqa by definition. It could be that households in rural Bangladesh are not aware of this. This leads me to believe that such donations to infrastructures are not motivated by devotion. These broader measures of religiosity only rise later, when negative income effects of droughts fully materialize. For example, the probability that households give sadaqa increases only in the year following the drought, with a statistically significant 5.9 percentage point increase. Similarly, time spent in religious activities rises later rather than immediately; one year after a drought shock, men increase time devoted to religious activities by approximately 15 percent, while no significant contemporaneous effect is observed. My findings suggest that religion works as a coping response to realized hardship rather than a precautionary spiritual investment as suggested by Auriol et al. (2020). Another interesting thing to note here is that excess rain has no significant positive effect on measures of religiosity like

time spent, zakat, sadaqa, religious group memberships, etc. The coping motivation behind religion seems to differ by shock as well. When disaster is visible like rise in water levels, households may need to focus mitigation strategies instead. My results highlight a strategic investment toward religion.

The main mechanism I propose is that visible religious contributions to a public good like mosque or temple can serve as a credibility signal to informal market lenders. In an informal setting, credit access depends on reputation and observable community behavior. While formal channels like banks rely on collateral or credit sources, informal lenders rely on information about a borrower's social standing and commitment to community institutions. A drought shock, with its slow onset and delayed income effects creates a window in which households can anticipate future income uncertainty and subsequent borrowing needs. Thus, they can make strategic decisions to invest in their informal credit standing before the financial distress materializes. Consistent with this mechanism, drought has a positive lagged effect on borrowing, with total borrowing increasing by approximately 32 percent in the year following a drought shock. Moreover, the probability that a household borrows increases by about 2.5 percentage points in the year after the drought. I also find that households who donated to religious infrastructure in the previous period are more likely to obtain informal credit in response to drought relative to non-donors.

My paper contributes to three main strands of literature. Firstly it adds to the growing literature on the economics of religion. The existing literature has emphasized several channels through which religion interacts with economic outcomes. One strand looks at religion as an individual choice shaped by economic incentives, highlighting that religiosity tends to decline with economic development (Azzi and Ehrenberg 1975; Berger 2011; Weber 1930; Wilson 2016). A second strand highlights the role of religion in shaping economic outcomes and preferences such as work ethic, human capital formation, and behavioral traits such as perseverance

and grit (Bryan et al. 2021). A third strand of literature views religion as a mechanism for insurance and risk sharing as discussed above. My paper contributes to this literature by distinguishing between different kinds of religious activities. I also provide additional insights by showing that publicly visible forms of religious participation can function as a strategic economic investment that facilitates access to credit even outside religious groups. My findings can be contrasted with the club-good model of religion developed by Iannaccone (1992) and Berman (2000). I find that economic outcomes associated with these religious contributions relate to access to informal credit markets, rather than redistribution or insurance within religious groups.

Secondly, I contribute to the broad literature on the impacts of weather shocks. A large body of literature has examined how climate variability such as rainfall and temperature affects outcomes like agricultural productivity (Schlenker and Roberts 2009), education and human capital formation (Barnor and Kafle 2025; Maccini and Yang 2009), health (Deschênes and Greenstone 2011). Studies highlight the long-term effects of climate shocks on educational attainment and labor productivity (Park 2022; Shah and Steinberg 2017). Another strand of the literature studies how recurrent climate shocks affect household welfare and poverty dynamics (Carter et al. 2007; Pinto et al. 2025). Work on natural disasters such as storms and cyclones has documented mixed economic impacts, ranging from potential long-run gains through human capital accumulation (Skidmore and Toya 2002) and large short-run economic losses (Hsiang and Jina 2014). I add to this literature in two ways. I distinguish between two different types of rainfall shocks and show that they generate different economic responses. Then, I study a relatively underexplored margin of climate adaptation which is religion. By studying how households adjust different forms of religious participation following climate shocks, my paper highlights religious behavior as an institutional and social response to climate risk which has not received much attention in climate literature.

Lastly, I contribute to the literature on risk sharing. Evidence suggests that households partially insure idiosyncratic shocks through informal risk sharing networks. Within such networks, households affected by negative shocks may receive transfers or support from others who are not simultaneously exposed to the same shock. Several papers suggest this pattern operate both within and across villages (De Weerdt and Dercon 2006; Gertler and Gruber 2002; Kazianga and Udry 2006; Townsend 1994; Udry 1994). My paper extends this literature by exploring how households adjust their donations in the religious public good when faced with persistent climate shocks in order to insure against anticipated income risks.

The rest of the paper is organized as follows: The rest of the paper is organized as follows. Section 2 describes the context and data. Section 3 outlines the empirical framework and identification strategy. Section 4 presents the main results, discusses the mechanisms and heterogeneity in responses and reports results of robustness checks. Section 5 concludes.

2 Context and data

2.1 Weather and religion in Bangladesh

2.1.1 Weather patterns in Bangladesh

Bangladesh lies in the Ganges-Brahmaputra-Meghna delta, which is the largest delta on earth composed of mainly fertile alluvial soil. The position of Bangladesh in this highly fertile deltaic ecosystem has attracted people promising high agricultural productivity (Lewis 2011). However, Bangladesh is considered to be one of the most vulnerable nations to natural disasters due to its geographic location and socioeconomic standing (Sarkar et al. 2024).

Climatic hazards such as floods, droughts, heatwaves, cyclones, cold waves, storms, hailstorms, shoreline recession, tidal surges, salinity intrusion, riverbank

erosion and sea-level rise occur regularly in Bangladesh (Neelim and Islam 2010). A key driver of climatic hazards in Bangladesh is rainfall variability. Heavy rainfall causes floods, flash floods and landslides, while droughts are caused by very low rainfall (Masum 2019). Lack of regularity in rainfall, high frequency of flooding, low rainfall during winter, high evaporation rates, long droughts, and extreme weather events along with other factors like, social status and technological capacity contribute to the vulnerability of Bangladesh (Chowdhury et al. 2022). It has been predicted that in future, global warming will increase the intensity and frequency of rainfall events in Bangladesh, and that drought intensity will also increase due to high rainfall variability (Masum 2019). Bangladesh has been predicted to face serious challenges from climate change as it is a highly populated agrarian country (Rahman and Lateh 2017)

Multi-hazard maps created using extreme climate indices show that for 31 years, northeastern and southeastern Bangladesh have experienced high rainfall, and southwestern region has experienced high temperatures (Chowdhury et al. 2022). Most rainfall occurs in monsoon and typically varies from 1527mm in the west to 4197mm in the northeast (Shahid 2011). Over the past five decades, trends in rainfall intensity in Bangladesh have varied across regions. Low and heavy rainfall levels show slight downward trends, although these changes are statistically insignificant. In contrast, medium rainfall levels exhibit a small but statistically insignificant upward trend. The magnitude and direction of these trends differ by region: rainfall has tended to increase in the northeast, southeast, and central regions, while decreasing trends are observed in the northwest and western parts of the country (Towfiqul Islam et al. 2020).

Watkins (2007) define drought as a naturally occurring phenomenon which materializes when precipitation has been significantly below the normal recorded levels, causing hydrological imbalances that adversely affects land resource production systems. Droughts occur in almost all climatic regions of Bangladesh. It

has been noted that drought occurs in Bangladesh every 2 to 2.5 years and it is more prominent in the northern, north-western and south-western parts of the country as seen particularly between 1981-2010 (Mondol et al. 2017). Between 1981-2010, drought conditions were found to be dynamic across Bangladesh and the country experienced short-term(3 month), medium short-term(6 month), and long-term drought(12 month).

Agricultural production in Bangladesh is strongly shaped by seasonal weather patterns. The country has four distinct seasons: a dry winter from December to February, a hot pre-monsoon summer from March to May, the rainy monsoon from June to September, and a post-monsoon autumn from October to November (Shahid 2010). Because agriculture depends heavily on rainfall, these seasonal cycles generate pronounced fluctuations in rural economic activity. Rice cultivation dominates agricultural production and follows three major crop cycles—Aus, Aman, and Boro (Khandker et al. 2017). Aman, the largest crop cycle, primarily relies on monsoon rainfall, while Boro cultivation depends on irrigation during the dry season. Consequently, seasonal rainfall variability directly influences agricultural output, labor demand, and rural livelihoods. These seasonal agricultural cycles also translate into fluctuations in household income and consumption. In particular, the lean period following Aman planting, commonly referred to as the *Monga* season, is associated with reduced employment opportunities and lower household consumption (Khandker et al. 2017). At the same time, rainfall variability can directly disrupt agricultural production. Excess rainfall during the monsoon season often leads to waterclogging and drainage congestion, especially in low-lying coastal and delta regions, resulting in crop submergence, delayed planting, and yield losses (Islam et al. 2025).

2.1.2 Religious practices and rural social structure in Bangladesh

Religion is one of the central elements of Bangladeshi identity, alongside class and ethnicity. Bangladesh is a Muslim-majority country where almost all Muslims follow Sunni Islam. Islam in Bangladesh generally takes three forms: a modernist form that accepts rational interpretations of the Quran, an orthodox form that relies on literal interpretations of religious texts, and a popular form of Islam that blends Islamic practices with local beliefs and traditions. This popular form of Islam has particularly strong influence among both rural and urban poor populations (Lewis 2011). Although the public sphere in Bangladesh has often been characterized as secular, recent research notes the emergence of a distinct Islamic space that operates alongside secular institutions. This space produces a parallel discourse grounded in Islamic values and is closely linked to educational institutions, political groups, and media organizations. Such developments have been argued to challenge the historically syncretic Muslim identity in Bangladesh (Huq et al. 2025). From broader macro-level perspectives, Bangladesh has sometimes been described as an "Islamic nation," and scholars have examined it as a relevant context for studying the politics of radical Islam (Riaz 2012; Seabrook 2001). More recent research, however, emphasizes micro-level lived experiences and the everyday organization of social and moral order within communities. These studies highlight how social relationships, cohesion, and fragmentation shape daily life in rural Bangladesh (Devine and White 2013). In everyday usage, the term "Dharma" (religion) refers not only to religious affiliation but also to broader social belonging and appropriate behavior. It influences aspects of life such as group membership, acceptable conduct, food choices, and marriage partners.

Nearly three-quarters of Bangladesh's population lives in rural areas. Although socio-political structures are changing rapidly, rural populations often remain insulated from influences such as popular media cultures due to widespread poverty.

At the same time, this poverty has historically kept rural populations embedded in hierarchical social relations characterized by feudal ideology, limited educational access, and dependence on local elites and moneylenders (Seabrook 2001). In fact rural money lenders are traditionally know as "Mahajan" which is a sanskrit term meaning "The great one". Even when opportunities emerge that allow villagers to move away from traditional elite control, similar relationships of allegiance can reappear in new forms. In these cases, emerging leaders, often younger individuals with connections to politically or economically powerful actors outside the village seek legitimacy and authority within the local community. One way this legitimacy is sometimes established is through the creation of religious institutions, particularly mosques.

Devine et al. (2019) conduct a qualitative analysis of village social organization in Bangladesh and document how religious institutions are closely tied to local power structures. Their study shows that a single village may contain multiple mosques, each led by an Imam[1] and representing a different community within the village. Power struggles within villages can lead to the formation of a new *Samaj*[2], or community grouping, when emerging leaders challenge existing leadership structures. In such situations, rising leaders must persuade a sufficient number of villagers to leave the existing *Samaj* and join the newly formed one. Breaking away from established *Samaj* allegiances was widely viewed as a violation of *Dharma*, and therefore the legitimacy of a new *Samaj* often depended on constructing a new mosque. The mosque served as a symbol of unity and collective identity for members of the newly formed community and distinguished them from other groups within the village. The study also notes that individuals some-

[1] An Imam is a Muslim religious leader who leads congregational prayers in a mosque and often provides religious guidance and instruction to the community.

[2] *Samaj* is bangla for society. In a rural setting it refers to a locally organized social community or faction within a village, typically centered around shared leadership, social ties, and religious institutions such as a mosque. Members of a *Samaj* often cooperate in social, economic, and religious activities.

times refrain from praying in mosques associated with other *Samaj* groups, and members of a particular mosque community tend to provide assistance primarily to fellow members rather than to outsiders.

Religious institutions also play important roles during times of crisis. In another qualitative study, mosques were shown to function not only as physical shelters during natural disasters but also as sources of information, as warnings and announcements are often issued after prayers (Hossain 2026). In coastal regions of Bangladesh, disasters such as cyclones can disrupt transportation networks and reduce the availability of formal institutional assistance. In such situations, villagers often rely on localized social networks and kinship ties for support. Members of the *Samaj* community frequently remain active in the aftermath of disasters by providing both physical and financial assistance to affected households (Alam and Collins 2010).

Village governance structures also interact with religious and social institutions. In one qualitative case study, the local union chairman maintained relationships with chairmen from neighboring villages, the local Imam, and other influential individuals. Tensions were also observed between union authorities and non-governmental organizations (NGOs) operating microcredit programs in the village. One explanation for anti-NGO sentiment in these communities is that traditional village moneylenders may perceive NGO lending activities as a threat to their economic interests (Lewis and Hossain 2008).

Patron–client relationships between rural elites and poorer households continue to play a significant role in village social structures. Although these relationships are often exploitative, they can sometimes provide a limited form of security for poor households, particularly during shocks that affect the entire community. In such situations, relationships among poor households alone may be insufficient to provide food or cash loans, and support from wealthier patrons may become important. However, the most destitute households may still be excluded from

these patron–client networks altogether. These relationships also reduce the likelihood of collective resistance against elites and weaken solidarity among poorer households (Scott 2014).

More broadly, religious beliefs themselves can influence economic and social behavior. Religious practices can shape attitudes and preferences, provide psychological benefits, and create community-based support systems. Religious groups may also provide financial assistance to poorer members, which can partially substitute for formal social welfare programs or state-based insurance mechanisms (Rahman 2025).

2.2 Data and summary statistics

2.2.1 Household panel

I use the Bangladesh Integrated Household Survey (BIHS) 2011-12, 2015, and 2018-19 for my analysis. The survey was implemented by the International Food Policy and Research Institute (IFPRI). The first wave of data collection ran from October 2011 to March 2012, the second from January 2015 to June 2015, and the third from November 2018 to March 2019. The survey is nationally representative of rural Bangladesh, covering all divisions, and follows approximately 6,500 households in 325 primary sampling units (PSUs). The survey utilized a two-stage stratified sampling design based on the 2001 Bangladesh population census. The PSUs were selected from 8 strata (7 divisions and feed-the-future zone) in the first stage, followed by random selection of 20 households from each PSU in the second stage (Ahmed 2013). I downloaded all data from the Harvard dataverse IFPRI dataverse catalogue. IFPRI also released a BIHS harmonized dataset combining Wave 1 and Wave 2 surveys that included household GIS coordinates (randomly offset by 2.5 kms to ensure anonymity). I, therefore, can use these coordinates to determine whether a household was exposed to weather shocks.

The attrition rate is fairly low with 4.29% between wave 1 and wave 2 and about 7.12% between wave 1 and wave 3. This can be characterized as moderate level attrition in the survey data (Ahmed and Tauseef 2022). Moreover, using this same panel data, Ahmed and Tauseef (2022) did not find evidence for the attrition to be non-random. Among the households that were successfully interviewed, 2.96% split between wave 1 and wave 2 and 8.24% split between wave 1 and wave 3. For my analysis, I restrict my sample to households that remained stable across survey waves. Newly formed households can represent endogenous demographic changes like marriage, migration, etc. instead of responses to weather shocks. Thus, restricting the sample to stable households across waves allows my fixed effects estimation strategy to capture within household changes over time and avoid conflating climate shock responses with structural changes in the household.

The data contains detailed information at the household and individual levels about socioeconomic characteristics, occupation, food and non-food expenses, agricultural production and marketing, savings and borrowing behavior, etc. The annual non-food expenditure module captures information on household level religious expenditures including expenses in zakat[3], sadaqa[4], qurbani[5] , hajj[6], pilgrimage and different religious functions like milads[7] or pujas[8]. The survey also includes data to measure the Women's Empowerment in Agriculture (WEAI) index. WEAI modules were administered to both the head of the household and their spouse. One of the modules of WEAI includes information on several group

[3]Zakat is one of the five pillars of Islam which refers to a tax on accumulated wealth of a person that should be distributed among beneficiaries such as the poor and the needy, people in debt, people employed to distribute zakat, etc. (Johari et al. 2014).

[4]Sadaqa refers to the voluntary act of providing charity in order to help those in need without expectation of gaining anything in return (Bensaid et al. 2013).

[5]Qurbani is a Muslim ritual of sacrificing a livestock during Eid-ul-Adha and it is an obligation that is fulfilled by those with wealth higher than their needs (Kroessin 2025).

[6]The Hajj is an annual pilgrimage by Muslims to Mecca, Saudi Arabia (Mitchell et al. 2013). It is a one-time obligation for those who are able to afford it.

[7]Milad refers to a religious gathering in Islam where devotional recitations or sermons are performed for a particular cause, such as commemorating the birth or death of a person, etc.

[8]Puja is a ritual in Hinduism where the deity is honored by the devotee as worshiper through a set of offerings (Chandola 1989).

memberships including religious groups and also on various charitable donations such as donation of time or money for the construction/maintenance of religious infrastructure, wells, roads, etc. Another module captures time use in various activities including religious activities. Time use data was collected using time diaries where respondents had to recall time spent on various activities 24 hours prior to the interview beginning at 4:00 AM of the day before the interview. Since a few of my outcomes of interest such as religious expenditures are measured at the household level, I combine the data by household.

Table 1 reports the summary statistics for my sample by waves. The average household is Muslim-headed and consists of about 4 members. Around 50% of the household heads are primarily engaged in farming[9] Education levels are relatively low among household heads. About 48% of the household heads reported never attending school in wave 1, and I find a slight decline to 45% in later waves. This could reflect the change in household head across waves. In rural Bangladesh, if the male household-head exits the household through migration or death, their spouse becomes the household head. This change in the gender could be reflected in education levels since education levels of females are lower in rural Bangladesh. In fact, the proportion of female-headed household follows an increasing trend in my sample. It is interesting to note that about 86% of households gain access to electricity by wave 3. This reflects the remarkable increase in infrastructure, such as electricity supply in the past two decades in Bangladesh. The average monthly real income is less than BDT 10,000 (USD 134) across all waves and the majority of the income was spent on food.

Looking at savings and borrowing behavior, a typical household had relatively high debt compared to their savings. Households mainly borrow from NGOs and informal channels. In 2011-12, 38% of the households borrowed from informal channels, increasing to 42% in 2015 and 46% in 2018-19. I am mainly interested in

[9]Farming includes crop farming, livestock/poultry related occupation, and aquaculture.

Table 1: Summary Statistics: Household Characteristics

	Wave 1 (2011–12)			Wave 2 (2015)			Wave 3 (2018–19)		
	Mean	SD	N	Mean	SD	N	Mean	SD	N
Panel A: Demographic Characteristics									
HH head is Muslim (=1)	0.88	0.32	6096	0.88	0.33	5982	0.89	0.32	4679
Total members in the HH	4.15	1.54	6096	4.30	1.70	5982	4.24	1.78	4679
Total members under 15	1.52	1.16	6096	1.47	1.15	5982	1.40	1.17	4679
Age of HH head	44.05	13.80	6096	46.10	13.61	5982	47.49	13.01	4679
HH head never went to school (=1)	0.48	0.50	6096	0.45	0.50	5982	0.45	0.50	4679
HH has access to electricity (=1)	0.47	0.50	6096	0.58	0.49	5982	0.86	0.35	4679
HH head engaged in farming activities	0.52	0.50	6096	0.48	0.50	5982	0.41	0.49	4679
Panel B: Household Income and Expenditures									
Total monthly earned income (BDT)	7952.56	8349.60	6096	8958.67	9091.47	5982	9195.70	8869.29	4679
Total monthly per capita consumption (BDT)	1529.68	1039.30	6096	1503.62	976.72	5982	1579.02	912.67	4678
Total monthly food expenditure (BDT)	4745.36	3198.44	6096	5021.92	3590.93	5982	5092.86	3337.36	4678
Total monthly non-food expenditure (BDT)	1358.02	2623.27	6096	1089.47	1014.87	5982	1209.42	956.70	4679
Panel C: Household Savings and Borrowings									
Total savings (BDT)	14399.92	54352.54	6096	18596.66	60807.93	5982	24335.70	104425.42	4679
HH has savings (=1)	0.58	0.49	6096	0.63	0.48	5982	0.65	0.48	4679
Total borrowings (BDT)	31882.97	93041.58	6096	43449.26	159020.01	5982	50251.65	96816.47	4679
HH borrows from formal channels (=1)	0.18	0.39	6096	0.13	0.33	5982	0.10	0.29	4679
HH borrows from NGOs (=1)	0.28	0.45	6096	0.36	0.48	5982	0.41	0.49	4679
HH borrows from informal channels (=1)	0.38	0.48	6096	0.42	0.49	5982	0.46	0.50	4679
HH borrows from social networks (=1)	0.30	0.46	6096	0.32	0.46	5982	0.38	0.48	4679
HH borrows from informal market lenders (=1)	0.11	0.31	6096	0.13	0.34	5982	0.11	0.32	4679
Panel D: Religious Activities and Contributions									
Daily minutes spent in religious activities by main HH female	33.13	48.63	6090	57.78	73.48	5930	66.33	77.59	4632
Daily minutes spent in religious activities by main HH male	24.65	57.53	3162	36.54	68.94	4962	46.78	81.68	3859
HH contributed to religious infrastructures (=1)	0.67	0.47	6091	0.83	0.38	5967	0.88	0.32	4666
Total annual religious expenditures (BDT)	2716.46	11154.00	6096	3341.50	8858.50	5982	4336.83	12270.17	4679
HH spent on zakat (=1)	0.04	0.19	6096	0.02	0.15	5982	0.05	0.21	4679
HH spent on sadaqa (=1)	0.37	0.48	6096	0.60	0.49	5982	0.74	0.44	4679
HH spent on qurbani (=1)	0.23	0.42	6096	0.26	0.44	5982	0.27	0.44	4679
HH spent on any religious functions (=1)	0.26	0.44	6096	0.41	0.49	5982	0.39	0.49	4679
HH spent on hajj (=1)	0.00	0.03	6096	0.00	0.03	5982	0.00	0.04	4679
HH spent on pilgrimage (=1)	0.02	0.12	6096	0.01	0.08	5982	0.01	0.12	4679
Main HH female is a member of a religious group (=1)	0.02	0.13	6091	0.12	0.32	5967	0.25	0.43	4666
Main HH male is a member of a religious group (=1)	0.06	0.23	6091	0.05	0.22	5967	0.10	0.30	4666
Main HH male joined at least 2 of 5 religious meetings (=1)	0.05	0.22	6091	0.04	0.20	5967	0.07	0.25	4666
Main HH female joined at least 2 of 5 religious meetings (=1)	0.01	0.12	6091	0.09	0.29	5967	0.16	0.37	4666

informal borrowing, so I further break it down to borrowing from social networks[10] and borrowing from informal market lenders[11] Social networks seem to be the more popular borrowing source. Across three waves, around 30-40% households borrowed from social networks. The proportion of households borrowing from informal market lenders was roughly between 11-13%.

I find an increasing trend in religious practices among households. In 2011-12, the primary female member spent 33 minutes on average per day doing religious activities, increasing to over an hour by 2018-19. The primary male household member spent relatively less time but also depicted an upward trend. Total annual religious expenditures also increased over time. This reflects the growing proportion of households spending on sadaqa and religious functions. In contrast, zakat payments were quite rare. Religious group memberships also rose particularly among the primary female household members. In 2011-12, only 2% of primary female household members were part of a religious group, increasing to 12% in 2015 and 25% in 2018-19. I am most interested in the prevalence of contributions to religious infrastructure. In 2011-12, 67% of the households reported contributing time or money towards construction or maintenance of religious infrastuctures like mosques or temples. The proportion increased sharply to 83% in 2015 and by 2018-19, 88% of the households reported making such contributions. These trends in my sample resonate with the findings of (WHITE 2012) who suggests that religiosity in Bangladesh is receiving a new emphasis evidenced by landscapes being peppered with more and more elaborate mosques.

2.2.2 Weather Data

Measuring rainfall shocks

I construct rainfall shock measures at the household level using satellite pre-

[10] I define social network as consisting of friends, relatives and employers.
[11] Informal market lenders include shopkeepers and money lenders.

cipitation data from the Climate Hazards InfraRed Precipitation with Station (CHIRPS) dataset. CHIRPS provides daily precipitation estimates in mm at approximately 0.05° spatial resolution. It combines satellite observations with station data to get the estimates. Since the agricultural sector is prominent in rural Bangladesh and livelihoods depend on monsoon rain, I measure shocks for the monsoon season. Monsoon typically lasts from early June to early October. For my analysis, I therefore, define monsoon rainfall as total precipitation during the June-September period.

For each household h and year t, I compute monsoon rainfall P_{ht} as the zonal mean rainfall within a 5km buffer around the household location. I spatially match the household cooridinates from the BIHS harmonized survey to the rainfall data using these buffers. For each household location, I calculate the long run mean and standard deviation of monsoon raifall over the 1981-2010 period. I then standardize monsoon rainfall in a particular year as follows:

$$z_{ht} = \frac{P_{ht} - \mu_h}{\sigma_h} \tag{1}$$

where P_{ht} is monsoon rainfall within a 5 km buffer around household h in year t, μ_h is the long-run mean monsoon rainfall for that location over 1981–2010, and σ_h is the corresponding long-run standard deviation. Then, I differentiate between excess rainfall shocks and drought shocks using the following specification:

$$ExcessRain_{ht} = 1\{z_{ht} > 1\} \tag{2}$$

$$Drought_{ht} = 1\{z_{ht} < -1\} \tag{3}$$

So, I define excess rainfall shock as rainfall exceeding the long run mean by more than one standard deviation during a particular monsoon and drought shock as rainfall falling more than one standard deviation below the mean. My shock

measures closely follow Riley (2018) and Jensen (2010). I consider deviations greater than one standard deviation because I want to study extreme deviations than can be classified as a drought and might have the potential to cause monsoon flooding. Moreover, a small deviation may not have a big effect and initially more rain can be beneficial for crop yields (Paxson 1992; Suri 2005).

I consider both contemporaneous and lagged shocks. For each suevey wave, the contemporaneous shock is defined as the shock in monsoon season prior to the survey, while lagged shock corresponds to the shock in the preceding monsoon season. Accordingly, 2011-12 wave uses the 2011 monsoon shock as the contemporaneous measure and the 2010 monsoon shock as the lagged measure, the 2015 wave uses the 2014 and 2013 monsoon shocks, and the 2018-19 wave uses the 2018 and 2017 monsoon shocks. Panels (a) to (f) of figure 1 visualizes the monsoon rainfall deviations in each of these years. Blue areas represent above average rainfall, whereas yellow areas indicate rainfall shortages relative to the historical mean. There is substantial variation in rainfall deviations across years. In particular, 2017 shows widespread positive rainfall deviations across most of the country. This is consistent with the unusually wet monsoon season of 2017 which led to nationwide flooding affecting more than 8 million people (Philip et al. 2019). Similarly, the 2014 monsoon season was also associated with major river flooding in northern Bangladesh due to heavy upsrteam rainfall in the Brahmaputra basin. 2013 and 2018 on the other hand represent relatively dry monsoon conditions and drought episodes. Across all years, the north-western region of Bangladesh which is documented as the most drought-prone area (Shahid and Behrawan 2008) show persistent low rainfall. Panel A of table 2 reports the percentage of my households in my analytic sample exposed to these weather shocks. 21% of the households were exposed to excess rain during monsoon 2011 while drought shocks were relatively rare, affecting only about 1% of the households. In contrast, lagged drought shock measure suggests that almost 39% of the house-

holds were exposed to drought shocks in monsoon of 2010. Both droughts and excess rainfall shocks were less common in monsoon 2014. Although 2014 monsoon season experienced massive flooding, the prevalence of excess rain exposure is relatively low in my sample since the monsoon floods were concentrated mainly in northeastern Bangladesh. Lagged shock measure for 2015 wave reveals that more than 50% of the households faced severe rainfall deficits corresponding to monsoon 2013 being very dry. No household faced excess rain shock in 2018 since 2018 was a dry year and consequently 56% of the households were exposed to a drought shock during that time. Conversely, 80% of the households were exposed to excess rain in 2017 which was a major flood year.

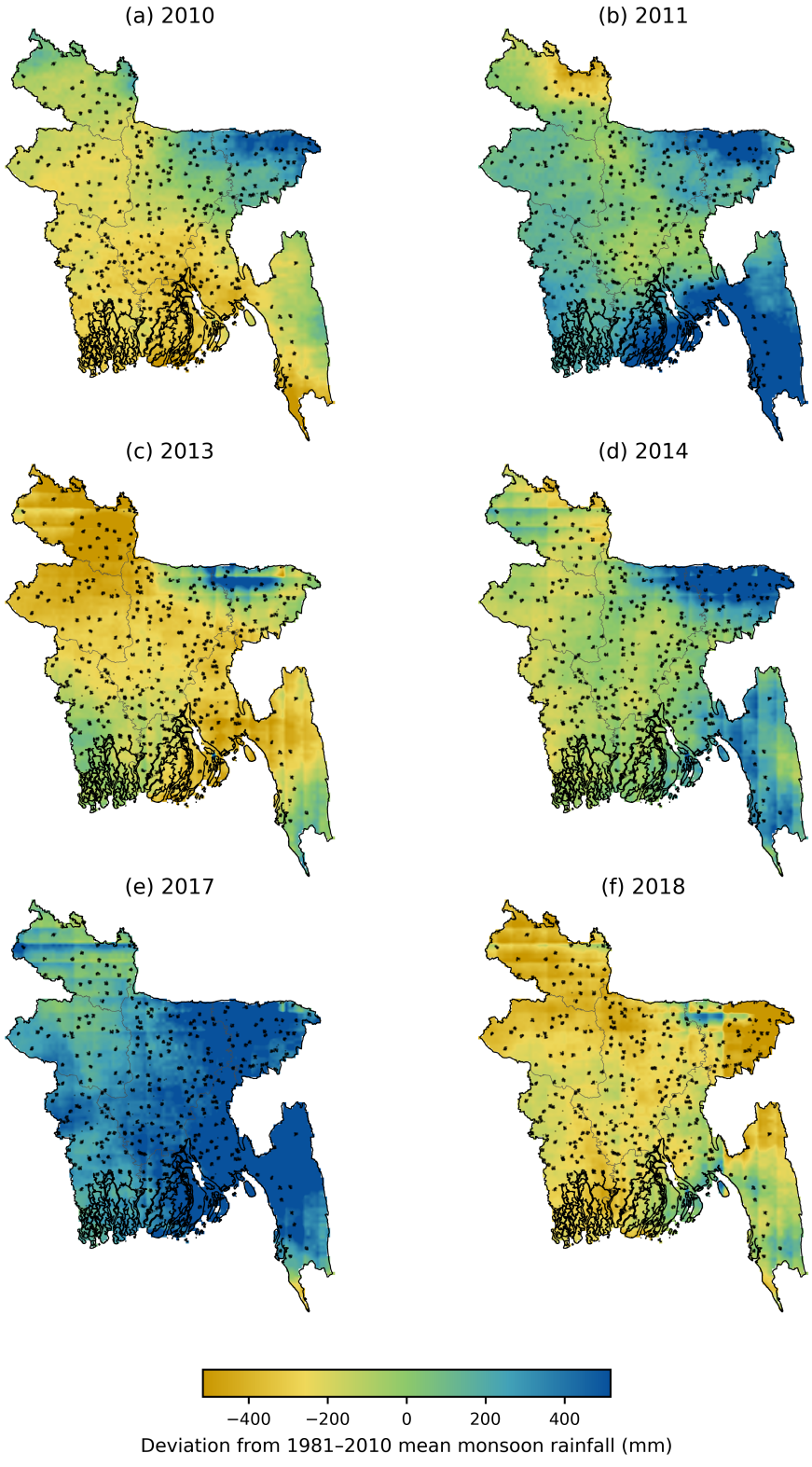


Figure 1: Deviations from Mean Monsoon Rainfall

Source: Figure prepared using CHIRPS rainfall data, household coordinates from BIHS harmonized survey and Bangladesh administrative division shapefile provided by IFPRI.

Table 2: Summary Statistics: Weather Variables

	Wave 1 (2011–12)			Wave 2 (2015)			Wave 3 (2018–19)		
	Mean	SD	N	Mean	SD	N	Mean	SD	N
ExcessRain_{ht}	0.21	0.40	6096	0.11	0.31	5982	0.00	0.00	4679
Drought_{ht}	0.01	0.11	6096	0.01	0.11	5982	0.56	0.50	4679
$\text{ExcessRain}_{h,t-1}$	0.02	0.15	6096	0.01	0.09	5982	0.80	0.40	4679
$\text{Drought}_{h,t-1}$	0.39	0.49	6096	0.51	0.50	5982	0.00	0.00	4679
$\text{Average temperature}_{ht}$	29.19	0.74	6096	28.90	0.70	5982	29.74	0.91	4679
$\text{Average temperature}_{h,t-1}$	28.11	0.78	6096	29.52	0.77	5982	29.35	0.77	4679
No. of days above $35°\text{C}_t$	0.29	0.65	6096	0.16	0.43	5982	0.20	0.46	4679
No. of days above $35°\text{C}_{t-1}$	0.17	0.44	6096	0.27	0.57	5982	0.15	0.40	4679

Measuring temperatures

To separate drought effects from heat stress, I control for average monsoon temperature and number of monsoon days above 35°C. I obtain temperature data from the Moderate Resolution Imaging Spectroradiometer (MODIS) Land Surface Temperature (LST) product (MOD11A1 Collection 6.1). This provides daily estimates of daytime land surface temperature at approximately 1 km spatial resolution (Wan et al. 2006). Panel B of Table 2 reports the summary statistics for temperature variables. Average monsoon temperature ranges between 28.9°C and 29.7°C across years with relatively low standard deviation. Based on my definition, extreme heat events were also relatively uncommon between monsoon 2010 and monsoon 2018.

3 Empirical framework

3.1 Empirical Specification

I empirically test how households respond to different types of weather shocks by estimating the impact of extreme rainfall deviations on household economic behavior, financial responses and religious activities. In rural Bangladesh, rainfall shocks affect agricultural production and income through different channels. Excess rainfall can generate immediate disruptions through water clogging (Islam et al. 2025) or consequential flooding that can damage crops or reduce labor opportunities. Droughts on the other hand are complicated due to its slow onset and inability to discern when it began and when it ended (Abuzar 2017). Through a comprehensive review of various characterizations of droughts, (Farah et al. 2025) indicate that droughts represent a persistent risk that erodes economic stability and resilience through long term cumulative effects. If households are unable to fully insure against these shocks, rainfall variability should affect outcomes like income, consumption, borrowing behavior, and participation in informal insurance mechanisms. In rural settings where there is limited access to formal financial channels, households often rely on community-based institutions to facilitate risk sharing and access to credit (Banerjee and Newman 1998; Townsend 1994). In Bangladesh, religious infrastructures like community mosques which are built and managed through the collective effort of ordinary people function as a central social anchor (Khan 2015). So, if droughts represent a persistent risk rather than temporary liquidity constraints, households may respond by increasing contributions to such institutions that can help insure against future uncertainty. Importantly, this response need not reflect increased devotional intensity. Households may increase such public contributions to religious infrastructure as a visible signal of of commitment to the community, strengthening their credibility within the informal lending networks and improving access to credit when negative income shocks hit.

To examine these responses, I estimate the following specification:

$$\begin{aligned} Y_{hvs} = {} & \beta_1 Drought_{ht} + \beta_2 Drought_{h,t-1} + \beta_3 ExcessRain_{ht} + \beta_4 ExcessRain_{h,t-1} \\ & + \gamma_1 Temp_{ht} + \gamma_2 Temp_{h,t-1} + \gamma_3 HeatDays_{ht} + \gamma_4 HeatDays_{h,t-1} \\ & + \delta_m + \alpha_h + \lambda_s + \varepsilon_{hvs} \end{aligned} \tag{4}$$

where Y_{hvs} denotes the outcome of interest for household h in village v measured at wave s. Outcomes include variables such as monthly earned income, monthly consumption per capita, remittances in, total borrowings, total savings, indicators for contributions in religious infrastructure, expenditure in religious activities, religious group memberships, borrowings from formal, NGOs and informal sources, etc. $Drought_{ht}$, $ExcessRain_{ht}$ are contemporaneous drought and excess rainfall shock indicators and $Drought_{h,t-1}$ and $ExcessRain_{t-1}$ are lagged drought and excess rainfall shock indicators. I control for temperature conditions. Here, $Temp_{ht}$ is the average monsoon daytime temperature at t and $Temp_{h,t-1}$ is the average daytime temperature during prior monsoon. $HeatDays_t$ refer to the number of days above 35°C during monsoon t and $HeatDays_{h,t-1}$ is the corresponding lagged measure.

I include household fixed effects α_h, which absorb time-invariant household characteristics and survey-year fixed effects λ_s, which capture the aggregate shocks affecting all households in a given survey wave. Outcomes of interest such as earned income and food expenditure which are measured over seven days prior to the interview. Time allocation outcomes on the other hand are measured using a 24-hour time diary. Thus, I include survey month fixed effects δ_m to account for seasonal variation in interview timing. Standard errors are clustered at the village level to account for spatial correlation in weather shocks and local economic conditions. Since rainfall shocks are spatially correlated across nearby locations,

residuals can exhibit spatial dependence beyond village boundaries. So, I estimate effects on my key outcomes using Conley (1999) spatial heteroskedasticity and autocorrelation consistent standard errors. This allows error terms to be correlated across households within a specified geographic distance.

I test the following predictions:

- *Income and production:* If excess rainfall creates immediate liquidity disruptions, I expect $\beta_3 < 0$ for income, and expenditures, while if drought is a persistent risk, I expect $\beta_1 = 0$ and $\beta_2 < 0$.

- *Borrowing and smoothing:* If drought raises persistent income risk, I expect $\beta_2 > 0$ for borrowing, remittances, safety-net receipts, and charity.

- *Religious infrastructure:* If religion operates as an informal insurance institution, I expect $\beta_1 > 0$ and $\beta_2 > 0$ for contributions to religious infrastructure.

- *Devotional religiosity:* If the mechanism is strategic institutional investment rather than intrinsic religiosity, I expect no comparable positive effect of drought on religious time use or other religious activities.

- *Heterogeneity in informal credit access:* If religious contributions build credibility in lending networks, I expect the interaction between prior contribution status and drought to be positive for informal borrowing, especially from market lenders.

3.2 Key Identifying assumption

I rely on the following identifying assumption:

$$E[\varepsilon_{hvt} \mid W_{ht}, Z_{ht}, \alpha_h, \lambda_s, \delta_m] = 0 \tag{5}$$

$$W_{ht} = (Drought_{ht}, Drought_{h,t-1}, ExcessRain_{ht}, ExcessRain_{h,t-1})$$

$$Z_{ht} = (Temp_{ht}, Temp_{h,t-1}, HeatDays_{ht}, HeatDays_{h,t-1})$$

Conditional on fixed effects and weather controls, rainfall shocks are uncorrelated with the unobserved determinants of household outcomes.

A potential concern is that rainfall shocks are correlated with geographic characteristics that also affect household responses. Inclusion of household fixed effects take care of such time invariant geographic characteristics. Rainfall shocks could also be correlated with broader regional shocks that simultaneously affect household outcomes. The inclusion of survey-wave fixed effects account for macroeconomic shocks although such shocks cannot be completely ruled out. The remaining variation comes from deviations in local rainfall exposures across years relative to the household location's long run average exposure. I interpret my estimated coefficients as the reduced form effect of unexpected rainfall deviations on household outcomes.

4 Results

4.1 Economic responses to weather shocks

4.1.1 Effects on income and consumption

To study the income and consumption responses to different rainfall shocks, I estimate equation 4 using monthly earned income and per capita consumption as my main outcome variables. Figure 2 represents the results. Excess rainfall shocks generate immediate negative income effects. Estimates suggest that households roughly face about 29%[12] decline in monthly earned income following monsoon with excess rainfall. My finding is consistent with excess rainfall generating flooding or water-clogging that disrupts agricultural production and reduces

[12]All monetary variables are transformed using the inverse hyperbolic sine (asinh) transformation. To facilitate interpretation, I convert coefficients into approximate percentage changes using $(e^{\beta} - 1) \times 100$

labor opportunities. Despite the large decline in income, consumption seems to be unaffected in the short run. One likely explanation is that households buffer against the income shock by drawing down savings or delaying their expenses. However, I observe a positive lagged effect of excess rainfall shock on per capita consumption. The estimated coefficient implies an increase of approximately 6% in the following year. Upon decomposing into monthly food and non-food expenditures, I find that the lagged increase is primarily driven by food expenditure. One possible explanation is that households face higher food prices in later periods due to reduced agricultural supply following harvest losses.

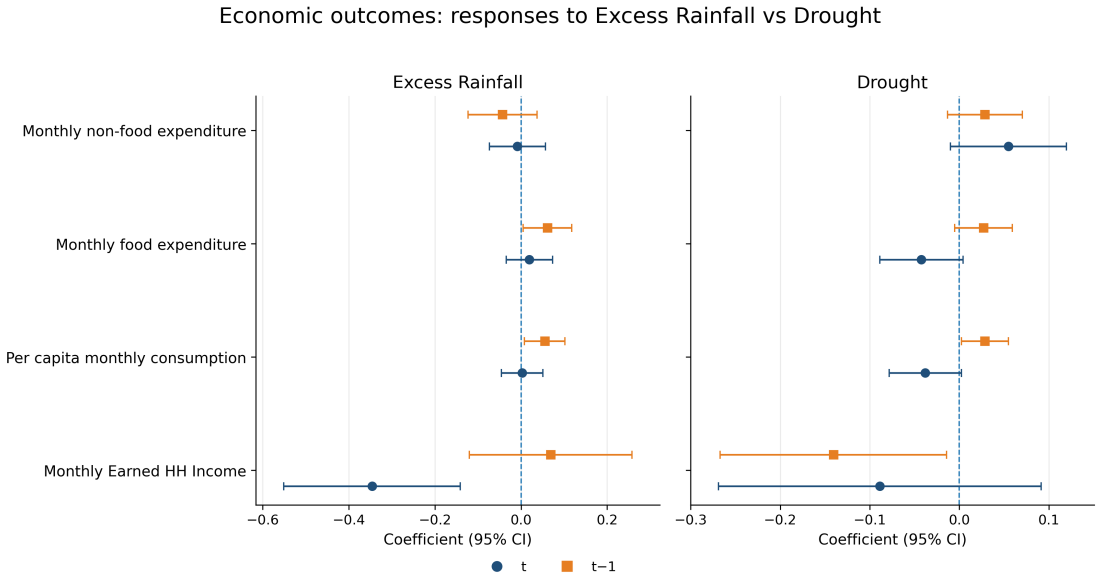


Figure 2: HH income and consumption responses to rainfall shocks

Notes: Following (Bellemare and Wichman 2020), dependent variables are inverse hyperbolic sine (IHS) transformed, and coefficients can be interpreted approximately as semi-elasticities. All monetary values are expressed in real 2011 terms using CPI deflation.

Droughts on the other hand exhibit a different pattern. The contemporaneous drought shock indicator has small and statistically insignificant effect on earned income. Income can be protected in the short run through labor reallocation

to non-farm sectors (Musungu et al. 2024) or temporary migration to cities for work. Per capita consumption decline slightly by about 4%. This decline appears to be driven primarily by a reduction in monthly food expenditure, which falls by about 4%. This finding is consistent with Gebre et al. (2021), who argue that households respond to drought by borrowing food from neighbors or shifting toward relatively cheaper food items. Non-food expenditure on the other hand rises slightly. The estimated coefficient implies an increase of approximately 6%. One possible explanation is that droughts may increase medical expenses and travel costs, as drought conditions are often associated with higher incidence of waterborne diseases such as dysentery and diarrhea due to the use of unsafe water sources when traditional water supplies dry out (Dey et al. 2011). In the longer run, however, I find negative and statistically significant lagged effects of drought on earned income. Households exposed to droughts during the monsoon season in the previous year experience an income decline of approximately 13 percent%. This delayed effect is consistent with the slow onset nature of droughts with the potential to hurt later. As farm labor demand falls, non-farm labor market gets saturated (Musungu et al. 2024) and food prices increase due to droughts (Hill and Porter 2017), households eventually have reduced income along with higher expenditure on food to be able to smooth consumption. Taken together, these findings suggest that droughts operate as a persistent risk shock, which households may anticipate and respond to through precautionary adjustments.

4.1.2 Effects on savings and borrowings

Figure 3 depicts the contemporaneous and lagged effects of excess rainfall and drought shocks on household's savings and borrowing behavior. I find that excess rain leads to about 27% decrease in total annual savings. Consistent with my previous results, households seem to be depleting their savings to smooth consumption as an immediate response to excess rainfall. This further restricts

household liquidity. The lagged effects of excess rain on savings and borrowings are less prominent, although there appears to be a significant lagged decrease in cash held at home by about 26%. Taken together, these patterns suggest that excess rainfall operates primarily as an immediate liquidity shock for households.

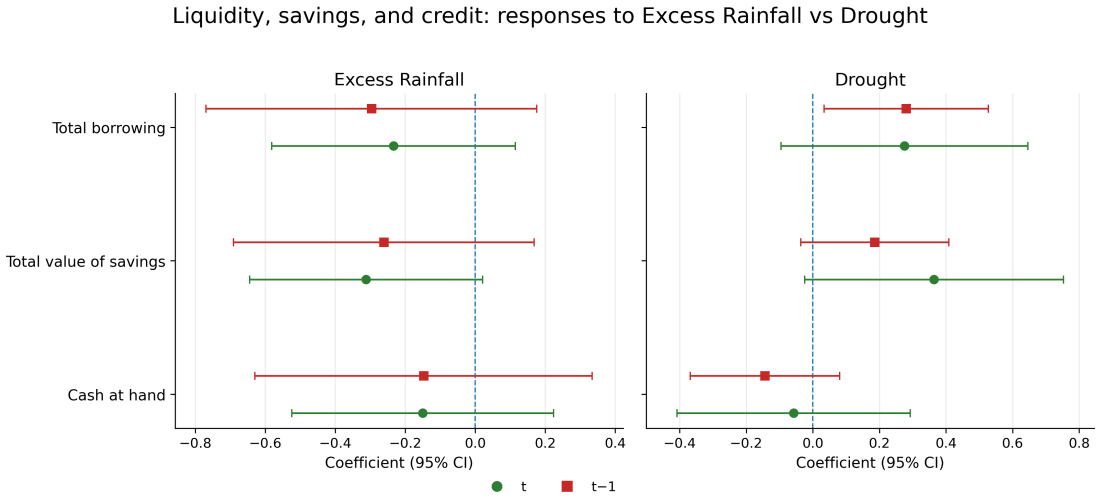


Figure 3: HH savings and borrowing responses to rainfall shocks

Notes: The outcomes are annual measures. Following (Bellemare and Wichman 2020), dependent variables are inverse hyperbolic sine (IHS) transformed, and coefficients can be interpreted approximately as semi-elasticities. All monetary values are expressed in real 2011 terms using CPI deflation.

Contrary to excess rain, droughts have an immediate positive effect on total savings which is significant at the 10% level. Total savings increase by about 44% in the short run. This is consistent with the buffer stock models (Carroll et al. 1992) where households save more in anticipation of future negative income shocks. On the other hand, there is significant lagged positive effect on borrowings. So, when negative income shock eventually hits as a result of droughts, household cope by increasing their borrowing by 32%. Consistent with this pattern, the probability that a household borrows also increases by 2.5 percentage points (Col-

umn 9, Table A2). Given that there is no contemporaneous increase in borrowing following droughts, borrowing appears to function as a coping mechanism once the income shock materializes.

4.1.3 Effects on remittances inflows and safety net benefits

From figure 4, it can be seen that households are not able to access remittances or other benefits post excess rainfall shock. In fact, the excess rainfall leads to a contemporaneous decrease in total social safety net receipt by approximately 24%. This is also consistent with the liquidity crisis faced by households following excess monsoon rain.

On the other hand, droughts have a positive lagged effect on total remittance inflows, total amount received in charities and total safety benefits. I find no such contemporaneous effects. This highlights a consumption smoothing mechanism in response to the negative income shock in the long run following droughts. When income falls in response to droughts, remittance inflows increase by approximately 25%, total amount received in charity increases by 51% and total safety net benefit increase by roughly 23%. These coefficients are statistically significant at the 5% level.

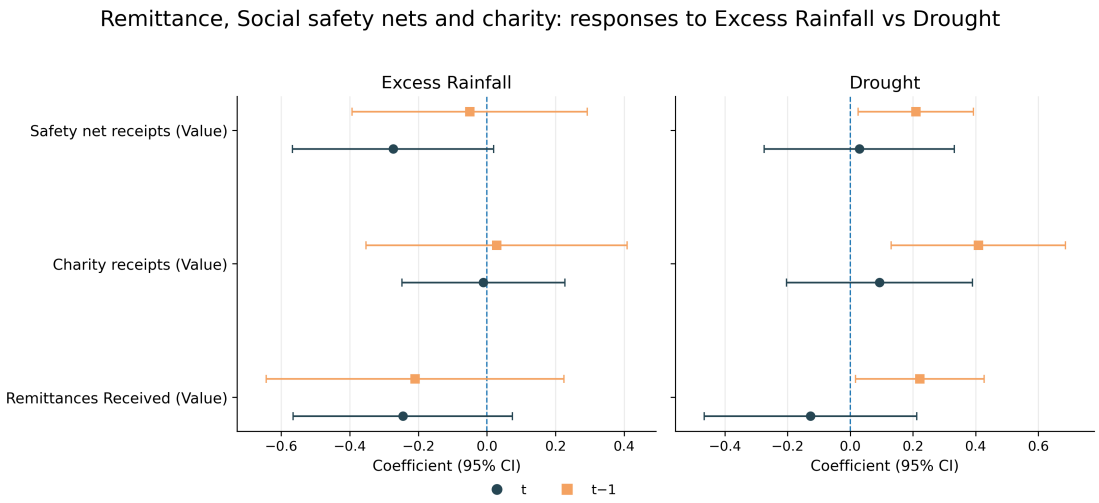


Figure 4: HH remittance inflows and safety net responses to rainfall shocks

Notes: Following (Bellemare and Wichman 2020), dependent variables are inverse hyperbolic sine (IHS) transformed, and coefficients can be interpreted approximately as semi-elasticities. All monetary values are expressed in real 2011 terms using CPI deflation.

As further proof of the coping mechanism in response to droughts in the long run, I present figure 5. The outcome is an indicator for whether the household reported using the remittances for consumption smoothing. Consistent with my findings so far, the contemporaneous effect of drought is and negative and statistically significant at 10% level since households reduce consumption and increase savings anticipating future income uncertainty. In contrast, the lagged drought coefficient is positive and statistically significant, suggesting that the probability that households use remittances to smooth consumption increases by 2.5 percentage points in the year following the drought.

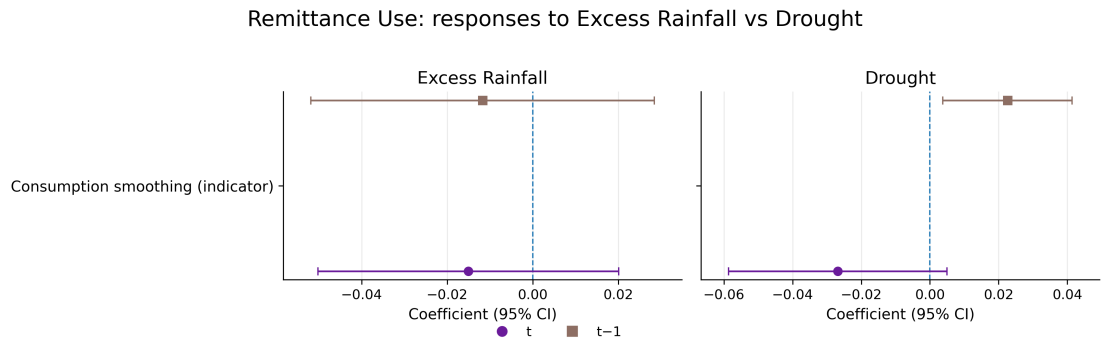


Figure 5: HH use of remittances in response to rainfall shocks

4.2 Religious responses to rainfall shocks

4.2.1 Effects on contributions to religious infrastructure

Column 1 of Table 3 reports the effects of rainfall shocks on contributions to religious infrastructure. The outcome is an indicator equal to one if the primary male or female member of the household reported contributing either time or money toward the construction or maintenance of a religious structure such as a mosque or temple. Droughts have both contemporaneous and lagged positive effects on religious infrastructure contributions. Immediately following a monsoon drought shock, the probability that a household contributes increases by 9 percentage points, and this effect is statistically significant at the 1 percent level. Excess rainfall has no statistically significant contemporaneous effect. Contributions also increase in the year following the drought, although the magnitude is smaller than the contemporaneous effect. Additionally, the positive lagged effect of excess rainfall may suggest that once households recover from the liquidity constraints induced by excess rainfall, they resume or increase their contributions as financial conditions improve.

In column 2, I report the effects of rainfall shocks on the probability of giving sadaqa. My outcome variable is an indicator that equals 1 if households report spending on sadaqa. Sadaqa refers to voluntary donations in Islam. Donating

Table 3: Effects of Rainfall Shocks on Voluntary Religious Contributions

	Voluntary Religious Contributions	
VARIABLES	(1) HH contributed to religious infrastructure = 1	(2) HH gave sadaqa (donations) = 1
$Drought_{ht}$	0.090***	-0.008
	(0.024)	(0.033)
$Drought_{h,t-1}$	0.078***	0.059**
	(0.019)	(0.026)
$ExcessRain_{ht}$	0.004	-0.017
	(0.028)	(0.035)
$ExcessRain_{h,t-1}$	0.050*	-0.034
	(0.026)	(0.036)
Monsoon Temperature Controls	Yes	Yes
Survey Month Controls	Yes	Yes
HH FE	Yes	Yes
Year FE	Yes	Yes
Constant	0.236	2.209***
	(0.493)	(0.793)
Mean dep. var.	0.784	0.555
Observations	16,709	16,756
R-squared	0.485	0.488

Notes: Contribution to religious infrastructure refers to providing time or money for the construction or maintenance of religious infrastructure such as a mosque or temple. Robust standard errors are reported in parentheses.
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

toward construction and maintenance of mosques is considered an act of sadaqa in Islam. Other examples of sadaqa include building a water well of providing clean access to water, establishing educational institutions, supporting orphanages and hospitals, planting trees, supporting agricultural development projects, etc If the increase in religious infrastructure contributions following drought reflects a rise in intrinsic religiosity, we would expect to observe a similar increase in households' probability of spending on sadaqa. However, I do not find any contemporaneous effect of drought on the probability of giving sadaqa. Instead, the effect appears only in the following year. This delayed response may suggest that devotional giving increases as a coping response over time rather than as an immediate hedging mechanism against shocks. One limitation of the religious in-

frastructure contribution variable is that it does not distinguish between time and monetary donations. However, in practice mosque contributions in Bangladesh are predominantly monetary. It is common for mosque committees to collect donations publicly from community members. It is also possible that households do not explicitly classify such contributions as sadaqa, even though they fall under voluntary charity in Islamic teaching because they are unaware. As a result, households may not perceive mosque contributions as purely devotional spending.

4.2.2 Effects on religious activities

Table 4 reports the effect of shocks on time spent in religious activities. Time was recorded in minutes spent on the activity in 24 hours. Among muslims, daily prayer(salat), which is obligatory and is performed five times a day, represents a regular time intensive activity. Hindus similarly devote time to religious practices through puja or other forms of worship. I therefore use time spent on religious activities as a proxy for devotional intensity. I look at the effects separately for the primary male and female member of the household. I find no statistically significant changes in time devoted to religious activities following excess rainfall shocks for either gender. Similarly, there are no statistically significant contemporaneous effects of drought. However, the estimated coefficient for males is negative, suggesting a potential immediate decline in time spent on religious activities, although the effect is not precisely estimated. While the lagged effect of drought shocks are not statistically significant for females, I find a significant increase in the time men devote to religious activity. Over a year after the drought, when negative income effects likely materialize, men tend to increase their time in devotional practices by about 15%. This pattern is consistent with the interpretation that households turn to religion as a coping mechanism in response to income shocks.

Table 5 presents the effects of shocks on annual expenditure in religious activites like zakat, qurbani, hajj, etc. Since the demographic of Bangladesh is

Table 4: Effects of Rainfall Shocks on Time Spent in Religious Activities

	Time Spent in Religious Activities	
VARIABLES	(1) ln(1 + daily minutes spent by main female member)	(2) ln(1 + daily minutes spent by main male member)
$Drought_{ht}$	0.078	-0.073
	(0.077)	(0.083)
$Drought_{h,t-1}$	0.054	0.152***
	(0.063)	(0.059)
$ExcessRain_{ht}$	-0.056	-0.105
	(0.098)	(0.101)
$ExcessRain_{h,t-1}$	0.049	0.028
	(0.089)	(0.097)
Monsoon Temperature Controls	Yes	Yes
Survey Month Controls	Yes	Yes
HH FE	Yes	Yes
Year FE	Yes	Yes
Constant	3.730**	-0.196
	(1.609)	(1.474)
Mean dep. var.	2.253	1.520
Observations	16,624	10,584
R^2	0.605	0.689

Robust standard errors in parentheses.
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

predominantly muslim, the survey focused on religious rituals in Islam. Column 1 to 5 are all indicator variables for whether the household spent money on the following ritual in the past one year. Immediately following a drought shock, the probability that a household gives zakat declines significantly by about 1.7 percentage points. In contrast, the lagged effect is positive and statistically significant, indicating an increase of approximately 1.3 percentage points in the following year. The magnitude of these effects is relatively small, which is consistent with the institutional features of zakat. Zakat is obligatory only for individuals whose wealth exceeds a certain threshold (nisab), and in rural Bangladesh the majority of households are typically recipients rather than payers of zakat. Payments are therefore concentrated among relatively wealthier or more influential households. One possible interpretation is that potential zakat payers temporarily reduce their contributions in anticipation of a negative income shock and increase them the following year when the economic consequences of the shock are more fully real-

ized for poorer households. Alternatively, households may delay zakat payments in anticipation of the shock and make these contributions later, when the focus shifts from precautionary behavior toward coping with realized hardship. I find no such effects of excess rainfall shocks on zakat payments.

For qurbani (Column 2, Table 5), I do not find any statistically significant effects of droughts. For qurbani (Column 2, Table 5), I do not find any statistically significant effects of drought shocks. This is plausible given the nature of the ritual. Qurbani is only required for individuals who can afford it, and therefore participation is concentrated among relatively better-off households whose ability to perform the ritual may be less sensitive droughts. Moreover, in rural Bangladesh, Eid-ul-Adha (the occasion when qurbani is performed) also represents an important economic opportunity for livestock farmers. Many households raise and sell cattle or goats in qurbani haats (seasonal livestock markets) during this period, generating income from the increased demand for sacrificial animals. As a result, the broader economic activity surrounding Eid-ul-Adha may offset potential income losses from drought, leaving the likelihood of performing qurbani largely unchanged. However, excess rainfall in the previous year's monsoon reduces the probability of performing qurbani by 3.5 percentage points. This suggests that the negative consequences of excess rainfall shocks may constrain household's ability to undertake costly religious rituals the following year.

Column (3) of table 5 examines spending on religious functions, which include events such as milad as well as Hindu religious observances such as puja, including annual festivals like Durga Puja. In contrast to qurbani, drought shocks are associated with a significant increase in the likelihood of such spending in the following year. The lagged drought coefficient indicates that households are about 5.6 percentage points more likely to spend on these activities. Religious functions are typically community-oriented events involving prayers, rituals, or gatherings, and the increase following drought is consistent with the interpretation that house-

holds engage more in collective religious practices as a coping response once the income consequences of the shock are realized. By contrast, lagged excess rainfall shocks significantly reduce the probability of such expenditures.

Table 5: Effects of Rainfall Shocks on Expenditure in Other Religious Activities

	Expenditure in Other Religious Activities					
VARIABLES	(1) HH gave Zakat = 1	(2) HH gave Qurbani = 1	(3) HH spent for religious functions (puja, milad) = 1	(4) HH spent for Hajj = 1	(5) HH spent for pilgrimage = 1	(6) asinh(Total religious expenditures)
$Drought_{ht}$	-0.017*	-0.012	0.036	-0.000	0.003	0.238*
	(0.009)	(0.014)	(0.028)	(0.001)	(0.007)	(0.134)
$Drought_{h,t-1}$	0.013**	0.013	0.056***	-0.001	-0.004	0.318***
	(0.006)	(0.008)	(0.020)	(0.001)	(0.004)	(0.108)
$ExcessRain_{ht}$	-0.003	0.020	-0.008	0.001*	-0.009	-0.034
	(0.008)	(0.013)	(0.033)	(0.001)	(0.007)	(0.172)
$ExcessRain_{h,t-1}$	0.010	-0.035**	-0.122***	-0.000	0.010*	-0.345*
	(0.007)	(0.016)	(0.037)	(0.001)	(0.006)	(0.190)
Monsoon Temperature Controls	Yes	Yes	Yes	Yes	Yes	Yes
Survey Month Controls	Yes	Yes	Yes	Yes	Yes	Yes
HH FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Constant	0.006	-0.294	0.471	-0.002	-0.229*	8.909***
	(0.155)	(0.285)	(0.530)	(0.016)	(0.136)	(3.129)
Mean dep. var.	0.0353	0.251	0.348	0.00119	0.0116	6.227
Observations	16,756	16,756	16,756	16,756	16,756	16,756
R^2	0.434	0.711	0.447	0.367	0.414	0.641

Robust standard errors in parentheses.
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Columns (4) and (5) in table 5 show the results for Hajj and other pilgrimages. These activities involve substantial financial costs and long-term planning. Consequently, I do not find robust effects of drought shocks on these expenditures. While the coefficient on excess rainfall in the current year shows a small positive effect for Hajj, the magnitude is extremely small and should be interpreted cautiously. Overall, the estimates suggest that high-cost religious investments such as Hajj are relatively insensitive to short-run weather shocks, likely because they are undertaken by a relatively small and wealthier subset of households.

Column (6) in table 5 reports the effects on total religious expenditure. I find that drought shocks increase total religious spending both contemporaneously and with a one-year lag. While participation in individual religious activities does not change substantially, the rise in total expenditure suggests that households already engaged in these activities may increase the amount they spend. One possible explanation is that drought shocks raise the cost of performing certain religious

rituals. For example, livestock prices for qurbani may increase. In such cases, households that continue to undertake these activities may face higher prices even if participation does not change, leading to higher total religious expenditures. In contrast, excess rainfall in the previous year significantly reduces total religious spending, consistent with the adverse income effects of excessive rainfall that may constrain households' ability to spend on religious activities.

4.2.3 Effects on religious group memberships

I further study how rainfall shocks affect religious group memberships and participation. In rural Bangladesh, religious groups may include mosque committees responsible for maintaining local mosques and collecting donations, local wings of religiously motivated political organizations, or small neighborhood circles where individuals gather to study Arabic, recite the Qur'an, or listen to religious sermons. These memberships are typically distinct from direct donations to mosques or participation in regular prayers in mosques. To better understand the motivation behind religious engagement, I report results separately for men and women. In Bangladesh, women have historically had limited participation in mosque-based activities. Women are not generally allowed to enter any mosque and pray unless it can be ensured that there is dedicated space for women to pray (Khan and Nia 2023). Religious practice for women mainly takes place within households or neighborhood study circles rather than in mosques. Qualitative evidence on religious movements in Bangladesh supports the idea that women's religious groups operate through localized networks of meetings and neighborhood committees. For example, studies of the Tablighi Ja'maat document how women increasingly participate in weekly neighborhood gatherings organized around mosque teachings and religious study circles (Karim 2014). These groups often meet regularly within neighborhoods and create dense networks of interaction among women. Because women's religious engagement typically occurs through such local gath-

erings rather than mosque congregations, participation in these groups can reflect both devotional activity and involvement in community-based religious networks.

Table 6 presents the effects of rainfall shocks on religious group membership and participation intensity. Columns (1)–(3) examine whether the primary male or female household member belongs to a religious group, while columns (4)–(5) measure participation intensity using an indicator for whether the individual attended at least two of the last five meetings. I find positive and statistically significant lagged effects of drought on religious group membership. One year after a drought shock, the probability that at least one household member belongs to a religious group increases by about 4.8 percentage points. When disaggregated by gender, the effect is present for both men and women but is larger for women. The probability that the primary female household member joins a religious group rises by approximately 3.9 percentage points, compared with 1.8 percentage points for men. A similar pattern emerges for participation intensity. Women are significantly more likely to attend religious group meetings one year after the drought shock, whereas there is no comparable lagged increase in men's participation intensity. Instead, men exhibit a modest contemporaneous increase in meeting attendance immediately following drought. This pattern may reflect the fact that male-dominated religious organizations, such as mosque committees or religious political groups, become active immediately after shocks as members coordinate activities such as fundraising or community support.

Excess rainfall shocks show a different pattern. Immediately following excess rainfall, men reduce both religious group membership and participation intensity, which is consistent with a short-run liquidity or time constraint when households must focus on coping with immediate economic disruptions. However, the lagged coefficient on men's meeting attendance becomes positive, suggesting that participation in these groups increases once the shock passes. This pattern is consistent with the idea that men may use religious networks strategically as informal insur-

Table 6: Effects of Rainfall Shocks on Religious Group Membership and Visits

	Religious Group Membership and Visits				
VARIABLES	(1) Main HH male/female is a religious group member = 1	(2) Main HH male is a religious group member = 1	(3) Main HH female is a religious group member = 1	(4) Main HH male attended at least 2 out of 5 group meetings = 1	(5) Main HH female attended at least 2 out of 5 group meetings = 1
$Drought_{ht}$	0.020	0.020	0.009	0.026**	-0.010
	(0.026)	(0.014)	(0.023)	(0.011)	(0.020)
$Drought_{h,t-1}$	0.048***	0.018**	0.039***	0.009	0.040***
	(0.015)	(0.008)	(0.013)	(0.007)	(0.011)
$ExcessRain_{ht}$	-0.015	-0.038**	0.017	-0.029**	-0.001
	(0.025)	(0.015)	(0.018)	(0.013)	(0.015)
$ExcessRain_{h,t-1}$	0.005	0.020	-0.003	0.020*	-0.021
	(0.031)	(0.014)	(0.027)	(0.010)	(0.024)
Monsoon Temperature Controls	Yes	Yes	Yes	Yes	Yes
Survey Month Controls	Yes	Yes	Yes	Yes	Yes
HH FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
Constant	0.309	0.529**	-0.037	0.576**	-0.100
	(0.488)	(0.267)	(0.408)	(0.231)	(0.349)
Mean dep. var.	0.173	0.0670	0.117	0.0522	0.0824
Observations	16,709	16,709	16,709	16,709	16,709
R^2	0.439	0.420	0.451	0.426	0.424

Robust standard errors in parentheses.
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

ance or support networks, increasing engagement after the shock to rebuild social ties and access potential assistance.

4.3 Mechanism

The main mechanism I propose is that households use publicly observable religious contributions to strengthen ties with influential informal money lenders in the village. In rural Bangladesh, droughts signal elevated future risk, rather than an immediate income loss. In response to this increased uncertainty, households may reallocate resources away from private devotional activities toward publicly observable contributions to religious infrastructure. Unlike other religious practices like prayers which can be discreet or zakat which is directed towards poorer beneficiaries rather than influential community members, contributions to the construction or maintenance of religious infrastructure are highly visible in the influential community and may serve as a signal of commitment to local institutions and networks. This visibility may be particularly important in villages where the credit markets are dominated by mahajans (traditional moneylenders) and shopkeepers. These lenders are typically wealthy, influential figures in the village community with strong political and social ties to local leadership. Using the BIHS commu-

nity survey data for wave 2 and wave 3, I report the average number of informal credit sources and mahajans in a typical village in table A2. A typical village has about 8-10 mahajans on average. In 2015 average number of shopkeepers who lent money was about 8 which greatly increased to almost 27 by 2018-19. These informal lenders often compete with local NGOs for borrowers.

To test this mechanism, I first show that drought exposure increases household's reliance on informal borrowing. I then examine whether households that previously donated to religious infrastructure experience different borrowing responses to drought.

4.3.1 Effects on informal borrowing

Figure 6 shows how households adjust their borrowing behavior in response to rainfall shocks across different credit sources. Current drought exposure is associated with a statistically significant increase in borrowing from NGOs. One possible explanation could be related to the structural pattern of microfinance lending in Bangladesh. Microfinance loans are typically provided through organized borrower groups who meet regularly with program staff and follow a fixed repayment schedule. Borrowers are commonly organized into small groups that meet weekly/monthly to repay loan installments and access subsequent loans within the established borrowing cycle (Zaman 2004). Since these arrangements are well structured, households who are already members of these microfinance programs may be able to increase borrowing relatively quickly when risk becomes apparent. In contrast, lagged drought exposure significantly increase borrowing from informal sources, particularly from market informal lenders (Figure 7) mahajans and shopkeepers. Unlike NGO loans, these informal loans are directly negotiated with the lender and depends heavily on personal ties, trust and discretion of the lender. Moreover, these loans can be obtained almost immediately unlike NGO loans where one needs to wait for the next group meeting. Households may there-

fore approach informal lenders when financial pressures become more apparent such as when income losses are realized after a drought. Because these lenders operate within village networks, maintaining relationships with influential lenders or signaling loyalty/credibility to them may be important for securing credit.

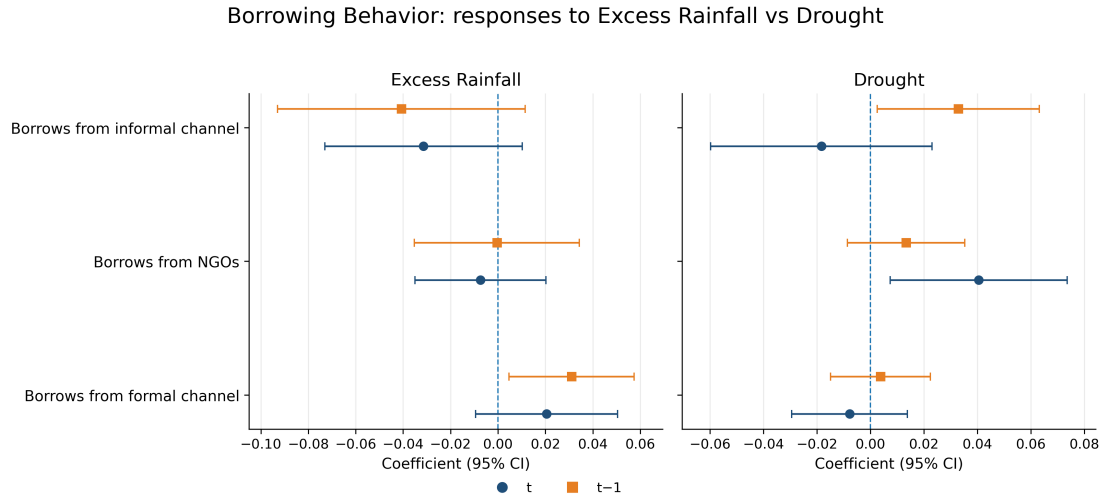


Figure 6: HH borrowing channel responses to rainfall shocks

Notes: The outcomes are all indicator variables for different borrowing sources.

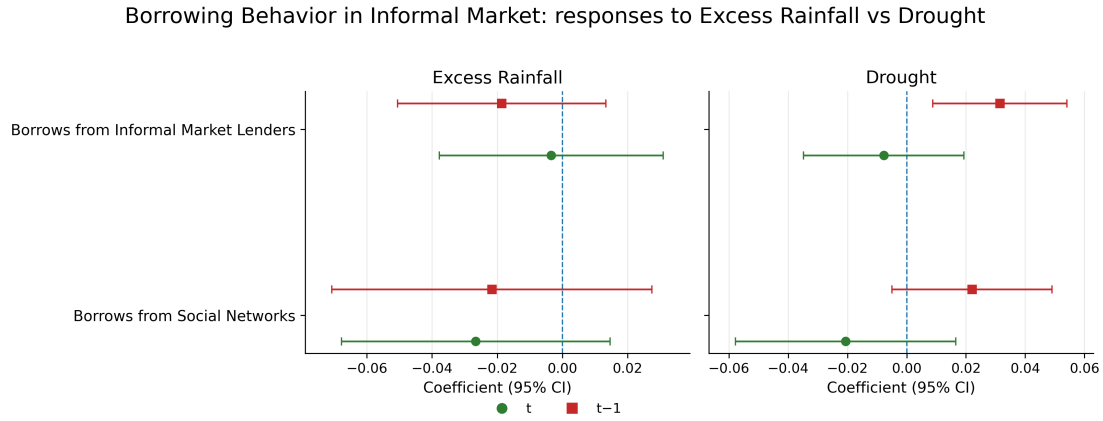


Figure 7: HH borrowing channel responses to rainfall shocks

Notes: The outcomes are all indicator variables for different borrowing sources.

4.3.2 Religious contributions and informal borrowing

To formally test the proposed signaling mechanism, I estimate the following specification:

$$\begin{aligned} Y_{hvs} = {} & \beta_1 Drought_{ht} + \beta_2 Drought_{h,t-1} + \beta_3 r_{h,s-1} \\ & + \beta_4 (r_{h,s-1} \times Drought_{ht}) + \beta_5 (r_{h,s-1} \times Drought_{h,t-1}) \\ & + \mathbf{X}_{ht}\gamma + \alpha_h + \lambda_s + \varepsilon_{hvs}. \end{aligned} \tag{6}$$

Here, Y_{hvs} denotes an indicator equal to one if household h reports borrowing from informal sources in wave s. The variable $r_{h,s-1}$ is an indicator equal to one if the household contributed time or money to religious infrastructure in the previous survey wave. The interaction terms allow the borrowing response to drought to differ between households that previously made such contributions and those that did not. The vector $\mathbf{X}_{ht}$ includes controls for excess monsoon rainfall shocks, average monsoon temperature, and extreme heat days, as well as interview month fixed effects. Household fixed effects α_h control for time-invariant household characteristics, and year fixed effects λ_s capture common shocks across survey waves.

Table 7 reports the regression results. The estimates indicate that prior religious contributions are associated with a differential borrowing response to drought shocks. Among households that previously did not contribute, drought reduces borrowing from informal market lenders by about 5.8 percentage points. In contrast, households with prior contributions show stronger borrowing response. The interaction estimate implies an increase of roughly 7.5 percentage points relative to non-contributors. My findings imply that while drought reduces access to informal credit among non-contributors, the decline is fully offset for households that previously contributed to religious infrastructure. This pattern is consistent with the interpretation that publicly observable religious contributions may improve

household's credibility within village institutions. Informal market lenders like mahajans may directly observe these contributions, may themselves be members of the mosque committees, or may rely on information from imams or committee leaders when evaluating potential borrowers. Thus, such visible contributions can strengthen a household's reputation and improve access to informal credit when drought risk materializes.

Table 7: Prior Religious Contributions and Informal Borrowing Responses to Drought

VARIABLES	(1) HH borrows from informal sources = 1	(2) HH borrows from informal market lenders = 1	(3) HH borrows from social networks = 1
$r_{h,s-1}$	-0.042*	-0.021	-0.035
	(0.023)	(0.018)	(0.022)
$Drought_{ht}$	-0.044	-0.058*	-0.032
	(0.041)	(0.030)	(0.038)
$r_{h,s-1} \times Drought_{ht}$	0.091**	0.075**	0.063
	(0.042)	(0.032)	(0.040)
$Drought_{h,t-1}$	-0.018	-0.013	0.011
	(0.042)	(0.032)	(0.036)
$r_{h,s-1} \times Drought_{h,t-1}$	0.027	0.035	-0.007
	(0.033)	(0.026)	(0.032)
Controls	Yes	Yes	Yes
HH FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Constant	0.854	-0.206	0.785
	(0.657)	(0.480)	(0.623)
Mean dep. var.	0.441	0.125	0.349
Observations	9,096	9,096	9,096
R-squared	0.624	0.610	0.618

Notes: $r_{h,s-1}$ is an indicator equal to one if the household contributed time or money to religious infrastructure in the previous survey wave. Robust standard errors reported in parentheses.
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

4.3.3 Alternative mechanisms

The evidence I presented so far suggests that droughts have both contemporaneous and persistent positive effects on contributions to religious infrastructure, while broader measures of religiosity have lagged effects. This pattern helps to my

proposed mechanism from several alternative explosions.

One possibility is that drought shocks increase intrinsic religiosity. If households become more religious in response to drought risk, we would expect to observe contemporaneous increases across multiple dimensions of religiosity, including time spent in religious activities and participation in religious groups. But, my empirical results do not support this pattern. Increases in religiosity across several measure like time spent in religious activities, participation in religious groups, probability of spending on religious functions, etc. appear later on when negative income effects begin to materialize. Closely related is the possibility that households increase religious giving as a form of spiritual insurance, where donations are made in expectation of divine protection against future uncertainty (Auriol et al. 2020). In this case, I would expect the probability of giving sadaqa to increase contemporaneously alongside infrastructure contributions. But my results show no such increase in sadaqa even though religious infrastructure contribution is also a sadaqa by Islamic definition. Instead, sadaqa only increase in the following period alongside other measures of religiosity. Taken together, my results point towards religiosity as a coping mechanism in response to realized hardship consistent with the ideas of Pargament et al. (2001).

Another explanation is that drought shocks increase generalized altruism or public goods provision. Under models of pure or impure altruism (Andreoni 1989; Becker 1974), individuals may increase charitable giving because helping others generates utility directly. If households respond to droughts by becoming more altruistic, I would expect to observe increases in contributions to other forms of community infrastructure as well. To test this possibility, I examine the effects of rainfall shocks on contributions to non-religious public infrastructure and interpersonal assistance using equation (4). Following Anderson (2008), I construct composite indices that aggregate several related indicators. The public infrastructure index combines three indicator variables measuring whether the household

contributed time or money to the construction or maintenance of village wells, village roads, town development and other public works. Each indicator is standardized to have mean zero and unit variance, and the index is constructed as the average of the standardized components before being standardized again for ease of interpretation. The interpersonal assistance index aggregates three indicators capturing whether the household provided: money to another household to help a sick member, agricultural labor to another household, child care assistance to another household. These indicators are similarly standardized and combined into a summary index. The results presented in table A5 show no evidence that drought increases contributions to non-religious public infrastructure. The estimated coefficients on both contemporaneous and lagged drought indicators are small and statistically insignificant. While interpersonal assistance increase, these responses do not translate into broader investment in public infrastructure for community benefits. Instead, the behavioral response is concentrated specifically in religious infrastructure investment, which is a highly visible form of contribution embedded in local religious institutions.

4.4 Heterogeneity

4.4.1 Heterogeneity by historical drought risk

Households located in historically drier regions may already be accustomed to drought risks, and this could decrease the marginal informational content of a drought shock. To explore this possibility, I interact drought exposure with an indicator for households located in the lowest quartile of the long run monsoon rainfall distribution. I estimate the following equation:

$$
\begin{aligned}
Y_{hvs} = \beta_1 Drought_{ht} + \beta_2 Drought_{h,t-1} + \beta_3 DryArea_h \\
+ \beta_4 (DryArea_h \times Drought_{ht}) \\
+ \beta_5 (DryArea_h \times Drought_{h,t-1}) \\
+ \mathbf{X}_{ht}\gamma + \alpha_h + \lambda_s + \varepsilon_{hvs}.
\end{aligned}
\tag{7}
$$

where $DryArea_h = 1$ if the household is located in the lowest quartile of the long run monsoon rainfall distribution.

Table 8: Heterogeneity by Historical Drought Risk

VARIABLES	(1) HH contributed to religious infrastructure = 1	(2) HH borrows from informal sources = 1	(3) HH borrows from informal market lenders = 1
$Drought_{ht}$	0.106***	-0.012	-0.006
	(0.027)	(0.023)	(0.015)
$DryArea_h \times Drought_{ht}$	-0.068*	-0.026	-0.007
	(0.036)	(0.038)	(0.023)
$Drought_{h,t-1}$	0.084***	0.030*	0.027**
	(0.021)	(0.017)	(0.013)
$DryArea_h \times Drought_{h,t-1}$	-0.029	0.011	0.015
	(0.030)	(0.030)	(0.020)
Controls	Yes	Yes	Yes
HH FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Mean dep. var.	0.784	0.414	0.118
Observations	16,709	16,756	16,756
R-squared	0.486	0.487	0.466

Notes: $DryArea_h$ is an indicator equal to one if the household is located in the lowest quartile of the long-run rainfall distribution. Standard errors clustered at the village level are reported in parentheses.

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

The results represented in table 8 show that the contemporaneous increase in religious infrastructure contributions is significantly smaller in historically dry

areas. This suggests that in regions where drought risk is already common, a drought shock may convey less new information about future risk. On the other hand, lagged effects of drought on informal borrowing remain positive and statistically significant, particularly for borrowing from informal market lenders with no significant difference between historically dry vs non dry areas.

4.4.2 Heterogeneity by household occupation

Because agricultural production and labor demands directly depends on rainfall conditions, farm households may face different consequences of rainfall shocks. For example, farm households may face a more immediate income effect compared to non-farm households. To test whether drought effects differ between farm and non-farm households, I estimate the following equation:

$$\begin{aligned} Y_{hvs} = \beta_1 Drought_{ht} + \beta_2 Drought_{h,t-1} + \beta_3 Farm_h \\ + \beta_4 (Farm_h \times Drought_{ht}) \\ + \beta_5 (Farm_h \times Drought_{h,t-1}) \\ + \mathbf{X}_{ht}\gamma + \alpha_h + \lambda_s + \varepsilon_{hvs}. \end{aligned} \tag{8}$$

where $Farm_h = 1$ if the household head was primarily engaged in farming during wave 1. The results are presented in table 9.

The estimated effects suggest that drought reduces income for farm households in both the contemporaneous and lagged periods. Contributions to religious infrastructure following drought on the other hand is similar across farming and non farming households. Lagged drought shocks increase informal borrowing response for both groups, particularly market informal loans. The probability that a farming household borrows from an informal market lender in the longer run after the drought shock increases by 35 percentage points. This is higher than the effect for non farming households, although the difference is not significant.

Interestingly, non-farming households also rely on social networks (friends, relatives, employer) following drought, unlike farm households. My results suggest that while income consequences of drought differ across livelihood types, the increase in visible religious contributions occurs broadly across households. This is consistent with the interpretation that households respond to drought risk rather than contemporaneous income shocks.

Table 9: Heterogeneity by Household Farming Status

VARIABLES	(1) asinh(Monthly earned income)	(2) HH contributed to religious infrastructure = 1	(3) HH borrows from informal sources = 1	(4) HH borrows from social networks = 1	(5) HH borrows from informal market lenders = 1
$Drought_{ht}$	0.016	0.091***	-0.021	-0.026	-0.003
	(0.115)	(0.028)	(0.025)	(0.022)	(0.015)
$Farm_h \times Drought_{ht}$	-0.192*	-0.002	0.002	0.008	-0.008
	(0.113)	(0.024)	(0.021)	(0.021)	(0.014)
Effect of $Drought_{ht}$ for farm households	-0.178*	0.089***	-0.018	-0.018	-0.011
	(0.101)	(0.026)	(0.023)	(0.021)	(0.016)
$Drought_{h,t-1}$	-0.129	0.078***	0.049***	0.042***	0.027**
	(0.089)	(0.023)	(0.017)	(0.016)	(0.013)
$Farm_h \times Drought_{h,t-1}$	-0.024	-0.000	-0.033*	-0.039**	0.008
	(0.088)	(0.018)	(0.018)	(0.018)	(0.012)
Effect of $Drought_{h,t-1}$ for farm households	-0.152**	0.078***	0.017	0.003	0.035***
	(0.065)	(0.020)	(0.018)	(0.017)	(0.013)
Controls	Yes	Yes	Yes	Yes	Yes
HH FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
Mean dep. var.	8.564	0.784	0.414	0.328	0.118
Observations	16,756	16,709	16,756	16,756	16,756
R-squared	0.665	0.485	0.488	0.470	0.466

Notes: $Farm_h$ is an indicator equal to one if the household head's primary occupation was farming in wave 1. Effects for farm households are calculated using linear combinations of the estimated coefficients. Standard errors clustered at the village level are reported in parentheses.

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

4.4.3 Heterogeneity by pre-existing connections to MFIs

Access to microfinance may provide alternative credit sources and can reduce reliance on informal lenders. To test whether households connected to microfinance institutions (MFIs) respond differently to drought shocks, I estimate the following

equation:

$$
\begin{aligned}
Y_{hvs} = \beta_1 Drought_{ht} + \beta_2 Drought_{h,t-1} \\
+ \beta_3(MFI_h \times Drought_{ht}) + \beta_4(MFI_h \times Drought_{h,t-1}) \\
+ \mathbf{X}_{ht}\gamma + \alpha_h + \lambda_s + \varepsilon_{hvs}.
\end{aligned} \tag{9}
$$

where $MFI_h = 1$ if any household member reported regularly visiting a microfinance institution in the baseline survey wave. Table 10 presents the estimation results.

Estimates suggest that drought increases religious infrastructure contributions for both groups, with a somewhat larger effect among households connected to MFIs. However, there are no statistically significant differences in lagged borrowing responses from informal market lenders between MFI exposed and non-exposed households. Even households with MFI access continue to rely on informal lenders once income consequences of droughts materialize. This could be because getting a loan from informal lenders are much faster. In addition, households that already have outstanding microfinance loans may turn to informal lenders as an alternative credit source when financial pressures worsen.

Table 10: Heterogeneity by Microfinance Exposure

VARIABLES	(1) HH contributed to religious infrastructure = 1	(2) HH borrows from informal sources = 1	(3) HH borrows from informal market lenders = 1
$Drought_{ht}$	0.052**	-0.009	-0.017
	(0.024)	(0.023)	(0.015)
$MFI_h \times Drought_{ht}$	0.080***	-0.020	0.020
	(0.027)	(0.025)	(0.015)
Effect of $Drought_{ht}$ for MFI households	0.132***	-0.028	0.003
	(0.030)	(0.026)	(0.016)
$Drought_{h,t-1}$	0.067***	0.035**	0.031**
	(0.020)	(0.018)	(0.012)
$MFI_h \times Drought_{h,t-1}$	0.022	-0.005	0.001
	(0.022)	(0.018)	(0.013)
Effect of $Drought_{h,t-1}$ for MFI HH	0.090***	0.030	0.031**
	(0.024)	(0.018)	(0.014)
Controls	Yes	Yes	Yes
HH FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Mean dep. var.	0.784	0.414	0.118
Observations	16,709	16,756	16,756
R-squared	0.486	0.487	0.466

Notes: MFI_h is an indicator equal to one if any household member reported regularly visiting a microfinance institution in the baseline survey wave. Effects for microfinance households are calculated using linear combinations of the estimated coefficients.
Standard errors clustered at the village level are reported in parentheses.
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

4.5 Robustness

Because nearby households may experience similar economic conditions or share local credit markets, error terms may exhibit spatial correlation. Ignoring such spatial dependence can lead to underestimated standard errors and overestimated statistical significance. To address this concern, I compute spatially corrected

errors following the procedure proposed by Conley (1999). This approach allows for correlation in regression residuals across observations located within a specific geographic distance. I implement the estimator using the provided household geographic coordinates and apply a Bartlett kernel with a spatial cutoff radius of 150 kilometers. Controls, household and survey wave fixed effects are maintained as the baseline specification. The estimates remain qualitatively similar to the baseline results (Table 11). In particular, drought shocks continue to increase contributions to religious infrastructure, while lagged drought exposure remains associated with increased reliance on informal borrowing. These results suggest that the main findings are robust to allowing for spatial correlation in the error terms.

In the baseline specification, I defined drought and excess rainfall using indicator variables based on rainfall deviations of one standard deviation above or below the historical mean. While this classification captures extreme rainfall realizations, it might mask potential nonlinearities in the relationship between rainfall shocks and household outcomes. To address this concern, I construct a seven category rainfall index based on the standardized precipitation measure z_{ht}. I group rainfall realizations into bins corresponding to extreme drought ($z_{ht} \leq -1.5$), severe drought $(-1.5, -1]$, moderate drought $(-1, -0.5]$, normal rainfall $(-0.5, 0.5)$, moderate excess rainfall $[0.5, 1)$, severe excess rainfall $[1, 1.5)$, and extreme excess rainfall ($z_{ht} \geq 1.5$). The "normal rainfall" category serves as the omitted reference group. I then estimate my baseline specification by replacing the drought and excess rainfall indicators with this set of bins for both contemporaneous and lagged realizations. Rather than imposing a single threshold, this approach allows effects of rainfall shocks to vary flexibly across different levels of deviation. The results are reported in table 12. In addition, I control for a continuous measure of flood exposure using the share of flooded pixels within a 5 km buffer around each household's coordinates during flood events in year t. Flood expo-

sure is constructed using satellite-based flood extent data from the Dartmouth Flood Observatory. Including this variable allows me to separate rainfall anomalies from realized flooding intensity, ensuring that the estimated rainfall effects are not driven by contemporaneous flood exposure. The results are reported in Table 12.

Table 11: Robustness: Spatially Adjusted Standard Errors

VARIABLES	(1) asinh(Monthly earned income)	(2) HH contributed to religious infrastructure = 1	(3) HH borrows from informal market lenders = 1
$Drought_{ht}$	-0.089	0.090**	-0.008
	(0.088)	(0.044)	(0.013)
$Drought_{h,t-1}$	-0.141*	0.078***	0.031***
	(0.073)	(0.026)	(0.012)
$ExcessRain_{ht}$	-0.346***	0.004	-0.003
	(0.129)	(0.041)	(0.023)
$ExcessRain_{h,t-1}$	0.069	0.050	-0.019
	(0.126)	(0.045)	(0.021)
Temperature controls	Yes	Yes	Yes
HH FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Month FE	Yes	Yes	Yes
Mean dep. var.	8.562	0.784	0.118
Observations	16,757	16,724	16,757
R-squared	0.004	0.020	0.008

Notes: Standard errors are spatially corrected using the Conley (1999) procedure with a Bartlett kernel and a spatial cutoff radius of 150 kilometers based on household geographic coordinates. Robust standard errors are reported in parentheses.

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 12: Robustness: Alternative Rainfall Shock Bins with Continuous Inundation Control

VARIABLES	(1) asinh(Monthly Income)	(2) Religious Infrastructure Contribution = 1	(3) HH Informal Loans =1	(4) HH Social Network Loans = 1	(5) HH Market Informal Loans = 1
Extreme drought ($z_{ht} \leq -1.5$)	-0.147	0.196***	-0.018	-0.029	0.003
	(0.141)	(0.041)	(0.036)	(0.032)	(0.024)
Severe drought ($-1.5 < z_{ht} \leq -1$)	-0.204*	0.072**	-0.038	-0.043*	0.004
	(0.119)	(0.028)	(0.026)	(0.024)	(0.019)
Moderate drought ($-1 < z_{ht} \leq -0.5$)	-0.050	0.002	-0.017	-0.019	0.007
	(0.078)	(0.022)	(0.020)	(0.021)	(0.015)
Moderate excess rain ($0.5 \leq z_{ht} < 1$)	0.147*	-0.033	0.032	0.002	0.054***
	(0.080)	(0.027)	(0.022)	(0.020)	(0.017)
Severe excess rain ($1 \leq z_{ht} < 1.5$)	-0.202*	-0.076**	0.027	-0.002	0.047**
	(0.121)	(0.035)	(0.027)	(0.024)	(0.023)
Extreme excess rain ($z_{ht} \geq 1.5$)	-0.322*	0.111***	-0.087**	-0.034	-0.062***
	(0.164)	(0.042)	(0.035)	(0.034)	(0.023)
Lagged extreme drought ($z_{h,t-1} \leq -1.5$)	-0.240**	0.190***	0.078***	0.071**	0.033
	(0.119)	(0.039)	(0.030)	(0.028)	(0.025)
Lagged severe drought ($-1.5 < z_{h,t-1} \leq -1$)	-0.030	0.098***	0.033	0.005	0.055***
	(0.098)	(0.031)	(0.023)	(0.021)	(0.017)
Lagged moderate drought ($-1 < z_{h,t-1} \leq -0.5$)	0.095	0.058*	0.018	-0.003	0.027
	(0.086)	(0.030)	(0.022)	(0.022)	(0.017)
Lagged moderate excess rain ($0.5 \leq z_{h,t-1} < 1$)	-0.159	0.049	0.060**	-0.032	0.133***
	(0.103)	(0.036)	(0.029)	(0.027)	(0.024)
Lagged severe excess rain ($1 \leq z_{h,t-1} < 1.5$)	0.072	0.049	0.030	-0.031	0.083***
	(0.117)	(0.037)	(0.040)	(0.036)	(0.022)

VARIABLES	(1) Income	(2) Religious Infrastructure	(3) Informal Loans	(4) Social Network Loans	(5) Market Informal Loans
Lagged extreme excess rain ($z_{h,t-1} \geq 1.5$)	-0.091	0.113**	-0.016	-0.077**	0.093***
	(0.157)	(0.044)	(0.040)	(0.038)	(0.024)
$\text{InundationShare}_{ht}$	-0.482**	0.053	0.008	-0.063	0.066
	(0.203)	(0.057)	(0.057)	(0.052)	(0.051)
$\text{InundationShare}_{h,t-1}$	-0.654***	0.150**	-0.010	0.005	-0.053
	(0.223)	(0.066)	(0.060)	(0.052)	(0.051)
Constant	11.486***	0.128	0.560	0.692	-0.437
	(1.830)	(0.503)	(0.479)	(0.458)	(0.325)
Observations	16,756	16,709	16,756	16,756	16,756
R-squared	0.666	0.493	0.490	0.471	0.474
Temperature Controls	Yes	Yes	Yes	Yes	Yes
HH FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
Month FE	Yes	Yes	Yes	Yes	Yes
Cluster	Village	Village	Village	Village	Village
Mean dep. var.	8.564	0.784	0.414	0.328	0.118

Notes: The omitted category is normal rainfall ($-0.5 < z_{ht} < 0.5$). Rainfall bins are constructed using standardized monsoon rainfall deviations. All regressions additionally control for contemporaneous and lagged continuous inundation share, household fixed effects, year fixed effects, interview month fixed effects, and temperature controls. Robust standard errors clustered at the village level are reported in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

The results broadly follow the patterns observed with my baseline specification. Religious contributions increase during severe and extreme drought realizations. Both contemporaneous and lagged drought bins are associated with higher probabilities of donating to religious infrastructures. Income declines and borrowing responses to droughts also appear with a lag which is consistent with the estimates of my baseline model. This bin specification also reveals that some excess rainfall realizations are associated with increases in religious infrastructure contri-

butions and borrowing from informal market lenders. While severe excess rainfall realizations are associated with declines in religious infrastructure contributions, the estimates show a different pattern for extreme excess rainfall events. In particular, extreme excess rainfall ($z > 1.5$) is associated with a contemporaneous and persistent increase in religious infrastructure contributions despite the negative income effects. One possible interpretation is that extremely high rainfall events can cause visible damage to local infrastructure, including mosques and other buildings. Particularly, in a flat terrain like Bangladesh with inadequate drainage systems, rain water accumulates and often gets into homes and other establishments. Since, religious institutions like community mosques are maintained through community donations, households may need to make additional contributions to repair or restore these religious spaces. Households in Bangladesh may also have incentives to do so as mosques/temples function as information hubs and shelters during trying times. The borrowing results show a related but distinct pattern. Unlike the drought case, these borrowing responses to excess rain are not systematically accompanied by increases in religious contributions. One possible explanation is that floods and extreme high rainfall events represent high visible shocks that are easily verified within the village environment. Because, the economic distress associated with such shocks is observable, lenders may be more willing to extend credit even without the type of reputation building signals that may appear relevant in case of droughts. At the same time, the contemporaneous coefficient on extreme rainfall is negative for borrowing from informal markets lenders, suggesting that immediately after severe rainfall events, households may face an economy-wide liquidity crunch that temporarily limits access to credits.

In my baseline specification, I constructed rainfall shocks using precipitation averaged within a 5 km radius around the household's reported coordinates. My choice was a conservative approach based on two considerations. First is the random displacement of household coordinates by 2.5 km as mentioned previously.

Second, rainfall shocks affecting agricultural production may operate over spatial scales larger than household location. In fact, the agricultural plots in Bangladesh are typically within 0.5 km of the household location (Vitellozzi and Giannelli 2024). Thus, a 5 km buffer ensures that the true household location is likely captured while still preserving localized weather variation. To verify that my results are not sensitive to my choice of spatial aggregation, I reconstruct rainfall shock measures using alternate buffer radii of 2.5 km and 10 km. The 2.5 km buffer corresponds to the maximum displacement radius used in the survey and therefore captures the most localized rainfall realizations. The 10 km buffer allows rainfall exposure to be measured over a broader spatial scale that may better reflect the geographic extent of agricultural weather shocks. I re-estimate my baseline specification with these alternative spatial definitions. Results are reported in tables A6 and A7. My results are confirmed using both alternative buffer definiitons, suggesting that my findings are robust across different spatial constructions of the treatment.

As an additional robustness check, I restrict the sample to households observed in all survey waves and re-estimate the baseline specification using a balanced panel. The direction of the estimated coefficients remain unchanged. The key patterns of higher religious infrastructure contributions following drought shocks and increased informal market borrowing in the lagged period continue to hold. The estimation results are reported in table A8.

4.5.1 Checking for pre-trends

I examine whether households exposed to droughts were already on different trajectories prior to the shock. Ideally, this would be assessed using an event-study framework with multiple pre-treatment periods. However, the BIHS panel contains only three survey waves (2011–12, 2015, and 2018–19), which limits the ability to conduct a full pre-trend test.

To address this limitation, I implement a simple difference-in-differences style diagnostic. Because 2018 monsoon was a major drought season in Bangladesh, I treat the 2018-19 wave as the shock period and define a treatment indicator $Treat_h$ equal to one if household h experiences drought in 2018. I then estimate the following specification:

$$\begin{aligned} Y_{hvs} = \alpha_h + \lambda_s \\ + \beta_2 \left(Treat_h \times 1\{s = 2015\} \right) \\ + \beta_3 \left(Treat_h \times 1\{s = 2018\text{–}19\} \right) \\ + \varepsilon_{hvs} \end{aligned} \tag{10}$$

where Y_{hvs} denotes the outcome of interest for household h in survey wave s, α_h are household fixed effects, and λ_s are survey-wave fixed effects. The coefficient on the 2015 interaction term provides a placebo pre-trend test by measuring whether households that are later exposed to drought already exhibit differential changes between the wave 1 (2011–12) and wave 2 (2015). The coefficient on the 2018–19 interaction term captures the differential change associated with drought exposure.

Figure 8 presents the estimates for religious infrastructure contributions and borrowing behavior. The placebo pre-trend coefficients for religious infrastructure contributions and borrowing behavior are close to zero and statistically insignificant, indicating that households later exposed to drought were not already on systematically different trajectories prior to the shock. In contrast, the post-shock estimates show an increase in religious infrastructure contributions among drought-exposed households. The absence of differential pre-trends supports the interpretation that the post-shock behavioral responses are associated with the drought rather than pre-existing trends.

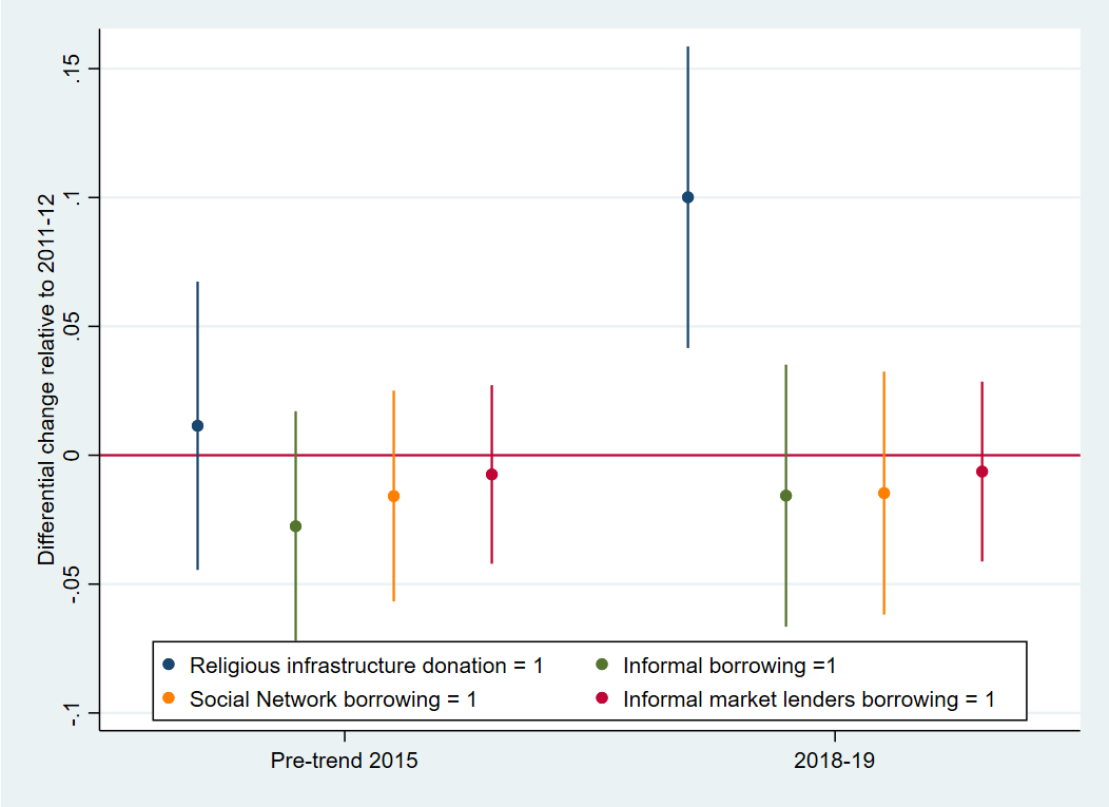


Figure 8: Check for pre-trends

Notes: The figure plots coefficients from a difference-in-differences style specification where households exposed to drought in 2018 are defined as the treated group. The baseline survey wave (2011–12) is the omitted category. The coefficient labeled "Pre-trend 2015" captures a placebo test for differential changes between 2011–12 and 2015 for households that later experience the 2018 drought. Social network borrowing and informal market borrowing are sub categories of borrowing. Points represent coefficient estimates and bars denote 95% confidence intervals. Standard errors are clustered at the village level.

5 Conclusion

In this paper, I explore how rural households respond to economic uncertainty created by rainfall shocks. I distinguish between two kinds of shocks: excess rainfall and drought. I show that different types of weather shocks generate generate dif-

ferent patterns of economic disruption and adaptation. I show that excess rainfall shock creates an immediate liquidity crisis through short-run income losses and reduction in savings. In contrast, drought functions as a slow-onset and persistent risk. Its economic consequences emerge gradually. I find lagged negative effects of drought shock on household's income. These contrasting dynamics generate different behavioral responses by households exposed to these shocks.

My results suggest that households initially respond to drought risk through a precautionary behavior. In the short run, household exposed to drought increase savings. When negative income effects materialize later on, households move to coping mechanisms and I find positive lagged effect of drought on remittance inflows, informal borrowing.

The central question of my paper is how these different types of weather shocks affect religious behavior of households and how they utilize religious institutions to adapt to these shocks. I find that a persistent risk like drought have immediate and sustained positive effects on household contributions to religious infrastructures like mosques. Importantly, this pattern does not appear to be driven by an increase in intrinsic religiosity. While contributions to the religious infrastructure increase immediately, devotional behavior such as time spent in religious activities increase with lag once the economic consequences of the shock become prominent. My findings provide suggestive evidence that this particular visible act of voluntary religious contribution immediately after drought serves as a social signal to local elites and money lenders, establishing the credibility needed to secure informal credit when negative income effects hit. I find a lagged positive effect of drought on informal borrowing, particularly from informal money lenders. I also find that households who previously donated to religious infrastructures gain better access to credit relative to non-contributors when drought hits.

There are several limitations to my study. Firstly, I am uncertain about the external validity of my study. While these results are plausible in the context of

Bangladesh, religious infrastructures may function differently in other economies, and therefore have different weather shock responses. However, I expect my results to hold in a muslim dominated agrarian setting where community mosques are built and maintained by the voluntary contributions of the community members. Secondly, assuming that rainfall shocks are plausibly exogenous, I hint that the effects I find on household economic outcomes, borrowings and religious contributions could be causal, but the mechanism linking religious infrastructure contributions to informal credit cannot be observed directly. Thirdly, my available measure of contribution to the construction/maintenance of religious infrastructure does not distinguish between monetary and time donations. Fourthly, my analysis focuses on rainfall variability during the monsoon season. This choice is motivated by the fact that the monsoon accounts for majority of the annual precipitation and rural livelihoods are directly tied to it. My fixed effects specification absorb time-invariant household characteristics and common seasonal shocks, but the specification may not fully capture other localized weather events occurring outside the monsoon window.

Despite the limitations, my research contributes to the growing literature on climate shocks and household adaptation by distinguishing between different types of rainfall shock and showing how religious responses vary by shock type. My paper also contributes to the limited literature on the economics of religion by distinguishing between private devotional behavior and publicly observable religious investment and by showing that different religious activities respond differently to climate shocks. Lastly, my paper adds to the growing literature on risk sharing by providing suggestive evidence that investing in religious infrastructure can serve as a signal to influential members of the society like informal money lenders and can help to get access to informal credit. My findings highlight how community based religious infrastructures can function as important nodes within the informal risk sharing networks in environments where informal markets still dominate.

Appendix

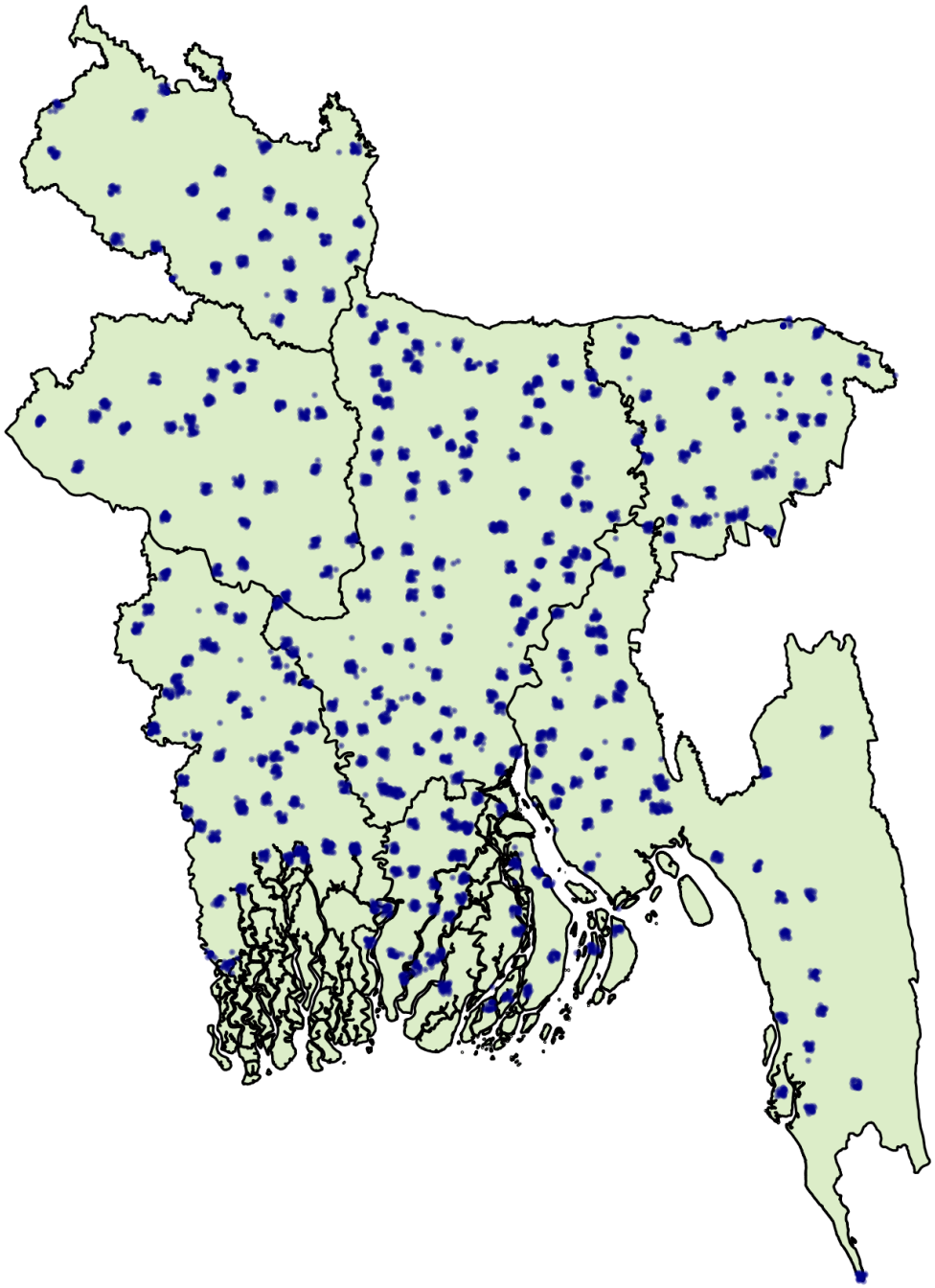


Figure A1: Spatial Distribution of BIHS Household Sample

Source: Figure prepared by author using household coordinates from BIHS harmonized survey and Bangladesh administrative division shape-file provided by IFPRI.

Note: At the time of survey, there were 7 divisions in Bangladesh.

Table A1: Summary Statistics: Household Characteristics

	Wave 1 (2011–12)			Wave 2 (2015)			Wave 3 (2018–19)		
	Mean	SD	N	Mean	SD	N	Mean	SD	N
Panel A: Household Assets									
Number of livestock/poultry	7.36	19.18	6096	10.87	52.38	5982	13.55	97.75	4679
Number of TV	0.26	0.46	6096	0.33	0.54	5982	0.42	0.54	4679
Number of cooking pots	10.07	7.48	6096	13.99	9.56	5982	18.32	12.34	4679
Number of functional mobile phones	0.95	0.78	6096	1.38	0.96	5982	1.75	1.09	4679
Cash at hand (BDT)	2006.41	21140.19	6096	1623.92	6281.17	5982	1232.60	4698.26	4679
Panel B: Remittances and Other Benefits									
Total remittance in (BDT)	17329.98	65136.57	6096	35998.21	126045.68	5982	28284.81	80426.43	4679
HH received remittances (=1)	0.24	0.43	6096	0.31	0.46	5982	0.39	0.49	4679
HH used remittances to smooth consumption (=1)	0.17	0.37	6096	0.26	0.44	5982	0.31	0.46	4679
Value of charity received (BDT)	200.55	3531.04	4206	282.40	3039.95	5982	83.98	860.73	4679
Total safety net benefits (BDT)	819.63	3140.96	6096	1320.94	5969.81	5982	1764.40	8638.42	4679
HH received safety net benefits (=1)	0.46	0.50	6096	0.43	0.50	5982	0.49	0.50	4679
Panel C: Other Community Activities									
HH head/spouse is a member of microfinance group (=1)	0.27	0.44	6091	0.14	0.34	5967	0.44	0.50	4666
HH head/spouse is a member of any other groups (=1)	0.06	0.24	6091	0.11	0.31	5967	0.13	0.34	4666
Index of HH contribution to other infrastructures	0.03	1.08	6091	0.00	0.97	5967	-0.03	0.93	4666
Index of HH contribution to other families	-0.38	0.92	6091	0.11	0.99	5967	0.38	0.93	4666
Panel D: Household Access to Institutions									
HH has access to banks (=1)	0.42	0.49	6096	0.29	0.46	5982	0.45	0.50	4679
HH has access to MFIs (=1)	0.45	0.50	6096	0.32	0.47	5982	0.43	0.50	4679

Table A2: Informal Credit Sources in Villages

	Mean	SD	N
Wave 2 (2015)			
Number of informal credit sources	4.380	5.759	353
Mahajan within village who give credit	8.533	14.907	353
Mahajan outside village who give credit	4.252	6.466	353
Shopkeepers who lend	8.133	18.467	353
Wave 3 (2018-19)			
Number of informal credit sources	7.130	6.268	447
Mahajan within village who give credit	10.470	16.025	447
Mahajan outside village who give credit	4.199	6.965	447
Shopkeepers who lend	26.613	68.081	447

Table A3: Effects of Rainfall Shocks on Household Outcomes

	Economic Outcomes				Financial Outcomes				Remittances and Other Benefits			
	(1)	(2)	(3)	(4)	(5)	(6)	(8)	(9)	(10)	(11)	(19)	(20)
VARIABLES	asinh(Total monthly earned income)	asinh(Consumption per capita)	asinh(Total monthly food expenditure)	asinh(Total monthly non-food expenditure)	asinh(Cash at hand)	asinh(Total savings)	asinh(Total borrowing)	HH borrowed = 1	asinh(Total remittance in)	Remittance for consumption smoothing = 1	asinh(Total charity in)	asinh(Total safety net benefits)
$Drought_{ht}$	-0.089	-0.038*	-0.042*	0.055*	0.011	0.364*	0.276	0.017	-0.127	-0.027*	0.093	0.029
	(0.092)	(0.021)	(0.024)	(0.033)	(0.074)	(0.197)	(0.188)	(0.017)	(0.172)	(0.016)	(0.151)	(0.154)
$Drought_{h,t-1}$	-0.141**	0.029**	0.027*	0.029	-0.038	0.186	0.281**	0.025**	0.222**	0.023**	0.409***	0.209**
	(0.064)	(0.013)	(0.016)	(0.021)	(0.054)	(0.113)	(0.125)	(0.012)	(0.104)	(0.010)	(0.141)	(0.093)
$ExcessRain_{ht}$	-0.346***	0.002	0.019	-0.008	-0.123	-0.312*	-0.234	-0.025	-0.246	-0.015	-0.011	-0.274*
	(0.104)	(0.024)	(0.027)	(0.033)	(0.099)	(0.169)	(0.177)	(0.017)	(0.163)	(0.018)	(0.121)	(0.149)
$ExcessRain_{h,t-1}$	0.069	0.055**	0.061**	-0.043	-0.301***	-0.261	-0.297	-0.032	-0.210	-0.012	0.028	-0.051
	(0.096)	(0.024)	(0.029)	(0.041)	(0.090)	(0.218)	(0.240)	(0.023)	(0.221)	(0.020)	(0.194)	(0.174)
Monsoon Temperature Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Survey Month Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
HH FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Survey Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	16,756	16,755	16,755	16,756	13,746	16,756	16,756	16,756	16,756	16,756	13,833	16,756
R-squared	0.665	0.680	0.681	0.676	0.605	0.586	0.588	0.563	0.676	0.601	0.401	0.534
Mean dep. var.	8.564	7.872	8.993	7.471	6.738	5.841	7.401	0.681	3.460	0.238	0.357	3.373

Notes: Following (Bellemare and Wichman 2020), dependent variables are inverse hyperbolic sine (IHS) transformed, and coefficients can be interpreted approximately as semi-elasticities. All monetary values are expressed in real 2011 terms using CPI deflation.
Robust standard errors in parentheses.
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table A4: Household Borrowing Sources

	HH Borrowing Sources			HH Borrowing from Informal Sources	
	(1)	(2)	(3)	(4)	(5)
VARIABLES	HH borrows from a formal source = 1	HH borrows from NGOs = 1	HH borrows from informal sources = 1	HH borrows from social networks = 1	HH borrows from informal market lenders = 1
$Drought_{ht}$	-0.009	0.037**	-0.017	-0.018	-0.007
	(0.011)	(0.017)	(0.021)	(0.019)	(0.013)
$Drought_{h,t-1}$	0.006	0.017*	0.036***	0.018	0.040***
	(0.009)	(0.010)	(0.014)	(0.012)	(0.010)
$ExcessRain_{ht}$	0.017	-0.008	-0.038*	-0.032	-0.007
	(0.015)	(0.014)	(0.022)	(0.021)	(0.018)
$ExcessRain_{h,t-1}$	0.027**	0.001	-0.048*	-0.026	-0.026
	(0.013)	(0.018)	(0.026)	(0.024)	(0.016)
Monsoon Temperature Controls	Yes	Yes	Yes	Yes	Yes
Survey Month Controls	Yes	Yes	Yes	Yes	Yes
HH FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
Constant	-0.124	0.165	0.949**	0.803*	-0.015
	(0.262)	(0.416)	(0.479)	(0.464)	(0.372)
Mean dep. var.	0.138	0.343	0.414	0.328	0.118
Observations	16,795	16,795	16,795	16,795	16,795
R-squared	0.567	0.607	0.487	0.469	0.464

Robust standard errors in parentheses.
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table A5: Effects of Rainfall Shocks on Household Contribution Indices

VARIABLES	(1) Other infrastructure contribution index	(2) Helping-other-families index
$Drought_{ht}$	0.022	0.221***
	(0.054)	(0.066)
$Drought_{h,t-1}$	-0.041	0.085*
	(0.032)	(0.044)
$ExcessRain_{ht}$	-0.088	0.068
	(0.055)	(0.069)
$ExcessRain_{h,t-1}$	0.016	0.173**
	(0.064)	(0.085)
Monsoon Temperature Controls	Yes	Yes
Survey Month Controls	Yes	Yes
HH FE	Yes	Yes
Year FE	Yes	Yes
Constant	-1.136	0.847
	(1.129)	(1.416)
Mean dep. var.	-0.0009	0.0064
Observations	16,748	16,748
R-squared	0.438	0.490

Notes: The other infrastructure contribution index aggregates household contributions to community infrastructure such as wells, roads, and town development projects. Contributions to religious infrastructure (e.g., mosque or temple construction) are excluded and analyzed separately. Indices are constructed following the summary index approach of (Anderson 2008): each component variable is standardized into a z-score, the standardized variables are averaged, and the resulting index is re-standardized to have mean zero and standard deviation one in the pooled sample. Higher values indicate greater participation in the corresponding activities. Robust standard errors are reported in parentheses.
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table A6: Robustness: Rainfall Shocks Constructed Using 2.5 km Buffer

VARIABLES	(1) asinh(Monthly earned income)	(2) HH contributed to religious infrastructure = 1	(3) HH borrows from informal market lenders = 1
$Drought_{ht}$	-0.089	0.076***	-0.004
	(0.087)	(0.023)	(0.014)
$Drought_{h,t-1}$	-0.136**	0.082***	0.027**
	(0.062)	(0.020)	(0.012)
$ExcessRain_{ht}$	-0.334***	0.000	0.003
	(0.098)	(0.028)	(0.016)
$ExcessRain_{h,t-1}$	0.116	0.050**	-0.019
	(0.097)	(0.026)	(0.017)
Constant	9.483***	0.600*	0.173
	(1.144)	(0.346)	(0.239)
Mean dep. var.	8.564	0.784	0.118
Observations	16,716	16,669	16,716
R-squared	0.666	0.485	0.465
Temperature controls	Yes	Yes	Yes
HH FE	Yes	Yes	Yes
Survey year FE	Yes	Yes	Yes
Survey month FE	Yes	Yes	Yes

Notes: Rainfall shocks are constructed using precipitation averaged within a 2.5 km buffer around each household's reported coordinates. Robust standard errors clustered at the village level are reported in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table A7: Robustness: Rainfall Shocks Constructed Using 10 km Buffer

VARIABLES	(1) asinh(Monthly earned income)	(2) HH contributed to religious infrastructure = 1	(3) HH borrows from informal market lenders = 1
$Drought_{ht}$	-0.105	0.095***	-0.005
	(0.092)	(0.026)	(0.015)
$Drought_{h,t-1}$	-0.144**	0.083***	0.037***
	(0.066)	(0.019)	(0.012)
$ExcessRain_{ht}$	-0.366***	0.022	-0.009
	(0.107)	(0.028)	(0.018)
$ExcessRain_{h,t-1}$	0.012	0.035	-0.028*
	(0.088)	(0.024)	(0.017)
Constant	14.325***	-0.958	-0.022
	(2.871)	(0.825)	(0.696)
Mean dep. var.	8.564	0.784	0.118
Observations	16,767	16,720	16,767
R-squared	0.665	0.486	0.466
Temperature controls	Yes	Yes	Yes
HH FE	Yes	Yes	Yes
Survey year FE	Yes	Yes	Yes
Survey month FE	Yes	Yes	Yes

Notes: Rainfall shocks are constructed using precipitation averaged within a 10 km buffer around each household's reported coordinates. Robust standard errors clustered at the village level are reported in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table A8: Robustness: Balanced Panel Specification

VARIABLES	(1) asinh(Monthly earned income)	(2) HH contributed to religious infrastructure = 1	(3) HH borrows from informal market lenders = 1
$Drought_{ht}$	-0.081	0.086***	-0.008
	(0.093)	(0.025)	(0.014)
$Drought_{h,t-1}$	-0.085	0.092***	0.037***
	(0.070)	(0.020)	(0.012)
$ExcessRain_{ht}$	-0.282**	0.029	-0.003
	(0.115)	(0.030)	(0.019)
$ExcessRain_{h,t-1}$	0.097	0.042	-0.018
	(0.100)	(0.026)	(0.016)
Constant	9.529***	0.305	0.073
	(1.864)	(0.507)	(0.361)
Mean dep. var.	8.562	0.796	0.121
Observations	13,632	13,613	13,632
R-squared	0.649	0.452	0.447
Temperature controls	Yes	Yes	Yes
HH FE	Yes	Yes	Yes
Survey year FE	Yes	Yes	Yes
Survey month FE	Yes	Yes	Yes

Notes: The sample is restricted to households observed in all survey waves (balanced panel). All regressions include household fixed effects, survey year fixed effects, survey month fixed effects, and temperature controls. Robust standard errors clustered at the village level are reported in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

References

M. Abuzar. Understanding drought: A review of its causes and effects. *Environmental Science and Technology*, 12(4):567–580, 2017.

Akhter Ahmed. Bangladesh Integrated Household Survey (BIHS) 2011-2012, 2013. URL https://doi.org/10.7910/DVN/OR6MHT.

Akhter U Ahmed and Salauddin Tauseef. Climbing up the ladder and watching out for the fall: Poverty dynamics in rural bangladesh. *Social Indicators Research*, 160(1):309–340, 2022.

Edris Alam and Andrew E Collins. Cyclone disaster vulnerability and response experiences in coastal bangladesh. *Disasters*, 34(4):931–954, 2010.

Michael L Anderson. Multiple inference and gender differences in the effects of early intervention: A reevaluation of the abecedarian, perry preschool, and early training projects. *Journal of the American statistical Association*, 103 (484):1481–1495, 2008.

James Andreoni. Giving with impure altruism: Applications to charity and ricardian equivalence. *Journal of Political Economy*, 97(6):1447–1458, 1989.

Emmanuelle Auriol, Julie Lassebie, Amma Panin, Eva Raiber, and Paul Seabright. God insures those who pay? formal insurance and religious offerings in ghana. *The Quarterly Journal of Economics*, 135(4):1799–1848, 2020.

Corry Azzi and Ronald Ehrenberg. Household allocation of time and church attendance. *Journal of political Economy*, 83(1):27–56, 1975.

Abhijit V Banerjee and Andrew F Newman. Information, the dual economy, and development. *The Review of Economic Studies*, 65(4):631–653, 1998.

Kodjo Barnor and Kashi Kafle. Dry weather, empty desks? rainfall shocks and child education in tanzania, 2025.

Gary S. Becker. A theory of social interactions. *Journal of Political Economy*, 82 (6):1063–1093, 1974.

Marc F Bellemare and Casey J Wichman. Elasticities and the inverse hyperbolic sine transformation. *Oxford Bulletin of Economics and Statistics*, 82(1):50–61, 2020.

Benaouda Bensaid, Fadila Grine, Mohd Roslan Mohd Nor, and Mohd Yakub Zulkifli MohdYusoff. Ethico-spiritual dimensions of charity: An islamic perspective. *Middle-East Journal of Scientific Research*, 13(13):2, 2013.

Jeanet Sinding Bentzen. In crisis, we pray: Religiosity and the covid-19 pandemic. *Journal of economic behavior & organization*, 192:541–583, 2021.

Peter L Berger. *The sacred canopy: Elements of a sociological theory of religion*. Open Road Media, 2011.

Eli Berman. Sect, subsidy, and sacrifice: an economist's view of ultra-orthodox jews. *The Quarterly Journal of Economics*, 115(3):905–953, 2000.

Gharad Bryan, James J Choi, and Dean Karlan. Randomizing religion: the impact of protestant evangelism on economic outcomes. *The Quarterly Journal of Economics*, 136(1):293–380, 2021.

Christopher D Carroll, Robert E Hall, and Stephen P Zeldes. The buffer-stock theory of saving: Some macroeconomic evidence. *Brookings papers on economic activity*, 1992(2):61–156, 1992.

Michael R. Carter, Peter D. Little, Tewodaj Mogues, and Workneh Negatu. Poverty traps and natural disasters in ethiopia and honduras. *World Development*, 35(5):835–856, 2007. ISSN 0305-750X. doi: https://doi.org/10.1016/

j.worlddev.2006.09.010. URL https://www.sciencedirect.com/science/article/pii/S0305750X07000149.

Anoop Chandola. On practical hinduism: The puja as human contact. *Mankind quarterly*, 29(4):353, 1989.

Daniel L Chen. Club goods and group identity: Evidence from islamic resurgence during the indonesian financial crisis. *Journal of political Economy*, 118(2): 300–354, 2010.

Md Arif Chowdhury, Rashed Uz Zzaman, Nusrat Jahan Tarin, and Mohammad Jobayer Hossain. Spatial variability of climatic hazards in bangladesh. *Natural Hazards*, 110(3):2329–2351, 2022.

Timothy G Conley. Gmm estimation with cross sectional dependence. *Journal of econometrics*, 92(1):1–45, 1999.

Joachim De Weerdt and Stefan Dercon. Risk-sharing networks and insurance against illness. *Journal of Development Economics*, 81(2):337–356, 2006.

Rajeev Dehejia, Thomas DeLeire, and Erzo FP Luttmer. Insuring consumption and happiness through religious organizations. *Journal of public Economics*, 91 (1-2):259–279, 2007.

Olivier Deschênes and Michael Greenstone. Climate change, mortality, and adaptation: Evidence from annual fluctuations in weather in the us. *American Economic Journal: Applied Economics*, 3(4):152–185, 2011.

Joe Devine, Timothy Hinks, and Arif Naveed. Happiness in bangladesh: The role of religion and connectedness. *Journal of Happiness Studies*, 20(2):351–371, 2019.

Joseph Devine and Sarah C. White. Religion, politics and the everyday moral order in bangladesh. *Journal of Contemporary Asia*, 43(1):127–147, 2013. doi: 10.1080/00472336.2012.735544.

Nepal Chandra Dey, MS Alam, AK Sajjan, MA Bhuiyan, L Ghose, Y Ibaraki, and F Karim. Assessing environmental and health impact of drought in the north-west bangladesh. *Journal of Environmental Science and Natural Resources*, 4 (2):89–97, 2011.

Oeindrila Dube, Joshua Blumenstock, and Michael Callen. Measuring religion from behavior: Climate shocks and religious adherence in afghanistan. Technical report, National Bureau of Economic Research, 2022.

José-Antonio Espín-Sánchez, Salvador Gil-Guirado, and Nicholas Ryan. Praying for rain. Technical report, National Bureau of Economic Research, 2023.

Fathi Abdirahman Farah, Abdiaziz Hassan Nur, Abdullahi Ali Ibrahim, Abas Abdi Warsame, A Mohammed, and S Ahmed. Impacts of drought on food security in bangladesh. *East African Scholars J Agri Life Sci*, 8(2):35–53, 2025.

Chris Funk, Pete Peterson, Martin Landsfeld, Diego Pedreros, James Verdin, Shraddhanand Shukla, Gregory Husak, James Rowland, Laura Harrison, Andrew Hoell, and Joel Michaelsen. The climate hazards infrared precipitation with stations—a new environmental record for monitoring extremes. *Scientific Data*, 2(1):150066, December 2015. ISSN 2052-4463. doi: 10.1038/sdata.2015.66. URL https://www.nature.com/articles/sdata201566.

Betemariam Gebre, Habtamu Yesigat Ayenew, and Sibhatu Biadgilign. Drought, hunger and coping mechanisms among rural household in southeast ethiopia. *Heliyon*, 7(3), 2021.

Paul Gertler and Jonathan Gruber. Insuring consumption against illness. *American Economic Review*, 92(1):51–70, March 2002. doi: 10.1257/000282802760015603. URL https://www.aeaweb.org/articles?id=10.1257/000282802760015603.

Ruth Vargas Hill and Catherine Porter. Vulnerability to drought and food price shocks: Evidence from ethiopia. *World Development*, 96:65–77, 2017.

Md Lokman Hossain. Beyond warnings and shelters: local institutions and trust build cyclone resilience in bangladesh. *npj Natural Hazards*, 3(1):17, 2026.

Solomon M. Hsiang and Amir S. Jina. The Causal Effect of Environmental Catastrophe on Long-Run Economic Growth: Evidence From 6,700 Cyclones, July 2014. URL https://www.nber.org/papers/w20352.

Samia Huq, Ratan Kumar Roy, Sudipta Roy, et al. Religion and development in the digital age: A policy note on waz mahfils in bangladesh: Policy and practice note. *Religion and Development*, 3(3):415–429, 2025.

Laurence R Iannaccone. Sacrifice and stigma: Reducing free-riding in cults, communes, and other collectives. *Journal of political economy*, 100(2):271–291, 1992.

Laurence R Iannaccone. Introduction to the economics of religion. *Journal of economic literature*, 36(3):1465–1495, 1998.

International Food Policy Research Institute (IFPRI). Bangladesh Integrated Household Survey (BIHS) 2015, 2016. URL https://doi.org/10.7910/DVN/BXSYEL.

International Food Policy Research Institute (IFPRI). BIHS Harmonized Dataset, 2017. URL https://doi.org/10.7910/DVN/PUK1P7.

International Food Policy Research Institute (IFPRI). Bangladesh Integrated Household Survey (BIHS) 2018-2019, 2020. URL https://doi.org/10.7910/DVN/NXKLZJ.

H. M. Touhidul Islam, Sharif Ahmed, Mohammad Kamruzzaman, Virender Kumar, and Humnath Bhandari. Impact of rainfall variability on crop intensification and diversification in the coastal region of bangladesh. Unpublished manuscript, 2025.

Sriya Iyer. The new economics of religion. *Journal of Economic Literature*, 54(2): 395–441, 2016.

Robert Jensen. The (perceived) returns to education and the demand for schooling. *The Quarterly Journal of Economics*, 125(2):515–548, 2010.

Fuadah Johari, Muhammad Ridhwan Ab Aziz, and Ahmad Fahme Mohd Ali. A review on literatures of zakat between 2003-2013. *Library Philosophy and Practice*, page 0_1, 2014.

Lamia N. Karim. Tablighi ja'maat and the regulation of women in bangladesh. Berkley Center for Religion, Peace and World Affairs, Georgetown University, 2014. URL https://berkleycenter.georgetown.edu/posts/tablighi-ja-maat-and-the-regulation-of-women-in-bangladesh. Accessed: 2026.

Harounan Kazianga and Christopher Udry. Consumption smoothing? livestock, insurance and drought in rural burkina faso. *Journal of Development Economics*, 79(2):413–446, 2006.

Fariel Khan. Community mosque is a symbol of social status-a case of participatory design process of mosque architecture in dhaka city. *International Journal of Research in Engineering and Technology*, 4(04):151–161, 2015.

Kashfia Alam Khan and Hourakhsh Ahmad Nia. Investigating female accessibility and prayer space in mosque architecture: A case study in dhaka, bangladesh. *A+ Arch Design International Journal of Architecture and Design*, 9(2):101–116, 2023.

Shahidur R Khandker, Hussain A Samad, and Syed Badruddoza. Seasonality of rural finance. *World Bank Policy Research Working Paper*, (7986), 2017.

Mohammed Kroessin. Udhiyyah and the livestock value chain: Islamic social finance for sustainable development. In *Islamic Finance and Sustainable Development*, pages 93–105. Routledge, 2025.

David Lewis. *Bangladesh: Politics, economy and civil society*. Cambridge University Press, 2011.

David Lewis and Abul Hossain. A tale of three villages: Power, difference and locality in rural bangladesh. *Journal of South Asian Development*, 3(1):33–51, 2008.

Sharon Maccini and Dean Yang. Under the weather: Health, schooling, and economic consequences of early-life rainfall. *American economic review*, 99(3): 1006–1026, 2009.

Jahangir H Masum. Climatic hazards in bangladesh: A literature review. *Coastal Development Partnership (CDP), Bangladesh, Coastal Development Partnership (CDP), Bangladesh*, 2019.

Ricardo O Mitchell, Hammad Rashid, Fakir Dawood, and Ali AlKhalidi. Hajj crowd management and navigation system: People tracking and location based services via integrated mobile and rfid systems. In *2013 International conference on computer applications technology (ICCAT)*, pages 1–7. IEEE, 2013.

Md Anarul Haque Mondol, Iffat Ara, and Subash Chandra Das. Meteorological drought index mapping in bangladesh using standardized precipitation index during 1981–2010. *Advances in Meteorology*, 2017(1):4642060, 2017.

Arnold L Musungu, Zaneta Kubik, and Matin Qaim. Drought shocks and labour reallocation in rural africa: evidence from ethiopia. *European Review of Agricultural Economics*, 51(4):1045–1068, 2024.

Ananta Neelim and Tawhidul Islam. *Climate change in Bangladesh: A closer look into temperature and rainfall data*. 01 2010. ISBN 9848815228, 9789848815229.

Kenneth I Pargament, Nalini Tarakeshwar, Christopher G Ellison, and Keith M Wulff. Religious coping among the religious: The relationships between religious coping and well-being in a national sample of presbyterian clergy, elders, and members. *Journal for the scientific study of religion*, 40(3):497–513, 2001.

R Jisung Park. Hot temperature and high-stakes performance. *Journal of Human Resources*, 57(2):400–434, 2022.

Christina H Paxson. Using weather variability to estimate the response of savings to transitory income in thailand. *The American Economic Review*, pages 15–33, 1992.

Sjoukje Philip, Sarah Sparrow, Sarah F Kew, Karin Van Der Wiel, Niko Wanders, Roop Singh, Ahmadul Hassan, Khaled Mohammed, Hammad Javid, Karsten Haustein, et al. Attributing the 2017 bangladesh floods from meteorological and hydrological perspectives. *Hydrology and Earth System Sciences*, 23(3): 1409–1429, 2019.

María Cristhina Llerena Pinto, Alisher Mirzabaev, and Matin Qaim. Effects of recurrent rainfall shocks on poverty and income distribution in rural ecuador. *World Development*, 195:107107, 2025.

Md Atikur Rahman. The significance of religious values in forming sustainable life and economic progress. *International Journal of Scientific Interdisciplinary Research*, 6(1):60–87, 2025.

Md Rejaur Rahman and Habibah Lateh. Climate change in bangladesh: a spatio-temporal analysis and simulation of recent temperature and rainfall data using gis and time series analysis model. *Theoretical and applied climatology*, 128(1): 27–41, 2017.

Ali Riaz. *Islamist militancy in Bangladesh: A complex web*. Routledge, 2012.

Emma Riley. Mobile money and risk sharing against village shocks. *Journal of Development Economics*, 135:43–58, 2018.

Showmitra Kumar Sarkar, Swadhin Das, Rhyme Rubayet Rudra, Khondaker Mohammed Mohiuddin Ekram, Mafrid Haydar, Edris Alam, Md Kamrul Islam, and Abu Reza Md Towfiqul Islam. Delineating the drought vulnerability zones in bangladesh. *Scientific reports*, 14(1):25564, 2024.

Wolfram Schlenker and Michael J Roberts. Nonlinear temperature effects indicate severe damages to us crop yields under climate change. *Proceedings of the National Academy of sciences*, 106(37):15594–15598, 2009.

Lucy Scott. Transfers for extreme poverty reduction: Implications for patron-client relationships in the context of bangladesh's agricultural reformation. Technical report, WIDER Working Paper, 2014.

Jeremy Seabrook. *Freedom unfinished: fundamentalism and popular resistance in Bangladesh today*. Zed Books, 2001.

Manisha Shah and Bryce Millett Steinberg. Drought of opportunities: Contemporaneous and long-term impacts of rainfall shocks on human capital. *Journal of Political Economy*, 125(2):527–561, 2017.

Shamsuddin Shahid. Rainfall variability and the trends of wet and dry periods in bangladesh. *International Journal of climatology*, 2010.

Shamsuddin Shahid. Trends in extreme rainfall events of bangladesh. *Theoretical and applied climatology*, 104(3):489–499, 2011.

Shamsuddin Shahid and Houshang Behrawan. Drought risk assessment in the western part of bangladesh. *Natural hazards*, 46(3):391–413, 2008.

Mark Skidmore and Hideki Toya. Do natural disasters promote long-run growth? *Economic Inquiry*, 40(4):664–687, 2002. doi: https://doi.org/10.1093/ei/40.4.664. URL https://onlinelibrary.wiley.com/doi/abs/10.1093/ei/40.4.664.

Tavneet Suri. Spillovers in village consumption: Testing the extent of partial insurance. *New Haven, Conn.: Yale University. mimeo*, 2005.

Abu Reza Md Towfiqul Islam, Md Siddiqur Rahman, Runa Khatun, and Zhenghua Hu. Spatiotemporal trends in the frequency of daily rainfall in bangladesh during 1975–2017: Arm towfiqul islam et al. *Theoretical and Applied Climatology*, 141 (3):869–887, 2020.

Robert M Townsend. Risk and insurance in village india. *Econometrica: journal of the Econometric Society*, pages 539–591, 1994.

Christopher Udry. Risk and insurance in a rural credit market: An empirical investigation in northern nigeria. *The Review of Economic Studies*, 61(3):495–526, 1994.

Sveva Vitellozzi and Gianna Claudia Giannelli. Thriving in the rain: natural shocks, time allocation, and women's empowerment in bangladesh. *World Development*, 181:106684, 2024.

Zhengming Wan et al. Modis land surface temperature products users' guide. *Institute for Computational Earth System Science, University of California: Santa Barbara, CA, USA*, 805:26, 2006.

Kevin Watkins. Human development report 2007/8. fighting climate change: Human solidarity in a divided world. *Fighting Climate Change: Human Solidarity in a Divided World (November 27, 2007). UNDP-HDRO Human Development Report*, 2007.

Max Weber. *The Protestant Ethic and the Spirit of Capitalism [1904–5]*. na, 1930.

SARAH C. WHITE. Beyond the paradox: Religion, family and modernity in contemporary bangladesh. *Modern Asian Studies*, 46(5):1429–1458, 2012. doi: 10.1017/S0026749X12000133.

Bryan R Wilson. *Religion in secular society: Fifty years on*. Oxford University Press, 2016.

Hassan Zaman. *The scaling-up of microfinance in Bangladesh: determinants, impact, and lessons*, volume 3398. World Bank Publications, 2004.