When the Rains Fail, Does Faith Pay? Weather Shocks and the Religious Margin of Adaptation

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Abstract

In this paper, I test a model in which visible contributions to religious institutions insure households through reputation with village lenders rather than divine protection. Reputation is effective only when lenders are able to lend. Such contributions should therefore rise after droughts, which hit poor households while sparing their richer lenders, and fall after floods, which hit the whole village. I test these predictions using a three-wave panel from rural Bangladesh. Droughts raise poor households' contributions to mosques and temples, while time spent on early-morning religious rituals does not rise, and past donors are more likely to receive informal loans. These findings are consistent with religious giving as a way to build reputation with lenders. Contrary to the model, floods have no detectable effect on contributions.

JEL codes: O12, O16, O17, Q54, Z12

Keywords: religious contributions, reputation, informal credit, spiritual insurance, idiosyncratic and aggregate shocks, Bangladesh

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1 Introduction

When a shock threatens a household's livelihood, religion offers more than one kind of protection. Religion is linked with several drivers of economic success, including trust and cooperation (Iannaccone 1998; Iyer 2016), and people often turn to it when they face 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 2019, 2021; Pargament et al. 2001). Most religions have designated public 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). These forms of protection reward different religious acts. God sees all religious acts done either in private or in public. But other people only observe the acts that are done in public. Which acts a household chooses after a shock can therefore reveal why it turns to religion.

I test a model in which visible contributions to public religious institutions protect poorer households by building a reputation with richer households who are able to lend. In my model, households choose their religious contributions, their secular contributions and their private devotion after a monsoon shock. I distinguish between two kinds of monsoon shocks. A drought is idiosyncratic in its impact. It acts through the market for agricultural labor and falls mainly on wage-dependent households (Jayachandran 2006; Kaur 2019), while richer households, who are able to lend, are largely unaffected. A flood is an aggregate shock that reduces resources for everyone in the village, including lenders. I consider three cases. Firstly, without any return to religious acts, a drought lowers all three choices of poorer households, whose resources fall and whose risk of a loss rises. Secondly, if religious contributions build a reputation with lenders (Glazer and Konrad

1996; Karlan et al. 2009), a drought can raise poorer households' contributions while their secular contributions and private devotion fall, and richer households do not respond. Lastly, if religious acts provide spiritual insurance, a drought can raise both the religious contributions and the private devotion of poorer households. A flood also reduces the resources of richer households and their capacity to lend. Under the reputation channel, a flood lowers all three choices of richer households, and it lowers poorer households' religious contributions if it leaves lenders unable to lend. Under spiritual insurance, in contrast, a flood that raises a household's risk can raise both its religious contributions and its private devotion, for poorer and richer households alike, if the value of divine protection outweighs the loss of resources.

I test these predictions using three waves of the Bangladesh Integrated Household Survey, a panel that is nationally representative of rural Bangladesh. Bangladesh is one of the world's most climate-vulnerable countries, and religious institutions are central to village life. Mosques and temples in rural Bangladesh are built and maintained through contributions collected from villagers, and they are run by elected committees of influential villagers who often also have the means to lend. These contexts make Bangladesh an ideal setting for my study. I measure droughts using satellite-based monsoon rainfall (Funk et al. 2015) and floods using satellite flood maps (Tellman et al. 2021), matched to each household's location. My main outcomes are whether the household contributed to the construction or maintenance of a mosque or temple, an index of contributions to secular public goods, and whether the main male and female members spent any time on religious activity between 3 and 6 AM. I use this early-morning activity as a proxy for private devotion. I compare the same household across waves in which it did and did not experience a shock, relying on the standard assumption that year-to-year variation in monsoon rainfall is as good as random (Dell et al. 2014).

I first show that droughts and floods affect households in the way the model assumes. A drought does not reduce average earnings, but it lowers agricultural wages by about 6 percent and reduces the share of households doing any daily-wage work. Households that rely on agricultural day labor lose about 16 percent of their agricultural earnings and

about a quarter of their days of wage work in the drought year, while other households do not. Households respond to a drought by borrowing more and drawing down their grain stocks. Floods, on the other hand, lower the monsoon rice harvest, non-food spending and cash at hand across the village, with no differential effect on the total earnings or consumption of agricultural-laborer households.

After a drought, poorer households give more to religious institutions while their private devotion falls. On average, households are 8.4 percentage points more likely to contribute to religious infrastructure in the drought year, and 7.7 percentage points more likely a year later. This response comes from poorer households, who are 12.3 percentage points more likely to contribute, while richer households do not change their contributions. In the same year, poorer men are 5.1 percentage points less likely to pray in the early morning, a 39 percent decline from the average levels, and poorer women are 3.7 percentage points less likely. Secular contributions do not change. My findings do not support the predictions of my model under the first case, since poorer households give more rather than less, or under spiritual insurance, since visible giving and private devotion move in opposite directions. They closely match the predictions under the reputation case. The response also rises with the severity of the drought. The difference between poorer and richer households holds within divisions and waves, with spatially corrected standard errors, and in a balanced panel.

Several pieces of evidence suggest that the reputation incentive in the model is at work. A year after a drought, poorer households are 2.3 percentage points more likely to borrow from a moneylender. In my data, a moneylender is any individual, inside or outside the village, who lends with an interest, so better-off villagers can be among them. Households that contributed to religious infrastructure in the previous wave keep their access to moneylenders after a drought, while households that did not contribute become 7.0 percentage points less likely to borrow from them. This premium is not explained by the wealth or past borrowing of contributors. Members of religious groups, in contrast, are 9.0 percentage points more likely to receive charity from others after a drought but do not borrow more. Religious groups therefore insure their members as club-good models

predict, while contributions to religious institutions are associated with access to credit. My flood effect estimates only partly support my model's claims. Religious contributions do not change after a flood, and neither does informal borrowing, which suggests that lenders are still able to lend.

My findings suggest that religious institutions are part of the informal credit system in rural villages. Poorer households give more to the mosque or temple precisely when they are most likely to need a loan, even though giving is costly when their earnings are uncertain. This pattern would be missed by a single measure of religiosity, since visible and private religious acts move in opposite directions. More broadly, my results suggest that religious choices respond to economic incentives in the same way as other household decisions, and that modeling them as such can help explain outcomes that economists study closely, such as access to credit and consumption smoothing after a shock. Policies that aim to help poor households cope with shocks may therefore benefit from taking these religious incentives into account. Interventions targeting at-risk households could, for example, work through religious institutions that are already central to village life, or take into account the religious practices that shape how these households respond to shocks.

My paper contributes to three strands of the literature. First, it adds to the economics of religion. Earlier work studies religion as a choice shaped by economic incentives (Azzi and Ehrenberg 1975; Berger 2011; Weber 1930; Wilson 2016), the effects of religion on economic outcomes and preferences (Bryan et al. 2021), and religion as a source of insurance (Auriol et al. 2020; Chen 2010; Dehejia et al. 2007). Recent studies show that religiosity rises after droughts and disasters (Bentzen 2019; Dube et al. 2022) and that rainmaking rituals persist where prayer is persuasive (Espín-Sánchez et al. 2023). I build on the framework of Auriol et al. (2020) by allowing the return to religious giving to depend on the type of shock and on whether village lenders are able to lend, and I distinguish visible contributions from private devotion in the same households. I also find support for the club-good view of religion (Berman 2000; Iannaccone 1992) in this setting, and I show that visible contributions bring a different benefit. While members of

religious groups receive more charity after a drought, households that contributed to religious institutions keep their access to credit from moneylenders. My results suggest that religion is not only a matter of faith or insurance, but also a margin that households use strategically to manage their economic relationships. This makes religious institutions part of the local economic infrastructure.

Second, I contribute to the literature on the impacts of weather shocks. A large body of work examines how rainfall and temperature affect agricultural productivity (Schlenker and Roberts 2009), education and human capital (Barnor and Kafle 2025; Maccini and Yang 2009; Shah and Steinberg 2017), health (Deschênes and Greenstone 2011), labor productivity (Park 2022), poverty dynamics (Carter et al. 2007; Pinto et al. 2025) and long-run growth (Hsiang and Jina 2014; Skidmore and Toya 2002). I distinguish between droughts, which are idiosyncratic in their impact, and floods, which affect the whole village, and show that they lead to different economic and religious responses. I also study a margin of climate adaptation that has received little attention in the climate literature, which is religion.

Lastly, I contribute to the literature on risk sharing. Households partially insure idiosyncratic shocks through informal networks within and across villages (De Weerdt and Dercon 2006; Gertler and Gruber 2002; Kazianga and Udry 2006; Townsend 1994; Udry 1994), and access to informal credit depends on trust and social collateral (Karlan et al. 2009). I provide suggestive evidence that poorer households invest in a religious public good to keep their access to informal credit, which shows how public religious institutions can function as nodes within informal risk sharing networks.

The rest of the paper is organized as follows. Section 2 presents the model. Section 3 describes the context, and Section 4 the data. Section 5 outlines the empirical framework and identification. Section 6 presents the effects of monsoon shocks on the household economy and on religious behavior. Section 7 examines the credit mechanism, and Section 8 reports robustness checks. Section 9 concludes.

2 A Model of Religious Contributions under Monsoon Shocks

I develop simple model of how rural households adjust their religious contributions, secular contributions, and private devotional activities after a monsoon shock. I extend the framework of Auriol et al. (2020) to allow for different types of monsoon shocks. Following Townsend (1994), I distinguish between two kinds of shocks. A within-village idiosyncratic shock affects some households in a village and leaves others unaffected, while an aggregate shock affects the entire village. In rural agricultural economies, rainfall shocks act largely through the labor market. Kaur (2019) treats rainfall as a transitory shock to the demand for agricultural labor and finds that droughts reduce employment since nominal wages do not fall during droughts. The effects are concentrated among poorer households with little land. Since I model the decisions of households in a similar rural agricultural economy, I treat a drought as a within-village idiosyncratic shock: drought is common to all, but the losses fall on poorer wage-dependent households, while the richer land owning households are largely unaffected. I treat a flood as an aggregate village shock which destroys resources for every household within the village. I then study three cases. In Case 1, religious contributions offer no reputation or spiritual insurance benefit. In Case 2, contributions to religious institutions build a reputation with the rich villagers with lending capabilities. In Case 3, religious acts provide spiritual insurance.

2.1 Setup

Following Chen (2010), I model all choice variables as ex-post choices. At the beginning of the period the monsoon outcome $\omega \in \{N, D, F\}$ (normal, drought or flood) is realized. Households then choose consumption, religious and secular activities. Later comes the lean season, when a household may suffer a loss. So, households make their choices after the monsoon shock but before they face losses in the lean season.

There are two types of households, $\theta \in \{L, H\}$. L-types are poor, wage-dependent households with little or no land; H-types are rich, landed, and has lending capabilities. A household of type θ in state ω has resources Y_θ^ω and chooses religious devotional activities

$d \geq 0$ at a cost $p > 0$ per unit, religious contributions $g_R \geq 0$, and secular contributions $g_S \geq 0$. Religious devotional activities are private and consist of the activities that God mandates in the household's religion. Following Bentzen (2019) such activities measure intrinsic religiosity. Religious contribution is a donation to public institutions such as mosque/temple, and secular contribution is donation to non-religious public goods such as roads, wells, community development projects, etc. Following Andreoni (1990), the household receives a warm glow from its own donations and also the benefits from the public goods it donates to: $G_R = g_R + G_{R,-i}$ and $G_S = g_S + G_{S,-i}$. Here, G_R is the total donation to religious institutions, which is the household's own religious donation plus the religious donations of all other households, $G_{R,-i}$. Similarly, G_S is the total donations to secular public goods. Each household takes other households' donations as given. Utility is additively separable:

$$U(c) + V_d(d) + V_R(g_R, G_R) + V_S(g_S, G_S). \tag{2.1}$$

Here, $U(c)$ is the utility from consumption, $V_d(d)$ is the warm glow from private devotion, $V_R(g_R, G_R)$ is the warm glow from own religious donations plus the benefit from religious public goods, and $V_S(g_S, G_S)$ is the warm glow from own secular donations plus the benefit from secular public goods. $U(\cdot)$, $V_d(\cdot)$, $V_R(\cdot)$ and $V_S(\cdot)$ are increasing, concave and thrice continuously differentiable. All goods are normal. Consumption is

$$c = Y_\theta^\omega - g_R - g_S - pd, \qquad c \geq 0.$$

Since the household takes other households' donations as given, I write $v_R(g_R) \equiv V_R(g_R, g_R + G_{R,-i})$, $v_S(g_S) \equiv V_S(g_S, g_S + G_{S,-i})$ and $v_d(d) \equiv V_d(d)$.

In the lean season, a type-θ household faces a loss $\Delta_\theta \geq 0$ with probability π_θ^ω. So consumption is $c_g = Y_\theta^\omega - g_R - g_S - pd$ in a good season and $c_b = c_g - \Delta_\theta$ in a bad season.

A drought lowers the resources of L-types and raises their risk of a bad lean season,

and leaves H-types unaffected:

$$Y_L^D < Y_L^N, \quad \pi_L^D > \pi_L^N; \qquad Y_H^D = Y_H^N, \quad \pi_H^D = \pi_H^N = 0. \tag{2.2}$$

A flood is a village-wide aggregate shock that destroys resources for everyone:

$$Y_\theta^F < Y_\theta^N, \quad \pi_\theta^F \geq \pi_\theta^N \qquad \text{for } \theta \in \{L, H\}. \tag{2.3}$$

Finally, L-types are credit-constrained, because they lack collateral, while H-types are not.

Throughout, I study the choices of one type at a time, and assume interior solutions.[1] I provide all proofs in Appendix A.

2.2 Case 1: No reputation and no spiritual insurance

In this case, religious activities do not protect the household against a bad lean season. Let $\pi = \pi_\theta^\omega$, $Y = Y_\theta^\omega$ and $\Delta = \Delta_\theta$. A household of type θ in monsoon state ω chooses d, g_R and g_S to maximize

$$(1 - \pi)\, U(c_g) + \pi\, U(c_b) + v_d(d) + v_R(g_R) + v_S(g_S), \tag{2.4}$$

where $c_g = Y - g_R - g_S - pd$ is consumption in a good season and $c_b = c_g - \Delta$ is consumption in a bad season. The expected marginal utility of consumption is

$$M \equiv (1 - \pi)\, U'(c_g) + \pi\, U'(c_b) > 0,$$

and the first-order conditions are

$$v_R'(g_R) = M, \qquad v_S'(g_S) = M, \qquad v_d'(d) = p\, M. \tag{2.5}$$

[1] With corner solutions the results hold with weak inequalities.

Each activity is chosen so that its marginal benefit equals the expected marginal utility of consumption given up. Here, the monsoon state affects giving and devotion only through M. Each choice is a decreasing function of M. M falls when resources Y increase and does not fall when the probability of loss π rises.

Proposition 1. *Without the reputation-building or spiritual insurance motive:*

(a) a drought lowers religious contribution, secular contribution and private devotion for L-types;

(b) a drought does not change H-types' contribution or devotion; and

(c) a flood lowers religious contribution, secular contribution and private devotion for both types.

In this case, without any reputation-building or spiritual insurance motive, all three household choices depend on the state of the monsoon only through M. So any shock moves religious contribution, secular contribution and private devotion in the same direction. Next, I introduce a reputation-building motive for credit-constrained households (L-types).

2.3 Case 2: Reputation-building incentive

Contributions to religious infrastructure, g_R, are made publicly and are visible to the committee members or attendees of the religious institution, which consists of rich H-type villagers with the ability to lend. An H-type member may be more willing to lend to an L-type villager who has a reputation for contributing to their institution, in situations where borrowers lack collateral (Bénabou and Tirole 2006; Glazer and Konrad 1996; Karlan et al. 2009). Secular public institutions are managed by the government, so secular contributions, g_S, are not seen by H-types with lending abilities. Private devotion, d, is also not publicly observed.

If the loss occurs, an L-type asks for a loan. They can get the loan from an H-type with probability $\lambda(\omega)\, q(g_R)$. Here, $q(g_R)$ represents the level of reputation or trustworthiness

of the L-type borrower given their religious contributions. I assume $q(0) = q_0 \geq 0$, $q' > 0$, $q'' < 0$ and $q \leq 1$. Since L-types are credit-constrained due to a lack of collateral, q_0 is low without reputation. $\lambda(\omega)$ represents H-types' capacity to lend in state ω, with $\lambda(N) = \lambda(D) = \bar{\lambda}$ and $\lambda(F) < \bar{\lambda}$, since a drought does not hurt H-types and only a flood does. Because I write a one-shot model for simplicity and repayment happens in a later period that the model does not include, I define B as the consumption gain from the loan in the bad season net of future repayments. I also assume that the loan does not more than offset the loss, $B \leq \Delta_L$, so that a household that gets a loan is never better off in a bad season than in a good one. Since H-types are not credit-constrained, additional reputation from religious contributions has no value to them, and their problem is the same as in Case 1.

So now, for an L-type,

$$\begin{aligned} c_g &= Y - g_R - g_S - pd && \text{with probability } 1-\pi, \\ c_b &= c_g - \Delta && \text{with probability } \pi\big[1-\lambda q(g_R)\big], \\ c_B &= c_b + B && \text{with probability } \pi\lambda q(g_R). \end{aligned}$$

and the L-type's maximization problem becomes

$$\max_{d,\, g_R,\, g_S} (1-\pi)\, U(c_g) + \pi\Big[\lambda q(g_R)\, U(c_B) + \big(1-\lambda q(g_R)\big)\, U(c_b)\Big] + v_d(d) + v_R(g_R) + v_S(g_S). \quad (2.6)$$

Let $\Gamma \equiv U(c_B) - U(c_b) = U(c_b + B) - U(c_b) > 0$ be the additional utility from the loan, and let $M \equiv (1-\pi)U'(c_g) + \pi\big[\lambda q(g_R)U'(c_B) + \big(1-\lambda q(g_R)\big)U'(c_b)\big]$. The first-order conditions are

$$\underbrace{v_R'(g_R)}_{\text{warm glow}} + \underbrace{\pi\, \lambda\, q'(g_R)\, \Gamma}_{\text{reputation payoff}} = M, \qquad v_S'(g_S) = M, \qquad v_d'(d) = p\, M. \quad (2.7)$$

Only religious contributions get the reputation payoff. Since U is concave, the value of a loan Γ is decreasing in bad-season consumption c_b, so a loan is worth more to a poorer household.

A higher chance of a bad season has two effects on religious contributions. It makes consumption more valuable (the income effect). It also makes reputation more valuable. Religious contributions rise for L-types if the reputation effect is larger than the income effect:

$$\frac{dg_R^*}{d\pi} > 0 \iff \underbrace{\lambda\, q'(g_R^*)\,\Gamma}_{\text{reputation effect}} > \underbrace{\lambda q(g_R)\,U'(c_B) + \big(1-\lambda q(g_R)\big)\,U'(c_b) - U'(c_g)}_{\text{income effect}}. \tag{C1}$$

Religious contributions are a normal good without reputation, so poorer households contribute less. But with the reputation incentive, reputation is worth more to poorer households, since a loan is worth more to them. If this need effect dominates, poorer households contribute more to religious institutions:

$$\begin{aligned}\frac{dg_R^*}{dY} < 0 \iff & \underbrace{\pi\lambda q'(g_R)\big[U'(c_b) - U'(c_B)\big]}_{\text{need effect}} \\ & > \underbrace{-\Big[(1-\pi)U''(c_g) + \pi\big(\lambda q(g_R)U''(c_B) + (1-\lambda q(g_R))U''(c_b)\big)\Big]}_{\text{income effect}}.\end{aligned} \tag{C2}$$

If $\lambda = 0$, then the need effect is zero and $dg_R^*/dY > 0$, as in Case 1.

Proposition 2. *If condition (C1) holds for π between π_L^N and π_L^D:*

(a) a drought raises L-types' contributions to religious institutions if either the fall in resources $Y_L^N - Y_L^D$ is small enough or the need effect is larger than the income effect, (C2), for Y between Y_L^D and Y_L^N; and

(b) holding religious contributions fixed, a drought lowers L-types' secular contributions and private devotion, and does not change H-types' choices.

Proposition 3. *A flood lowers L-types' religious contributions if lenders' capacity after a flood, $\lambda(F)$, is low enough. Holding religious contributions fixed, a flood lowers L-types' secular contributions and private devotion, and it lowers all three choices of H-types.*

So basically, a flood removes what makes religious contributions worthwhile. If H-types are unable to lend because they are hit by the flood, reputation through contributions is

worth little. Then religious contributions behave like the other choices: they fall when the L-type household faces more risk.

2.4 Case 3: Intrinsic religiosity as spiritual insurance

Following Bentzen (2019), I define intrinsic religiosity as belief and prayer, as opposed to religious attendance.[2] In line with Auriol et al. (2020), I model the belief that religious acts that please God lower the chance of a bad lean season. In this case, there are no lenders who reward religious contributions. The probability of a bad lean season becomes

$$P = \pi_\theta^\omega \left[1 - s(a)\right], \qquad a \equiv g_R + p\,d. \tag{2.8}$$

Here, a is the value of resources that the household devotes to religious acts, and s is the share of the risk the household believes these activities remove, with $s(0) = 0$, $s' > 0$, $s'' < 0$ and $s(a) < 1$; s is thrice continuously differentiable. s is the same for both L- and H-types. The risk each type faces, π_θ^ω, is different.

Only religious activities, including religious contributions, enter a. A household does not need to be religious to contribute to secular public goods. What makes a religious household go the extra mile during a shock is the belief that God will provide protection, so it spends more on the activities God mandates, not on secular public goods. Unlike Case 2, visibility is irrelevant, since God sees both private and public activities. Insurance is also proportional to risk. Religious acts remove a share s of the risk π, so a household that faces no risk has nothing to be insured from.[3] Both religious activities, d and g_R, share one payoff in this case. So I study the two together while holding secular contributions fixed, and study secular contributions while holding religious activities fixed.

[2] This definition differs from the intrinsic/extrinsic distinction of Allport and Ross (1967), in which religion used for comfort or protection counts as extrinsic ("extrinsic-personal" in Gorsuch and McPherson 1989).

[3] Auriol et al. (2020) write the subjective probability of a loss as $\tilde{\pi} - p(g)$, so that giving subtracts a fixed amount. With a share instead, a shock that raises risk also raises the value of protection.

For an L-type, let $\pi = \pi_L^\omega$, $Y = Y_L^\omega$ and $\Delta = \Delta_L$. There are two lean-season outcomes:

$$\begin{aligned} c_g &= Y - g_R - g_S - pd = Y - g_S - a && \text{with probability } 1-P, \\ c_b &= c_g - \Delta && \text{with probability } P = \pi\big[1 - s(a)\big]. \end{aligned}$$

An L-type household chooses d, g_R and g_S to maximize

$$(1-P)\,U(c_g) + P\,U(c_b) + v_d(d) + v_R(g_R) + v_S(g_S). \tag{2.9}$$

With $s \equiv 0$, this becomes Case 1. Let $M \equiv (1-P)U'(c_g) + PU'(c_b)$ and $\Omega \equiv U(c_g) - U(c_b)$, the utility lost in a bad season. I define the net marginal cost of a religious act as

$$\tilde{M} \equiv M - \underbrace{\pi\, s'(a)\, \Omega}_{\text{spiritual payoff}}.$$

The first-order conditions are

$$v_R'(g_R) = \tilde{M}, \qquad v_d'(d) = p\,\tilde{M}, \qquad v_S'(g_S) = M. \tag{2.10}$$

Religious contributions and private devotion are decreasing in the net marginal cost $\tilde{M}$, and secular contributions are decreasing in M.

Proposition 4. *For each type and any change in the monsoon state, religious contributions and private devotion move in the same direction.*

Both religious activities depend on the monsoon state only through $\tilde{M}$. Which way they move depends on the following conditions:

$$\underbrace{s'(a)\,\Omega}_{\text{spiritual effect}} > \underbrace{\big[1 - s(a)\big]\big[U'(c_b) - U'(c_g)\big]}_{\text{income effect}}, \tag{C3}$$

$$\underbrace{\pi\, s'(a)\big[U'(c_b) - U'(c_g)\big]}_{\text{need effect}} > \underbrace{-\big[(1-P)U''(c_g) + PU''(c_b)\big]}_{\text{income effect}}. \tag{C4}$$

Under (C3), a higher risk raises both religious activities. Under (C4), lower resources

raise them.

Proposition 5. *Under spiritual insurance:*

(a) if (C3) holds for π between π_L^N and π_L^D, a drought raises L-types' religious contributions and private devotion if either the fall in resources is small enough or (C4) holds for Y between Y_L^D and Y_L^N; holding religious activities fixed, it lowers their secular contributions, and it does not change H-types' choices; and

(b) a flood raises a type's religious contributions and private devotion if it raises that type's risk and the conditions in (a) hold for that type; holding religious activities fixed, it lowers secular contributions.

So, a household that believes in spiritual insurance responds to a drought by doing more of all the activities God likes, both public and private, while cutting secular contributions. Since a flood can also raise the risk faced by H-types, spiritual insurance allows H-types to turn to religion after a flood too.

3 Context: Weather shocks and religious institutions in rural Bangladesh

To study the religious response to monsoon shocks in rural agricultural households, Bangladesh provides an appropriate setting for three particular reasons. First, Bangladeshi households are prone to facing both floods and droughts during monsoon. Second, rural livelihoods depend on monsoon rainfall and so these shocks play a role in the severity of the lean season. Third, Bangladesh is a country with multiple religious institutions like mosques or temples in each village and they are closely tied to local power and credit support networks. I describe in more detail below.

3.1 Weather and religion 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).

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). Floods on the other hand are more frequent. About 80 percent of the country is floodplain, and around 20 to 25 percent of the land is inundated in a typical year, rising to over 60 percent in extreme years (Khan et al. 2024). Bangladesh experienced major floods in 1988, 1998, 2004, 2007, 2014 and 2017 (Choudhury and Yabar 2025).

These weather shocks are relevant because agricultural production in Bangladesh is strongly shaped by seasonal weather patterns. 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).

3.2 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. A popular form of Islam that blends Islamic beliefs with local traditions has a particularly strong influence in both rural and urban poor populations (Lewis 2011). 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. 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 known 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. Although exploitative, patron-client relationships between rural elites and poorer households can provide a limited form of security for poor households, particularly during shocks that affect the entire community. In these situations, relationships among poor households alone may be insufficient, and support from wealthier patrons becomes important (Scott 2014).

Religious institutions are closely tied to power structures. Devine et al. (2019) doc-

ument that a single village may contain multiple mosques, each led by an Imam[4] and representing a different community within the village. Power struggles within villages can lead to the formation of a new *Samaj*[5], 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. Members of a particular mosque community also tend to provide assistance primarily to fellow members rather than to outsiders.

Religious institutions also play important roles during times of crisis. Mosques in Bangladesh function as physical shelters during natural disasters and as sources of information, since warnings and announcements are often issued after prayers (Hossain 2026). Members of the *Samaj* community frequently remain active in the aftermath of disasters, providing both physical and financial assistance to affected households (Alam and Collins 2010). More broadly, religious practices can shape attitudes and preferences, and religious groups may provide financial assistance to poorer members, which can partially substitute for formal insurance (Rahman 2025).

These particular features of rural Bangladesh closely resemble the two channels in my model. Contributions to a religious institution like a mosque are visible to the community and to the local elites who are able to lend in a crisis. This reflects the reputation channel in Case 2. Simultaneously, religious faith and identity are central to rural life, which characterizes the spiritual insurance channel in Case 3.

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

[5]*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.

4 Data and summary statistics

4.1 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 km to ensure anonymity). I, therefore, can use these coordinates to determine whether a household was exposed to weather shocks.

The attrition rate is low, with 4.29 percent between wave 1 and wave 2 and about 7.12 percent between wave 1 and wave 3, and 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 percent split between wave 1 and wave 2 and 8.24 percent 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. Appendix Table B1 reports descriptive statistics of household characteristics by wave. The average household is Muslim-headed and consists of about 4 members. Around half of the household heads are primarily engaged in farming,[6] and about 48 percent of them never attended school. The average monthly real income ranges from about BDT 5,750 in wave 1 to BDT 7,000 in wave 3, and the majority of the income is spent on food. A typical household had relatively high debt compared to their savings, and households mainly borrow from NGOs and informal channels. The share of households borrowing from informal channels rose from 38 percent in 2011-12 to 46 percent in 2018-19. The two main sources of informal borrowing are social networks[7] (30–38 percent of households) and informal market lenders[8] (11–13 percent of households).

4.1.1 Measuring religious activities

I measure religious activities using two parts of the survey: the non-food expenditure module and the Women's Empowerment in Agriculture Index (WEAI) module.

The annual non-food expenditure module captures information on household level religious expenditures in the past 12 months, including expenses in:

- *Zakat*: 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).

- *Fitra*: a small obligatory payment made at the end of the fasting month of Ramadan, before the Eid-ul-Fitr prayer, on behalf of each member of the household (Singer 2008).

- *Qurbani*: a Muslim ritual of sacrificing livestock during Eid-ul-Adha, and it is an

[6] Farming includes crop farming, livestock/poultry related occupation, and aquaculture.
[7] I define social network as consisting of friends, relatives and employers.
[8] Informal market lenders include shopkeepers and money lenders.

obligation that is fulfilled by those with wealth higher than their needs (Kroessin 2025).

- *Sadaqa*: the voluntary act of providing charity in order to help those in need without expectation of gaining anything in return (Bensaid et al. 2013). However, it is worth mentioning that in Bangladeshi culture, it is common to use the term "sadaqa" to imply any acts of charity and is not culturally tied to Islam only.

- *Religious functions*: these include milads - religious gatherings in Islam where devotional recitations or sermons are performed for a particular cause, such as commemorating the birth or death of a person, and pujas - rituals in Hinduism where the deity is honored by the devotee as worshiper through a set of offerings (Chandola 1989).

For each of these items, I construct an indicator equal to one if the household spent on that item in the past 12 months. Since zakat, fitra and qurbani are Islamic obligations, I study these three outcomes among Muslim households only. I also use total annual religious expenditure in Bangladeshi taka.

The survey also includes modules 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 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. My main measure of religious contributions is an indicator equal to one if either respondent within the household donated time or money for the construction or maintenance of religious infrastructure such as a mosque or a temple. Unlike other donations mandated by the religion which can be given privately, these contributions to institutions are visible to the committee that collects the funds and to the community. From the same module, I measure membership in a religious group for any household member, the main male and the main female, and whether the main male and the main female member of the household attended at least two of the last five meetings in their

religious group.

The WEAI module also collects time use data using time diaries where the respondents had to recall time spent on various activities in the 24 hours prior to the interview, beginning at 4:00 AM of the day before the interview and ending at 4:00 AM on the day of the interview. Using the time diary records, I measure the total minutes spent in religious activities in 24 hours for both the main male and the main female member of the household. I also construct an indicator variable equal to one if the respondent recorded spending any time on religious activities between 3:00 AM and 6:00 AM. For Muslim households, I also construct a dawn prayer window that follows the actual time of Fajr,[9] the obligatory dawn prayer. Fajr can only be prayed from dawn, when the first light appears in the sky, until sunrise. For each household and diary date, I calculate the start of Fajr, when the sun is 18 degrees below the horizon, and the sunrise, using the NOAA[10] solar position equations and the household's GPS coordinates. This indicator equals one if the respondent spent any time on religious activities between the start of Fajr and sunrise. Since the time of Fajr changes with the season and the location, the window adjusts to the date and place of each household. In cases where the exact survey date is not recorded, I use the 15th day of the interview month. I use the two early morning measures as proxies for private devotion or intrinsic religiosity. In my model, private devotion captures activities mandated by God that are not observed by others, so they cannot build reputation. Early morning religious activities such as the dawn prayer are private and unmonitored. Women in rural Bangladesh pray at home, and Muslim men who end up going to the mosque to pray Fajr do so when few people are awake to observe them. Moreover, getting up early in the morning, particularly before dawn, to pray is costly as it requires giving up sleep, and the incentive to do so may be low unless one has strong faith in God. The other measures of religious activity in the survey come from the expenditure module and involve monetary payments, which may poorly reflect religious intensity. These payments and expenses are also infrequent, made once a year or on particular religious occasions. Prayer, on the other hand, is a daily practice,

[9]Muslims have 5 daily obligatory prayers whose timing depends on the position of the sun.
[10]NOAA stands for the National Oceanic and Atmospheric Administration.

Table 1: Summary statistics: religious activities

	Wave 1		Wave 2		Wave 3	
	Mean (SD)	N	Mean (SD)	N	Mean (SD)	N
Annual religious expenditure (BDT)	2,716.46 (11,154.00)	6,096	3,341.50 (8,858.50)	5,982	4,336.83 (12,270.17)	4,679
Contributed to religious infrastructure (=1)	0.67 (0.47)	6,091	0.83 (0.38)	5,967	0.88 (0.32)	4,666
Gave sadaqa (=1)	0.37 (0.48)	6,096	0.60 (0.49)	5,982	0.74 (0.44)	4,679
Paid zakat (=1)[a]	0.04 (0.20)	5,386	0.03 (0.16)	5,272	0.05 (0.22)	4,169
Spent on religious functions (=1)	0.26 (0.44)	6,096	0.41 (0.49)	5,982	0.39 (0.49)	4,679
Paid fitra (=1)[a]	0.49 (0.50)	5,386	0.61 (0.49)	5,272	0.68 (0.47)	4,169
Religious activity 3–6 AM, male (=1)[b]	0.11 (0.31)	3,164	0.18 (0.38)	4,962	0.18 (0.39)	3,859
Religious activity 3–6 AM, female (=1)[b]	0.15 (0.36)	6,096	0.25 (0.43)	5,930	0.29 (0.45)	4,632
Fajr-window religious activity, male (=1)[a,b]	0.25 (0.43)	2,772	0.21 (0.41)	4,303	0.28 (0.45)	3,409
Fajr-window religious activity, female (=1)[a,b]	0.33 (0.47)	5,386	0.30 (0.46)	5,210	0.43 (0.50)	4,130

Notes: Cells show means, with standard deviations in parentheses. N is the number of households. Wave 1 is 2011–12, wave 2 is 2015 and wave 3 is 2018–19. Monetary values are in real 2011 BDT.
[a] Muslim households only.
[b] Respondents who completed the time diary.

so early morning religious activity reflects devotion that is maintained every day rather than a single act in the year. I therefore argue that early morning religious activity is a reasonable, though imperfect, proxy for intrinsic religiosity.

Table 1 reports the descriptive statistics for my measures of religious activities. I find an increasing trend in religious practices among households. In 2011-12, 67% of the households reported contributing time or money towards construction or maintenance of religious infrastructures like mosques or temples. The proportion increased sharply to 83% in 2015 and by 2018-19, 88% of the households reported making such contributions. Total annual religious expenditures also increased over time, from about BDT 2,700 in 2011-12 to BDT 4,300 in 2018-19. This reflects the growing proportion of households

spending on sadaqa and religious functions. The share of households giving sadaqa doubled from 37% to 74%, and the share spending on religious functions rose from 26% to 39%. Among Muslim households, the share paying fitra rose from 49% to 68%. In contrast, zakat payments were quite rare, with only 3–5% of Muslim households paying zakat. Early morning religious activity also rose over time. In 2011-12, 11% of primary male and 15% of primary female household members spent time on religious activities between 3:00 and 6:00 AM, increasing to 18% and 29% by 2018-19. 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.

4.2 Weather data

Since I model a rural agricultural economy where livelihoods depend on monsoon rain, I measure shocks for the monsoon season. Monsoon typically lasts from early June to early October in Bangladesh. For my analysis, I therefore, consider shocks during the June-September period. I consider both contemporaneous and lagged shocks. For each survey 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.

4.2.1 Measuring droughts

I construct drought measures at the household level using satellite precipitation 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.

For each household h and year t, I compute monsoon rainfall P_{ht} as the zonal mean

rainfall within a 5 km buffer around the household location. I spatially match the household coordinates 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 rainfall over the 1981-2010 period. I then standardize monsoon rainfall in a particular year as follows:

$$z_{ht} = \frac{P_{ht} - \mu_h}{\sigma_h} \tag{4.1}$$

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 define a drought using the following specification:

$$Drought_{ht} = 1\{z_{ht} < -1\} \tag{4.2}$$

So, I define drought shock as rain falling more than one standard deviation below the mean. My drought shock measure 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.

Table 2 reports the weather shocks faced by households in my analytic sample in each wave. Drought shocks in the current monsoon were rare in the first two waves, affecting only about 1% of the households in 2011 and 2014, while 56% of the households were exposed to a drought shock in 2018. In contrast, the lagged drought shock was common in the first two waves: almost 39% of the households were exposed to drought in the 2010 monsoon and more than 50% in the 2013 monsoon, while no household faced a drought in 2017. I do not find any evidence of droughts being positively correlated across years. Using village-level monsoon rainfall from 1981 to 2018, I find that a village experiences a drought in 6.4% of the years that follow a drought year compared to 17.1% of the years that follow a year without drought. Wet and dry monsoons tend to alternate, so a dry monsoon is more likely to be followed by a wet one. Regressions of village rainfall and drought on their values in the previous year confirm that neither is positively correlated across years (Appendix Table B2). Rainfall deficits in dry years are spread

across several parts of the country and are particularly prominent in the north-western region (Appendix Figure B2) which is documented as the most drought prone area of Bangladesh (Shahid and Behrawan 2008).

4.2.2 Measuring floods

I measure floods directly using satellite flood maps from the Global Flood Database (Tellman et al. 2021). The database maps the extent of major flood events using daily images from the Moderate Resolution Imaging Spectroradiometer (MODIS) at a spatial resolution of 250 m. For each survey year, I keep flood events in Bangladesh that began during the June–September monsoon and classify a pixel as flooded if it was flooded in any of these events. I exclude permanent water bodies such as rivers and lakes using the permanent water layer included in the database. For each household, I then calculate the share of the area within a 5 km buffer around the household location that was flooded during the monsoon. As with drought, I construct this measure for the current monsoon and for the previous monsoon.

On average, 5% of the area around a household was flooded in the 2011 monsoon, 9% in 2014 and 7% in 2018 (Table 2). The 2014 monsoon season was associated with major river flooding due to heavy upstream rainfall in the Brahmaputra basin, but these floods were concentrated mainly in northern and north-eastern Bangladesh, so the share flooded around the average household in my sample remains low. The lagged flood share is highest for 2010 (11%) and 2017 (12%). 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). Across years, floods are concentrated along the major rivers and in the low-lying north-east of the country (Appendix Figure B3).

4.2.3 Measuring temperatures

To separate drought effects from heat stress, I control for average monsoon temperature and number of monsoon days above 35°C. Since temperature and rainfall are correlated, omitting temperature could bias the estimated effects of rainfall shocks (Dell et al. 2014).

Table 2: Summary statistics: weather variables

	Wave 1		Wave 2		Wave 3	
	Mean (SD)	N	Mean (SD)	N	Mean (SD)	N
A. Weather shocks						
Drought, this monsoon (=1)	0.01 (0.11)	6,096	0.01 (0.11)	5,982	0.56 (0.50)	4,679
Drought, last monsoon (=1)	0.39 (0.49)	6,096	0.51 (0.50)	5,982	0.00 (0.00)	4,679
Share flooded, this monsoon	0.05 (0.12)	6,096	0.09 (0.20)	5,982	0.07 (0.17)	4,679
Share flooded, last monsoon	0.11 (0.21)	6,096	0.02 (0.08)	5,982	0.12 (0.22)	4,679
B. Temperature						
Average temperature, this monsoon (°C)	29.19 (0.74)	6,096	28.90 (0.70)	5,982	29.74 (0.91)	4,679
Average temperature, last monsoon (°C)	28.11 (0.78)	6,096	29.52 (0.77)	5,982	29.35 (0.77)	4,679
Days above 35°C, this monsoon	0.29 (0.65)	6,096	0.16 (0.43)	5,982	0.20 (0.46)	4,679
Days above 35°C, last monsoon	0.17 (0.44)	6,096	0.27 (0.57)	5,982	0.15 (0.40)	4,679

Notes: Cells show means, with standard deviations in parentheses. N is the number of households. Drought equals one if monsoon (June–September) rainfall within 5 km of the household is more than one standard deviation below its 1981–2010 mean. Share flooded is the share of the area within 5 km of the household that was flooded during the monsoon. Wave 1 is 2011–12, wave 2 is 2015 and wave 3 is 2018–19.

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.

5 Empirical framework

5.1 Empirical specification

To test my model predictions, I estimate the effects of droughts and floods separately using the following specification:

$$\begin{aligned} Y_{hvs} = {} & \beta_1 Drought_{ht} + \beta_2 Drought_{h,t-1} + \beta_3 Flood_{ht} + \beta_4 Flood_{h,t-1} \\ & + \gamma_1 Temp_{ht} + \gamma_2 Temp_{h,t-1} + \gamma_3 HeatDays_{ht} + \gamma_4 HeatDays_{h,t-1} \\ & + \delta_m + \alpha_h + \lambda_s + \varepsilon_{hvs} \end{aligned} \tag{5.1}$$

where Y_{hvs} denotes the outcome of interest for household h in village v measured at wave s, and t denotes the monsoon preceding wave s. $Drought_{ht}$ is an indicator for a drought in the contemporaneous monsoon and $Flood_{ht}$ is the share of the area around household h flooded in the contemporaneous monsoon. $Drought_{h,t-1}$ and $Flood_{h,t-1}$ are the corresponding measures for the previous monsoon. I include the previous monsoon because a monsoon shock affects income and credit through the following harvest and lean season, so some responses can appear a year later. I control for temperature conditions to address any correlation between rainfall and temperature.[11] Here, $Temp_{ht}$ is the average monsoon daytime temperature at t and $Temp_{h,t-1}$ is the average daytime temperature during prior monsoon. $HeatDays_{ht}$ 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 wave 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

[11] In my data, the correlation between monsoon temperature and rainfall z-score is -0.23.

economic conditions.

My main outcomes of interest are contributions to religious infrastructure as a measure of publicly observable giving to religious institutions, early morning religious activity as a measure of private devotion, and contributions to non-religious public goods such as roads and wells as a measure of secular giving. I also report effects on other religious outcomes, earnings, consumption, borrowing by source, and savings. Binary outcomes are estimated as linear probability models. Outcomes in Bangladeshi taka (BDT) or minutes are estimated by Poisson pseudo-maximum likelihood (PPML) with the same fixed effects (Correia et al. 2020; Santos Silva and Tenreyro 2006), and the coefficients are proportional effects, $\exp(\beta) - 1$. I report flood effects for a one standard deviation (0.17) increase in the share flooded.

My model predicts that a drought changes the choices of poor households but not of rich ones. To test this, I interact each shock with a household characteristic X_h measured before the shocks:

$$\begin{aligned} Y_{hvs} = {} & \beta_1 Drought_{ht} + \theta_1 (Drought_{ht} \times X_h) + \beta_2 Drought_{h,t-1} + \theta_2 (Drought_{h,t-1} \times X_h) \\ & + \beta_3 Flood_{ht} + \theta_3 (Flood_{ht} \times X_h) + \beta_4 Flood_{h,t-1} + \theta_4 (Flood_{h,t-1} \times X_h) \\ & + Z'_{ht}\gamma + \alpha_h + \lambda_s + \delta_m + \varepsilon_{hvs} \end{aligned} \tag{5.2}$$

where Z_{ht} is the vector of temperature controls. X_h equals one if the household is in the top two quintiles of a wave-1 wealth index which I constructed following Filmer and Pritchett (2001) and Rutstein (2008). Then β_1 is the drought-year effect for poorer households, $\beta_1 + \theta_1$ the effect for richer households, and θ_1 the difference between them.

5.2 Identification

I rely on the following identifying assumption:

$$E[\varepsilon_{hvs} \mid W_{ht}, Z_{ht}, \alpha_h, \lambda_s, \delta_m] = 0 \tag{5.3}$$

where

$$W_{ht} = (Drought_{ht},\ Drought_{h,t-1},\ Flood_{ht},\ Flood_{h,t-1})\,,$$
$$Z_{ht} = (Temp_{ht},\ Temp_{h,t-1},\ HeatDays_{ht},\ HeatDays_{h,t-1})\,.$$

Conditional on fixed effects and weather controls, droughts and floods are uncorrelated with the unobserved determinants of household outcomes (Dell et al. 2014). Households in drought-prone or flood-prone areas may differ from other households and the household fixed effects absorb these differences. But, time trends must be the same. So, in the absence of a shock, the change in outcomes would have been the same for households that experience a shock and those that do not.

I test whether households that later experience a shock differed before the shock. To do so I regress drought in the 2013 and 2018 monsoons and share flooded in the 2014 and 2017 monsoons, all of which occurred after the wave 1 interview, on wave 1 household characteristics with division fixed effects (Appendix Table B3). Shock exposure is related to some characteristics. Households that experienced future droughts were smaller and less likely to be female-headed, while future flood-exposed households were more likely to be engaged in farming, owned more land and were less wealthy. These differences in levels are taken care of by household fixed effects, but they could bias my estimates if the same characteristics led to different trends over time. Following Hornbeck (2012), I re-estimate the main specification adding interactions between wave indicators and wave 1 household characteristics (Appendix Table B4). This allows households with different initial characteristics, such as farming households or wealthier households, to follow different paths across waves. The estimates are almost unchanged. The effect of drought on contributions to religious infrastructure moves from 0.081 to 0.090 in the drought year and from 0.074 to 0.068 a year later, and the effect on early morning religious activity of men moves from -0.033 to -0.032.

To check for pre-trends, I add the next wave's drought and share flooded to the main specification, following Maccini and Yang (2009). Since drought was rare in the

2011 and 2014 monsoons, this test asks whether households that experienced the 2018 drought were already changing differently between 2011–12 and 2015. Future shocks do not predict contributions to religious infrastructure or early morning religious activity of men or women, with joint p-values of 0.63, 0.49 and 0.79 (Appendix Table B5). Future floods predict a decline in the secular giving index (-0.070, $p < 0.10$), so I interpret the effect of floods on secular giving with caution.

Regional changes that coincide with a widespread drought or flood could also bias my estimates. So, I also estimate my main results with division-by-wave fixed effects and report the results in Appendix B. This specification compares changes over time for households with more and less exposure within the same division and wave.[12] Because monsoon shocks are spatially correlated, these fixed effects also absorb much of the variation in exposure. I keep household and wave fixed effects as my preferred specification and discuss the results where the two specifications differ.

6 Empirical results

6.1 Monsoon shocks and the household economy

In my model, I assume that drought is idiosyncratic in its impact. It lowers the resources of wage dependent households and raises their risk of a lean season. Richer households on the other hand are not affected. A flood, in contrast, affects everyone in the village. To provide an empirical justification, I first report the average effects of droughts and floods on household earnings, consumption, savings and borrowing (Table 3).On average, a drought does not reduce household earnings, either in the drought year or a year later. It doesn't also reduce the harvest of Aman, the rice crop grown during the monsoon season in Bangladesh (Appendix Table B7). However, households adjust their spending. Food expenditure falls by about 7 percent in the drought year and rises by about 4 percent a year later ($p < 0.001$ for the difference), consistent with households cutting

[12]Divisions are the largest administrative units in Bangladesh. Each division is divided into districts, and districts into upazilas (sub-districts) and unions. The BIHS was designed to be representative of the seven divisions that existed in 2011. I use the 2011 division boundaries.

food spending in the short run and catching up later (Gebre et al. 2021). Households also borrow more after a drought: the total amount of current loans rises by about 17 percent in the drought year and by about 20 percent a year later, and I cannot reject that the two effects are equal ($p = 0.84$). Households sell more of their rice in the drought year and draw down their rice stocks a year later (Appendix Table B7). So, it seems to be the case that households smooth consumption after a drought by borrowing and drawing down their grain stocks, two of the ex post smoothing mechanisms described by Morduch (1995).

Table 3: Monsoon Shocks and the Household Economy

A. Income and consumption				
	Monthly earned income	Monthly per capita consumption	Monthly food expenditure	Monthly non-food expenditure
	(1)	(2)	(3)	(4)
Drought, this monsoon	0.015	−0.034	−0.068***	0.111**
	(0.037)	(0.022)	(0.023)	(0.048)
Drought, last monsoon	0.015	0.034**	0.035**	0.038
	(0.031)	(0.015)	(0.017)	(0.036)
Share flooded, this monsoon (1 SD)	0.017	0.004	0.020**	−0.070***
	(0.014)	(0.008)	(0.010)	(0.026)
Share flooded, last monsoon (1 SD)	−0.008	0.021**	0.015	−0.024
	(0.015)	(0.009)	(0.010)	(0.023)
Mean of outcome (BDT)	6,504	1,534	4,941	1,221
Observations	16,498	16,755	16,755	16,756
B. Savings and borrowing				
	Total amount of current loans	Amount currently saved	Cash at hand	
	(5)	(6)	(7)	
Drought, this monsoon	0.159*	0.116	0.055	
	(0.087)	(0.132)	(0.194)	
Drought, last monsoon	0.179***	−0.042	−0.025	
	(0.068)	(0.089)	(0.093)	
Share flooded, this monsoon (1 SD)	0.054	0.019	−0.132**	
	(0.039)	(0.045)	(0.064)	
Share flooded, last monsoon (1 SD)	0.015	−0.058	−0.024	
	(0.042)	(0.054)	(0.059)	
Mean of outcome (BDT)	46,704	22,441	1,698	
Observations	14,759	13,962	16,316	

Notes: Each column is a separate Poisson pseudo-maximum likelihood regression with household, wave and interview-month fixed effects, controlling for current and lagged average monsoon temperature and days above 35°C. Coefficients are proportional effects; the percent effect is $100 \times (\exp(\beta) - 1)$. Monetary values are in real 2011 BDT. Share flooded is in standard deviations. Appendix Table B6 reports estimates with division-by-wave fixed effects. Standard errors clustered by village in parentheses. * p<0.10, ** p<0.05, *** p<0.01.

Floods have different effects. A one standard deviation increase in the share of land flooded reduces the Aman harvest by about 4 percent, and by about 9 percent when I compare households within the same division and wave (Appendix Table B7). In the flood year, non-food expenditure falls by about 7 percent and cash at hand by about 12 percent (Table 3). These effects are concentrated in the flood year and disappear a year later ($p = 0.008$ and $p = 0.009$ for the tests that the two years are equal).

If a drought does not reduce the harvest, how does it affect households? Jayachandran (2006) shows that agricultural wages fall after negative productivity shocks, and fall more where workers are poorer, less able to borrow and less able to migrate. Kaur (2019) finds instead that nominal wages are sticky during droughts, so the adjustment happens through employment. In either case, the cost falls on households that sell their labor. Table 4 shows that in the drought year, the daily agricultural wage falls by about 6 percent and the share of households doing any daily-wage work falls by 2.6 percentage points. A year later, the share doing daily-wage work is still 2.5 percentage points lower and total person-days of wage work are about 8 percent lower. Farm households also hire less labor for planting the next Aman crop (Appendix Table B8).

These labor market effects imply that a drought affects households in the same village differently. To show this, I interact the shocks with an indicator for households in which a member worked as an agricultural day laborer in wave 1 (Appendix Table B10). In the drought year, agricultural earnings of these households fall by about 16 percent and their days of wage work fall by about 26 percent. Agricultural earnings of other households rise by about 15 percent. Agricultural-laborer households partly make up for this loss by moving into non-agricultural work, where their earnings rise by about 45 percent, consistent with labor reallocation to non-farm work after droughts (Musungu et al. 2024). A year after a drought, however, the gap shows up in their income and consumption. Relative to other households, agricultural-laborer households earn about 7 percent less. While per capita consumption of other households rises by about 4 percent, consumption of agricultural-laborer households does not rise. The results are similar when I compare households within the same division and wave. The only exception is

Table 4: Monsoon Shocks and Wage Labor

	Agricultural day labor		Daily-wage work (any sector)		
	Any member (=1)	Total days, past 7 days	Any member (=1)	Total days, past 7 days	Daily agricultural wage (BDT)
	(1)	(2)	(3)	(4)	(5)
Drought, this monsoon	0.001	0.082	−0.026*	−0.060	−0.066**
	(0.011)	(0.093)	(0.014)	(0.063)	(0.032)
Drought, last monsoon	−0.013	−0.075	−0.025**	−0.082**	−0.020
	(0.008)	(0.063)	(0.010)	(0.042)	(0.021)
Share flooded, this monsoon (1 SD)	0.000	−0.000	−0.005	−0.036	0.005
	(0.007)	(0.037)	(0.006)	(0.026)	(0.011)
Share flooded, last monsoon (1 SD)	−0.001	−0.009	−0.004	−0.033	−0.028**
	(0.008)	(0.045)	(0.007)	(0.031)	(0.012)
Estimator	LPM	PPML	LPM	PPML	PPML
Mean of outcome	0.17	2.77	0.29	3.46	210.11
Observations	16,756	4,941	16,756	7,787	1,725

Notes: All regressions include household, wave and interview-month fixed effects and control for current and lagged average monsoon temperature and days above 35°C. Columns (1) and (3) are estimated as linear probability models; columns (2), (4) and (5) by Poisson pseudo-maximum likelihood. Days of work are summed across all household members over the 7 days before the interview. The daily agricultural wage is the average wage of household members who did agricultural day labor and is observed only for households with an agricultural day laborer. Share flooded is in standard deviations. Appendix Table B9 reports estimates with division-by-wave fixed effects. Standard errors clustered by village in parentheses. * p<0.10, ** p<0.05, *** p<0.01.

the earnings gap a year later, which is smaller and less precise. A drought is therefore not a shock that every household in the village experiences equally. It falls mainly on households that depend on wage labor.

Floods do not show this pattern. The interactions between flooding and the agricultural-laborer indicator are small and statistically insignificant for total earnings and consumption (Appendix Table B10). So I find no evidence that floods affect agricultural-laborer households differently. The only differences are in where these households find work. They earn less from non-agricultural work in the flood year and a year later. A year after a flood, their days of wage work do not fall. In contrast, other households work about 10 percent fewer days. Agricultural-laborer households also earn more from agriculture than other households. This fits the larger Aman harvest and the higher demand for hired labor after floods (Appendix Tables B7 and B8). These shifts cancel out. Their total earnings and consumption do not change differently from those of other households. Floods instead reduce harvests, non-food spending and cash at hand across the village

(Table 3 and Appendix Table B7). These results support the way my model distinguishes the two shocks.

6.2 Monsoon shocks, religious contributions and devotion

6.2.1 Overview of religious responses to monsoon shocks

Before testing the implications of my model, I ask whether religious behavior responds to monsoon shocks at all. I use the several religious ritual expenses that households report in the expenditure module.Table 5 reports the results. Columns 1–4 indicate whether the household spent money on a ritual in the past year, and column 5 is total religious expenditure. In the drought year, households are 5.7 percentage points more likely to spend on religious functions such as milad and puja. A year after a drought, they are 5.3 percentage points more likely to spend on religious functions, 5.6 percentage points more likely to give sadaqa and 5.3 percentage points more likely to pay fitra. Sadaqa is an Islamic act of voluntary charity, but in Bangladesh the term is commonly used for any donation, and about a third of Hindu households also report giving it, so I interpret this column with caution. On average, total religious expenditure does not change significantly, and floods have almost no effect on any of these outcomes. The effects are heterogeneous by wave–1 wealth (Appendix Table B12). In the drought year, poorer households are 7.1 percentage points more likely to spend on religious functions and 7.1 percentage points more likely to pay fitra, and their total religious expenditure rises by about 53 percent. Religious functions are communal events that households choose to organize and pay for. Pujas are part of Hindu religious practice, but milads are not obligatory in Islam, and in rural Bangladesh it is common to hold pujas and special milads or prayer gatherings to ask for rain. The rise in spending on religious functions in a drought year therefore suggests that poorer households turn to religion when the rains fail. A year after a drought, richer households respond more than poorer households. Relative to poorer households, they are 5.1 percentage points more likely to spend on religious functions, 5.5 percentage points more likely to give sadaqa, 3.6 percentage points more likely to pay fitra and 2.5 percentage points more likely to pay zakat. Since zakat

and fitra go to the poor, this suggests that richer households give more once the effects of the drought on poorer households are realized. Most of these patterns hold when I compare households within the same division and wave, although the drought-year increase in spending on religious functions for poorer households becomes smaller and less precise. Religious participation therefore responds to droughts more than to floods. That poorer households spend more on religion in a drought year is also hard to reconcile with Proposition 1, in which a drought lowers their religious activity in the absence of a reputation building or spiritual insurance motive. However, since these are monetary expenditures, and they mix obligations, such as zakat, fitra and pujas, with voluntary acts, such as milads and sadaqa, it is hard to isolate the implications or motivation behind these responses. Next, I separate voluntary religious giving that the village can see like contributions to the mosque or temple, from secular giving and from private devotion that no one observes.

Table 5: Expenses in Religious Rituals

	Paid or spent on (=1)				Total religious expenditure (BDT)
	Religious functions, puja/milad	Sadaqa	Zakat†	Fitra†	Past 12 months
	(1)	(2)	(3)	(4)	(5)
Drought, this monsoon	0.057**	−0.002	−0.021**	0.025	0.049
	(0.028)	(0.032)	(0.010)	(0.020)	(0.102)
Drought, last monsoon	0.053***	0.056**	0.016**	0.053***	0.097
	(0.020)	(0.026)	(0.007)	(0.017)	(0.063)
Share flooded (1 SD), this monsoon	0.000	0.004	−0.001	−0.007	−0.049
	(0.015)	(0.013)	(0.003)	(0.011)	(0.043)
Share flooded (1 SD), last monsoon	0.019	0.028**	−0.001	−0.006	−0.050
	(0.017)	(0.014)	(0.003)	(0.011)	(0.067)
Estimator	LPM	LPM	LPM	LPM	PPML
Mean of outcome	0.35	0.55	0.04	0.59	3,514.92
Observations	16,756	16,756	14,826	14,826	16,171

Notes: Each column is a separate regression with household, wave and interview-month fixed effects and controls for temperature and heat days in this and the last monsoon. Columns 1–4 are linear probability models. Column 5 is estimated by Poisson pseudo-maximum likelihood, so coefficients are proportional effects, $\exp(\beta) - 1$. Flood effects are for a one standard deviation increase in the share flooded. †Muslim households only. Sadaqa is an Islamic act of voluntary charity, but in Bangladesh the term is commonly used for any donation, and some Hindu households also report it. Standard errors clustered by village in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

6.2.2 Reputation or spiritual insurance?

The three cases in Section 2 make different predictions for three choices: contributions to religious institutions, contributions to secular public goods and private devotion. I distinguish the channels by comparing how these choices respond to the same shock. In the absence of a reputation or spiritual insurance motive, all three move together (Proposition 1). If contributions to religious public institutions help build a reputation with influential villagers, a drought can raise poorer households' contributions to the mosque or temple while lowering their secular contributions and private devotion, since only the first is seen by those who can lend (Proposition 2). If religion functions as a spiritual insurance, contributions and private devotion move in the same direction, since God sees both (Proposition 4). The reputation channel is related to club-good models of religion, in which costly participation screens out free riders and members insure one another (Berman 2000; Iannaccone 1992). Unlike a church, a mosque or temple in rural Bangladesh has no congregational membership. Anyone can pray there, and contributing does not buy access to a group that pays out. What a contribution can buy is a reputation with the better-off villagers with lending capabilities who are often elected member of the mosque/temple committee. Table 6 reports the average effects, and Table 7 reports the effects separately for poorer and richer households.

1. After a drought, households contribute more to religious infrastructure but not to secular public goods. In the drought year, households are 8.4 percentage points more likely to contribute time or money to the construction or maintenance of a mosque or temple (Table 6, column 1). The effect is similar a year later, at 7.7 percentage points. These contributions are mostly money collected in public by the mosque or temple committee, so they are seen by the committee and by other villagers. Contributions to secular public goods such as wells, roads and town development do not change. The coefficients on the secular index are 0.011 and 0.006 standard deviations, and neither is statistically significant (column 2).

Table 6: Religious Contributions, Secular Contributions and Private Devotion

	Contributions		Private devotion			
	Religious infrastructure (=1)	Secular index (std.)	Religious activity 3–6 AM (=1)		Religious activity in Fajr window (=1)†	
			Main male	Main female	Main male	Main female
	(1)	(2)	(3)	(4)	(5)	(6)
Drought, this monsoon	0.084***	0.011	−0.032**	−0.026	−0.013	−0.028
	(0.023)	(0.052)	(0.016)	(0.016)	(0.019)	(0.019)
Drought, last monsoon	0.077***	0.006	0.001	0.014	0.020	0.013
	(0.019)	(0.035)	(0.013)	(0.016)	(0.015)	(0.018)
Share flooded (1 SD), this monsoon	0.001	−0.064***	−0.018***	0.003	−0.002	0.007
	(0.009)	(0.018)	(0.006)	(0.007)	(0.008)	(0.009)
Share flooded (1 SD), last monsoon	0.014	0.007	−0.018***	0.003	0.003	0.004
	(0.011)	(0.024)	(0.006)	(0.007)	(0.010)	(0.010)
Estimator	LPM	OLS	LPM	LPM	LPM	LPM
Mean of outcome	0.78	−0.00	0.16	0.22	0.26	0.37
Observations	16,709	16,709	10,586	16,632	7,932	13,336

Notes: Each column is a separate regression with household, wave and interview-month fixed effects and controls for temperature and heat days in this and the last monsoon. The secular contributions index is the standardized mean of standardized contributions to wells, roads and town development, with mean 0 and standard deviation 1. Private devotion is measured from the 24-hour time-use diary of the main male and main female. †Muslim households only, days on which the Fajr window is fully observed in the diary. Flood effects are for a one standard deviation increase in the share flooded. Standard errors clustered by village in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

2. After a drought, early-morning religious activity falls. I find that in the drought year, the main male member is 3.2 percentage points less likely to spend any time on religious activity between 3 and 6 AM, a 20 percent decline from a mean of 0.16 (column 3). The estimate for the main female member is also negative, at 2.6 percentage points, but less precise (column 4). The Fajr-window measures for Muslim households give negative but smaller and insignificant estimates (columns 5–6). Private devotion does not change a year after a drought. So in the year when households give more to the mosque, they spend less time on the religious acts that no one sees.

3. The response to a drought comes from poorer households. Table 7 suggests that both patterns come from poorer households. In the drought year, poorer households are 12.3 percentage points more likely to contribute to religious infrastructure. The difference for richer households is −10.0 percentage points, so richer households do not change their contributions. Among poorer households, the main male member is 5.1

Table 7: Religious Contributions, Secular Contributions and Private Devotion by Wave–1 Wealth

	Contributions		Private devotion			
	Religious infrastructure (=1)	Secular index (std.)	Religious activity 3–6 AM (=1)		Religious activity in Fajr window (=1)†	
			Main male	Main female	Main male	Main female
	(1)	(2)	(3)	(4)	(5)	(6)
Drought, this monsoon	0.123***	0.043	−0.051***	−0.037**	−0.032	−0.017
	(0.026)	(0.052)	(0.016)	(0.018)	(0.021)	(0.021)
× Richer	−0.100***	−0.080	0.046**	0.028	0.048**	−0.028
	(0.022)	(0.066)	(0.019)	(0.021)	(0.024)	(0.024)
Drought, last monsoon	0.084***	−0.017	−0.023	0.003	0.007	0.023
	(0.022)	(0.035)	(0.015)	(0.017)	(0.016)	(0.020)
× Richer	−0.018	0.056	0.055***	0.024	0.030	−0.028
	(0.018)	(0.048)	(0.018)	(0.016)	(0.025)	(0.019)
Share flooded (1 SD), this monsoon	0.001	−0.073***	−0.019***	−0.005	0.001	0.005
	(0.010)	(0.023)	(0.007)	(0.007)	(0.009)	(0.009)
× Richer	0.003	0.028	0.001	0.020*	−0.010	0.006
	(0.011)	(0.035)	(0.010)	(0.011)	(0.014)	(0.016)
Share flooded (1 SD), last monsoon	0.004	−0.007	−0.011*	0.004	0.011	0.007
	(0.012)	(0.025)	(0.006)	(0.007)	(0.012)	(0.012)
× Richer	0.034***	0.041	−0.026**	−0.007	−0.024	−0.010
	(0.011)	(0.040)	(0.011)	(0.012)	(0.017)	(0.016)
Estimator	LPM	OLS	LPM	LPM	LPM	LPM
Mean of outcome, poorer	0.73	−0.10	0.13	0.20	0.20	0.33
Mean of outcome, richer	0.86	0.15	0.20	0.26	0.33	0.44
Observations	16,703	16,703	10,580	16,626	7,926	13,330

Notes: Each column is a separate regression with household, wave and interview-month fixed effects and temperature controls. Each shock is interacted with an indicator for richer households (top two quintiles of the wave-1 wealth index). The shock rows give the effect for poorer households, and the "× Richer" rows the difference between richer and poorer households. The secular contributions index is the standardized mean of standardized contributions to wells, roads and town development. Private devotion is from the 24-hour time-use diary of the main male and main female. †Muslim households, days with the Fajr window fully observed. Flood effects are per one standard deviation in the share flooded. Standard errors clustered by village in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

percentage points less likely to be religiously active between 3 and 6 AM, a 39 percent decline from a mean of 0.13, and the main female member is 3.7 percentage points less likely, a 19 percent decline. Private devotion of richer households does not change. Secular contributions do not change for either group. A year after a drought, however, richer households also contribute more to religious infrastructure, and the difference between the two groups is small. When I compare households within the same division and wave, the average drought-year effect on contributions is smaller, since much of the variation in drought comes from the widespread drought of 2018. The gap between poorer and richer households is unchanged.

4. After a flood, secular contributions and private devotion fall, but religious contributions do not respond. Floods have a different pattern. A one standard deviation increase in the share flooded does not change contributions to religious infrastructure in the flood year or a year later (Table 6, column 1). It lowers secular contributions by 0.064 standard deviations, and it lowers the probability that the main male member is religiously active between 3 and 6 AM by 1.8 percentage points, both in the flood year and a year later (columns 2–3). The fall in secular contributions mainly from poorer households (Table 7). Richer men also spend less time on early-morning religious activity a year after a flood. At the same time, richer households become more likely to contribute to religious infrastructure, with a difference of 3.4 percentage points relative to poorer households. The flood effects on secular contributions and on men's early-morning religious activity are similar within divisions and waves.

My drought effect estimates reject (Proposition 1(a)), since poorer households contribute more to religious institutions, not less. They also reject spiritual insurance (Proposition 4), since poorer households' contributions and private devotion move in opposite directions. The reputation case fits most of the drought results. The rise in contributions, the fall in private devotion and the absence of a response among richer households in the drought year match Proposition 2. However, secular contributions do not fall as Propositions 2(b) and 5(a) predict. In rural Bangladesh, roads, wells and other local public infrastructure are mainly provided by the government, and few households contribute to them. Only 11 percent of poorer households contribute time or money to any secular public good in a given wave.

My flood estimates, on the other hand, support some parts of the propositions but none of them fully. Religious contributions do not fall, which goes against Proposition 1(c). The fall in poorer households' secular contributions and private devotion matches Proposition 3, and their unchanged religious contributions are consistent with it only if lenders can still lend after a flood. A year after a flood, however, richer households contribute more while the early-morning religious activity of richer men falls, which matches neither Proposition 3 nor Proposition 4.

7 Mechanism: reputation incentive for credit access

My empirical estimates of religious responses to monsoon shocks match the reputation case of my model. Poorer households give more to the mosque or temple after a drought while their private devotion falls, and richer households do not change their choices. However, this does not empirically establish that a reputation motive exists. The model assumes that contributions to religious institutions raise a household's chance of getting a loan from richer villagers. I cannot observe this incentive directly in my data. Instead, I provide three pieces of evidence that are consistent with it. First, I examine how droughts and floods affect borrowing from different lenders. Second, I ask whether these effects differ between poorer and richer households, since in my model only poorer households lack collateral and need a reputation to borrow. Third, I test whether households that contributed to religious infrastructure in the previous wave are more likely to borrow from informal lenders after a drought than households that did not contribute. Fourth, I separate this channel from religion as a club good, in which members of a religious community insure one another (Chen 2010; Iannaccone 1992). If past contributors borrow more because they belong to such a community, they should also receive more help from other members, such as charity. I compare past contributors with members of religious groups. Under the reputation channel, contributions should bring loans from lenders, while group membership should bring charity from other members.

7.1 Effects on informal credit

Households adjust their borrowing after droughts and floods differently across credit sources (Appendix Table B15). In the drought year, households are 4.1 percentage points more likely to borrow 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 or 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, a year after a drought, households borrow more from informal lenders, particularly from moneylenders and shopkeepers. They are 1.9 percentage points more likely to borrow from a moneylender, and 1.5 percentage points more likely to borrow from a shopkeeper. In my data, a moneylender is any individual who lends money at interest. Unlike NGO loans, these informal loans are directly negotiated with the lender and depend 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. Because these lenders operate within village networks, maintaining relationships or signaling loyalty or credibility to them may be important for securing credit.

Table 8 shows that the rise in borrowing from moneylenders comes mainly from poorer households. A year after a drought, poorer households are 2.3 percentage points more likely to borrow from a moneylender, and 1.5 percentage points more likely to borrow from a shopkeeper. For moneylenders, the increase for richer households is smaller, although the difference between the two groups is not statistically significant. When I compare households within the same division and wave, the increase in moneylender borrowing among poorer households is 3.2 percentage points. This pattern fits the way my model treats a drought. It raises the probability that poorer households will need a loan, while leaving richer villagers able to lend. Floods, in contrast, have little effect on borrowing from informal lenders for either group. The absence of a fall in informal borrowing suggests that informal lenders are still able to lend after a flood. In my model, a flood lowers poorer households' religious contributions only if it reduces lenders' capacity to lend enough (Proposition 3). If lenders can still lend, a reputation keeps its value after a flood, and poorer households have no reason to cut their contributions. This is consistent with my earlier finding that religious contributions do not fall after floods.

Table 8: Borrowing from Informal Lenders by Wave-1 Wealth

	Borrowed from (=1)			
	Any informal lender	Social network	Moneylender	Shopkeeper
	(1)	(2)	(3)	(4)
Drought, this monsoon	−0.027	−0.030	0.003	0.002
	(0.024)	(0.022)	(0.014)	(0.009)
× Richer	0.029	0.031	−0.010	0.004
	(0.023)	(0.021)	(0.014)	(0.006)
Drought, last monsoon	0.033*	0.018	0.023**	0.015**
	(0.018)	(0.016)	(0.011)	(0.007)
× Richer	−0.002	0.005	−0.010	−0.001
	(0.020)	(0.019)	(0.011)	(0.005)
Share flooded (1 SD), this monsoon	0.002	−0.009	0.006	−0.005
	(0.010)	(0.009)	(0.008)	(0.006)
× Richer	0.005	0.004	−0.002	0.011**
	(0.014)	(0.013)	(0.008)	(0.005)
Share flooded (1 SD), last monsoon	0.003	0.003	−0.006	0.005
	(0.009)	(0.008)	(0.009)	(0.005)
× Richer	0.015	0.017	0.007	−0.004
	(0.015)	(0.013)	(0.009)	(0.005)
Mean of outcome, poorer	0.40	0.31	0.12	0.02
Mean of outcome, richer	0.43	0.37	0.07	0.02
Observations	16,750	16,750	16,750	16,750

Notes: Each column is a separate linear probability model with household, wave and interview-month fixed effects and temperature controls. Each shock is interacted with an indicator for richer households (top two quintiles of the wave-1 wealth index). Any informal lender includes social networks (friends, relatives and employers), moneylenders and shopkeepers. Flood effects are per one standard deviation in the share flooded. Standard errors clustered by village in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

7.2 Prior religious contributions and informal credit

If contributions build a reputation with lenders, past contributors should find it easier to borrow after a drought. To examine this, I estimate equation (5.2) with X_h replaced by $r_{h,s-1}$, an indicator equal to one if the household contributed time or money to religious infrastructure in the previous survey wave. Since $r_{h,s-1}$ changes across waves, I include its main effect, and since it requires a previous wave, the sample covers waves 2 and 3. The interaction terms allow the borrowing response to drought to differ between households that previously made such contributions and those that did not. The outcomes are indicators equal to one if the household borrowed from a social network (friends, relatives or employers), a moneylender or a shopkeeper.

Panel A of Table 9 reports the results. The estimates indicate that prior religious contributions are associated with a differential borrowing response to drought. Among households that did not contribute in the previous wave, a drought reduces borrowing from moneylenders by 7.0 percentage points in the drought year. In contrast, households with prior contributions show a stronger borrowing response. The interaction estimate implies an increase of 8.4 percentage points relative to non-contributors, so past contributors do not lose access to moneylenders. Non-contributors instead turn to shopkeepers. Borrowing from social networks does not differ between the two groups.

These results are similar when I compare households within the same division and wave (Appendix Table B18). A concern is that past contributors differ from non-contributors in ways that also affect their access to credit after a drought. Contributors are on average richer, and richer households have more collateral and may borrow differently when a drought arrives. Contributors may also have borrowed before and already have ties with lenders. To address this, I allow the response to drought to differ by wave-1 wealth (top two quintiles) and by whether the household borrowed in wave 1 (Appendix Table B19). The premium for past contributors is essentially unchanged: 8.5 percentage points, and 7.9 percentage points within divisions and waves.

My findings imply that while drought reduces access to moneylenders 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 contributions to religious institution may improve a household's reputation or trustworthiness within village. Moneylenders may directly observe these contributions, may themselves be members of the mosque or temple committees, or may rely on information from committee members when evaluating potential borrowers. Thus, such visible contributions can strengthen a household's reputation and improve access to informal credit during lean season post drought.

Panel B Table 9 separates this channel from religion as a club good. If past contributors borrow more because they belong to a religious community whose members insure one another, membership in a religious group should bring the same benefits. It does not.

Table 9: Past Contributiors and Religious Group Members after a Drought

	Borrowed from (=1)			Received any charity (=1)
	Social network	Moneylender	Shopkeeper	
	(1)	(2)	(3)	(4)
A. Contributed to religious infrastructure in the previous wave				
Past donor	−0.021	−0.021	0.005	0.020
	(0.022)	(0.018)	(0.004)	(0.014)
Drought, this monsoon	−0.020	−0.070**	0.013***	0.053**
	(0.039)	(0.030)	(0.005)	(0.026)
× Past donor	0.048	0.084***	−0.012**	−0.044
	(0.040)	(0.031)	(0.006)	(0.028)
Drought, last monsoon	0.074**	0.003	0.007	0.000
	(0.033)	(0.026)	(0.005)	(0.023)
× Past donor	−0.029	0.034	−0.002	−0.024
	(0.032)	(0.026)	(0.006)	(0.023)
Mean of outcome	0.36	0.12	0.01	0.05
Observations	9,074	9,074	9,074	9,074
B. Member of a religious group in the previous wave				
Group member	0.014	−0.033	0.000	−0.014
	(0.035)	(0.023)	(0.005)	(0.015)
Drought, this monsoon	0.028	−0.008	0.003	0.004
	(0.023)	(0.016)	(0.004)	(0.021)
× Group member	−0.073	0.037	0.005	0.090**
	(0.047)	(0.032)	(0.006)	(0.037)
Drought, last monsoon	0.054**	0.014	0.006*	−0.012
	(0.026)	(0.019)	(0.004)	(0.018)
× Group member	−0.095	0.040	0.006	0.079***
	(0.062)	(0.030)	(0.009)	(0.030)
Mean of outcome	0.36	0.12	0.01	0.05
Observations	9,074	9,074	9,074	9,074

Notes: Each column is a separate linear probability model with household, wave and interview-month fixed effects and controls for temperature and floods (per one standard deviation in the share flooded) in this and the last monsoon. Panel A interacts drought with contributing to religious infrastructure in the previous wave; Panel B with membership in a religious group in the previous wave. The drought rows give the effect for households without that status, and the "×" rows the difference. Since both measures come from the previous wave, the sample is waves 2 and 3. Social networks include friends, relatives and employers. Standard errors clustered by village in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Households in which a member belonged to a religious group in the previous wave are 9.0 percentage points more likely to receive charity in the drought year and 7.9 percentage points more likely a year later, but they do not borrow more from moneylenders, shopkeepers or social networks. Past contributors, on the other hand, do not receive more charity after a drought (Panel A, column 4). Group membership therefore brings help from others, as club-good models predict, while contributions to religious infrastructure bring access to credit from lenders.

8 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 standard errors following Conley (1999). This approach allows for correlation in regression residuals across villages within a given distance of each other in the same wave, as well as correlation within a village across waves. I compute distances between villages from the household geographic coordinates and use a Bartlett kernel with cutoffs of 50, 150 and 300 kilometers. Controls and fixed effects are the same as in the main specification. The main estimates remain statistically significant (Appendix Tables B20 and B21). In particular, a drought continues to increase contributions to religious infrastructure at every cutoff, at the 5 percent level in the drought year and at the 1 percent level a year later. The decline in men's early-morning religious activity in the drought year is less precise and is significant at the 10 percent level. The difference between poorer and richer households is fully robust: at every cutoff, the drought-year gap in religious contributions remains significant at the 1 percent level, and the gap in men's early-morning religious activity at the 5 percent level. These results suggest that the main findings are robust to allowing for spatial correlation in the error terms.

In the main specification, I defined drought using an indicator for rainfall at least one standard deviation 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, and my drought indicator corresponds to the two driest bins. I then estimate my baseline specification by replacing the drought indicators with this set of bins, for this monsoon and the last, while keeping the share flooded as a control. Rather than imposing a single threshold, this approach allows the effects of rainfall shocks to vary flexibly across different levels of deviation. Appendix Figure B4 reports the results.

The results broadly follow the patterns observed with my main specification. Religious contributions increase in severe and extreme drought realizations, by 7.2 and 19.6 percentage points in the drought year and by 9.8 and 19.0 percentage points a year later, while moderate drought has a small effect. The response therefore rises with the severity of the drought, and it is concentrated in the bins that my drought indicator captures. Early-morning religious activity falls in the driest bins. For the main male member, the decline is 5.3 percentage points under extreme drought. For the main female member, it is 9.5, 6.7 and 4.1 percentage points under extreme, severe and moderate drought. Secular contributions do not respond to any drought bin.

As an additional robustness check, I restrict the sample to the 4,544 households observed in all three survey waves and re-estimate the main specification using a balanced panel (Appendix Tables B22 and B23). The direction of the estimated coefficients remains unchanged, and their magnitudes are very close to those in the full sample. A drought raises contributions to religious infrastructure by 8.3 percentage points in the drought year and 8.9 percentage points a year later, and it lowers men's early-morning religious activity by 3.2 percentage points. The difference between poorer and richer households also holds: poorer households are 11.8 percentage points more likely to contribute in the

drought year, and the difference for richer households is −8.8 percentage points.

9 Conclusion

In this paper, I explore how rural households use religion to respond to economic uncertainty created by monsoon shocks. I test a model in which households choose contributions to public religious institutions, contributions to secular public goods and private devotion after a monsoon shock. I distinguish between two kinds of shocks. A drought is idiosyncratic in its impact: it falls mainly on poorer, wage-dependent households and leaves richer households, who are able to lend, largely unaffected. A flood is an aggregate shock that reduces resources for every household in the village. The model compares three cases. Without any reputation or spiritual insurance return to religious acts, a drought lowers all three choices of poorer households. If contributions to religious institutions can build a reputation with village lenders, a drought raises poorer households' contributions while lowering their secular contributions and private devotion, and leaves richer households unchanged. If religious acts are spiritual insurance, contributions and private devotion move together.

I first show that the two shocks affect households in the way the model assumes. A drought does not reduce average earnings, but it acts through the labor market. Agricultural wages and days of wage work fall, and households that depend on agricultural day labor lose earnings while other households do not. Floods instead reduce harvests, non-food spending and cash at hand across the village. Households respond to a drought by borrowing more and drawing down their grain stocks.

The central question of my paper is how these different types of weather shocks affect the religious behavior of households and how they utilize religion to adapt to these shocks. I find that a drought has positive effects on household contributions to religious infrastructure like mosques and temples. This response comes from poorer households, while richer households do not change their contributions in the drought year. Importantly, this pattern does not appear to be driven by an increase in intrinsic religiosity. In the year when poorer households give more to religious institutions, they are

less likely to engage in religious activities in the early morning, which are largely private, and their contributions to secular public goods do not change. These results reject my benchmark and spiritual insurance as explanations for the response to droughts, and fit the reputation case of my model. My findings provide suggestive evidence that this particular visible act of voluntary contribution to public religious institution serves as a social signal to local elites and moneylenders, establishing the reputation needed to secure informal credit during lean season. A year after a drought, poorer households are more likely to borrow from moneylenders. Households that previously contributed to religious infrastructure keep their access to moneylenders after a drought, while households that did not contribute lose it, and this premium is not explained by wealth or past borrowing. Members of religious groups, in contrast, receive more charity but not more credit, which separates the reputation channel from religion as a club good. Floods fit no case of the model fully. Religious contributions do not fall after a flood, consistent with my finding that informal lenders are still able to lend.

There are several limitations to my study. Firstly, I am uncertain about the external validity of my study. My model describes a rural agricultural economy in which droughts act through the market for agricultural labor and fall mainly on wage-dependent households, as documented in South Asia (Jayachandran 2006; Kaur 2019), and in which religious institutions are funded by the villagers themselves. While these results are plausible in the context of Bangladesh, religious infrastructure may function differently in other economies, and therefore have different weather shock responses. However, I expect my results to hold in similar agrarian settings, particularly Muslim-dominated ones, where community mosques are built and maintained by the voluntary contributions of the community members. Secondly, assuming that rainfall shocks are plausibly exogenous, the effects I find on household economic outcomes, borrowing and religious contributions can be interpreted as causal, but the mechanism linking religious infrastructure contributions to informal credit cannot be observed directly. Past contribution status is not randomly assigned, and although the credit premium for past contributors is not explained by wealth or past borrowing, other characteristics such as social ties to

lenders may also play a role. Thirdly, much of the variation in drought in the year of the shock comes from the widespread drought of 2018. When I compare households within the same division and wave, the average drought-year effects are smaller, although the difference between poorer and richer households remains. Fourthly my available measure of contribution to the construction or maintenance of religious infrastructure records only whether a household contributed and does not distinguish between monetary and time donations, and my measure of private devotion relies on a single 24-hour time diary. Few households contribute to secular public goods at all, which limits my ability to detect a fall in these contributions. Lastly, my analysis focuses on rainfall variability during the monsoon season. This choice is motivated by the fact that the monsoon accounts for the majority of annual precipitation and rural livelihoods are directly tied to it. My fixed effects specification absorbs 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 weather shocks and household adaptation by distinguishing between droughts and floods and showing how religious responses vary by shock type. My paper also contributes to the literature on the economics of religion by distinguishing between private devotional behavior and publicly observable religious contribution and by showing that different religious activities respond differently to weather shocks. I extend the framework of Auriol et al. (2020), in which religious giving insures households either through the community or through God, by allowing its return to depend on the type of shock and on whether village lenders are still able to lend. In this setting, I also find support for the club-good view of religion (Iannaccone 1992): members of religious groups receive more charity after a drought. Contributions to religious infrastructure, however, are associated with access to credit rather than charity, which points to a separate credit channel. Lastly, my paper adds to the growing literature on risk sharing by providing suggestive evidence that investing in public religious institutions can serve as a signal to influential members of the society and can help to get access to informal credit. My findings highlight

how community-based religious institutions can function as important nodes within informal risk sharing networks in environments where informal markets still dominate. More broadly, the implications of religion go beyond faith. Religious activities can be strategic economic decisions that shape outcomes economists study closely, such as access to credit and the ability to smooth consumption after a shock. My paper therefore points to the importance of studying religious behavior as a mainstream microeconomic choice.

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Appendix A

A Model of Religious Contribution under Monsoon Shocks

In this appendix, I prove the results in Section 2. I solve for each type separately. Throughout, let $\pi = \pi_\theta^\omega$, $Y = Y_\theta^\omega$ and $\Delta = \Delta_\theta$ for the type and monsoon state under study. c_g is consumption in a good lean season and c_b is consumption in a bad lean season. All functions are increasing, concave and thrice continuously differentiable, and solutions are interior.

A.1 Case 1: No reputation and no spiritual insurance

A household of type θ in monsoon state ω chooses d, g_R and g_S to maximize

$$(1-\pi)\,U(\underbrace{Y - g_R - g_S - pd}_{c_g}) + \pi\,U(\underbrace{Y - g_R - g_S - pd - \Delta}_{c_b}) + v_d(d) + v_R(g_R) + v_S(g_S).$$

For H-types in a normal year or a drought, $\Delta = 0$, so $c_b = c_g$.

First-order conditions. For religious contributions,

$$\begin{aligned}
[g_R]: \quad & (1-\pi)\,\frac{\partial U}{\partial c_g}\cdot\frac{\partial c_g}{\partial g_R} + \pi\,\frac{\partial U}{\partial c_b}\cdot\frac{\partial c_b}{\partial g_R} + v_R'(g_R) = 0 \\
\Rightarrow \quad & (1-\pi)\,U'(c_g)\,[-1] + \pi\,U'(c_b)\,[-1] + v_R'(g_R) = 0 \\
\Rightarrow \quad & v_R'(g_R) = (1-\pi)\,U'(c_g) + \pi\,U'(c_b).
\end{aligned}$$

Similarly, for secular contributions,

$$[g_S]: \quad v_S'(g_S) = (1-\pi)\,U'(c_g) + \pi\,U'(c_b).$$

and for private devotion,

$$\begin{aligned}[d]: \quad & (1-\pi)\,U'(c_g)\,[-p] + \pi\,U'(c_b)\,[-p] + v_d'(d) = 0 \\ \Rightarrow \quad & \tfrac{1}{p}\,v_d'(d) = (1-\pi)\,U'(c_g) + \pi\,U'(c_b).\end{aligned}$$

Now, the expected marginal utility of consumption is

$$M \equiv (1-\pi)\,U'(c_g) + \pi\,U'(c_b) > 0.$$

So the first-order conditions are

$$v_R'(g_R) = M, \qquad v_S'(g_S) = M, \qquad v_d'(d) = p\,M. \tag{A.1}$$

Each activity is chosen so that its marginal benefit equals the expected marginal utility of consumption given up. Here, the monsoon state affects contributions and devotion only through M.

Second-order condition. The objective function is a sum of concave functions, so the objective function is also concave. So the first-order conditions give us the maximum.

Lemma 1. *Each choice is a decreasing function of M.*

Proof. From (A.1), $v_R'(g_R(M)) = M$. Differentiating both sides with respect to M, I get

$$\begin{aligned} & \frac{dv_R'}{dg_R} \cdot \frac{dg_R}{dM} = 1 \\ \Rightarrow \quad & v_R''\big(g_R(M)\big)\,g_R'(M) = 1 \\ \Rightarrow \quad & g_R'(M) = \frac{1}{v_R''\big(g_R(M)\big)} < 0, \end{aligned}$$

since $v_R(\cdot)$ is a concave function, so $v_R'(\cdot) > 0$ and $v_R''(\cdot) < 0$. Similarly, I can show that

$$g_S'(M) = \frac{1}{v_S''\big(g_S(M)\big)} < 0 \qquad \text{and} \qquad d'(M) = \frac{p}{v_d''\big(d(M)\big)} < 0. \qquad \square$$

Lemma 2. *M falls when resources Y increase and does not fall when the probability of loss π rises:*

$$\frac{dM}{dY} < 0, \qquad \frac{dM}{d\pi} \geq 0,$$

with $dM/d\pi > 0$ when $\Delta > 0$.

Proof. Total spending on contributions and devotion is

$$E(M) \equiv g_R(M) + g_S(M) + p\, d(M),$$

and $E'(M) < 0$ by Lemma 1. So $c_g = Y - E(M)$ and $c_b = Y - E(M) - \Delta$. From the definition of expected marginal utility,

$$\begin{aligned}
& M = (1-\pi)\, U'(c_g) + \pi\, U'(c_b) \\
\Rightarrow \quad & M = (1-\pi)\, U'\big(Y - E(M)\big) + \pi\, U'\big(Y - E(M) - \Delta\big) \\
\Rightarrow \quad & \Phi(M; Y, \pi) \equiv (1-\pi)\, U'\big(Y - E(M)\big) + \pi\, U'\big(Y - E(M) - \Delta\big) - M = 0.
\end{aligned}$$

So M is a function of the parameters Y and π, and I can use the implicit function theorem to find $dM/d\pi$ and dM/dY:

$$\frac{dM}{d\pi} = -\frac{\partial\Phi/\partial\pi}{\partial\Phi/\partial M}, \qquad \frac{dM}{dY} = -\frac{\partial\Phi/\partial Y}{\partial\Phi/\partial M}.$$

The denominator is

$$\begin{aligned}
\frac{\partial\Phi}{\partial M} &= (1-\pi)\, U''(c_g)\big(-E'(M)\big) + \pi\, U''(c_b)\big(-E'(M)\big) - 1 \\
&= \underbrace{-E'(M)}_{(+)}\ \underbrace{\big[(1-\pi)\, U''(c_g) + \pi\, U''(c_b)\big]}_{(-)} - 1 < 0,
\end{aligned}$$

since $E'(M) < 0$ and $U''(\cdot) < 0$. For risk,

$$\frac{\partial\Phi}{\partial\pi} = U'(c_b) - U'(c_g) \geq 0,$$

since $c_b = c_g - \Delta \leq c_g$, so $U'(c_g) \leq U'(c_b)$, with strict inequality when $\Delta > 0$. So,

$$\frac{dM}{d\pi} = -\frac{\partial\Phi/\partial\pi}{\partial\Phi/\partial M} = -\frac{(\geq 0)}{(-)} \geq 0.$$

Similarly,

$$\frac{\partial\Phi}{\partial Y} = (1-\pi)\,U''(c_g) + \pi\,U''(c_b) < 0, \qquad \text{so} \qquad \frac{dM}{dY} = -\frac{\partial\Phi/\partial Y}{\partial\Phi/\partial M} = -\frac{(-)}{(-)} < 0. \quad \square$$

Proof of Proposition 1. The effect of resources on religious contributions is

$$\frac{dg_R}{dY} = \frac{dg_R(M)}{dM} \cdot \frac{dM}{dY} = \underbrace{g_R'(M)}_{(-)}\,\underbrace{\frac{dM}{dY}}_{(-)} > 0$$

from Lemmas 1 and 2. The effect of risk on religious contributions is

$$\frac{dg_R}{d\pi} = \underbrace{g_R'(M)}_{(-)}\,\underbrace{\frac{dM}{d\pi}}_{(\geq 0)} \leq 0.$$

Similarly, I can show that

$$\frac{dg_S}{dY} > 0, \qquad \frac{dg_S}{d\pi} \leq 0, \qquad \frac{dd}{dY} > 0, \qquad \frac{dd}{d\pi} \leq 0.$$

Now, the monsoon states differ only in (Y, π). Since M is decreasing in Y and increasing in π, a state with lower Y and higher π has a higher M, so g_R, g_S and d are lower.

(a) For an L-type in a drought, $Y_L^D < Y_L^N$ and $\pi_L^D > \pi_L^N$ by (2.2). So $M_L^D > M_L^N$, which implies

$$g_R^{L*}(D) < g_R^{L*}(N), \qquad g_S^{L*}(D) < g_S^{L*}(N), \qquad d^{L*}(D) < d^{L*}(N).$$

(b) For an H-type, $Y_H^D = Y_H^N$ and $\pi_H^D = \pi_H^N = 0$ by (2.2). So c_b plays no role in the H-type's objective function, which becomes $U(c_g) + v_d(d) + v_R(g_R) + v_S(g_S)$ in both the normal and the drought state. So the optimal choices in both states are identical.

(c) For both types in a flood, $Y_\theta^F < Y_\theta^N$ and $\pi_\theta^F \geq \pi_\theta^N$ by (2.3). So $M_\theta^F > M_\theta^N$, and by Lemma 1 all three choices are lower in the flood state. □

A.2 Case 2: Reputation-building incentive

For an L-type, the three lean-season outcomes are

$$\begin{aligned} c_g &= Y - g_R - g_S - pd && \text{with probability } 1-\pi, \\ c_b &= c_g - \Delta && \text{with probability } \pi\big[1-\lambda q(g_R)\big], \\ c_B &= c_b + B && \text{with probability } \pi\lambda q(g_R), \end{aligned}$$

and $c_b < c_B \leq c_g$ since $B \leq \Delta$. The L-type maximizes (2.6). Here,

$$M \equiv (1-\pi)\,U'(c_g) + \pi\big[\lambda q(g_R)\,U'(c_B) + \big(1-\lambda q(g_R)\big)\,U'(c_b)\big],$$

and Γ is the additional utility from the loan,

$$\Gamma \equiv U(c_B) - U(c_b) = U(c_b+B) - U(c_b) > 0.$$

First-order conditions. For religious contributions,

$$\begin{aligned} [g_R]: \quad 0 &= (1-\pi)\,U'(c_g)(-1) + \pi\lambda\big[q'(g_R)\,U(c_B) + q(g_R)\,U'(c_B)(-1)\big] \\ &\quad - \pi\lambda\big[q'(g_R)\,U(c_b) + U'(c_b)\,q(g_R)(-1)\big] + \pi\,U'(c_b)(-1) + v_R'(g_R). \end{aligned}$$

So,

$$\begin{aligned} & v_R'(g_R) = (1-\pi)\,U'(c_g) + \pi\lambda q(g_R)\,U'(c_B) - \pi\lambda q(g_R)\,U'(c_b) \\ &\qquad + \pi\,U'(c_b) - \pi\lambda q'(g_R)\big[U(c_B) - U(c_b)\big] \\ \Rightarrow \quad & v_R'(g_R) = (1-\pi)\,U'(c_g) \\ &\qquad + \pi\big[\lambda q(g_R)\,U'(c_B) - \lambda q(g_R)\,U'(c_b) + U'(c_b)\big] - \pi\lambda q'(g_R)\,\Gamma \\ \Rightarrow \quad & v_R'(g_R) + \pi\lambda q'(g_R)\,\Gamma = (1-\pi)\,U'(c_g) \end{aligned}$$

$$+\,\pi\big[\lambda q(g_R)\,U'(c_B)+\big(1-\lambda q(g_R)\big)\,U'(c_b)\big]$$
$$\Rightarrow\quad v_R'(g_R)+\pi\lambda q'(g_R)\,\Gamma=M.$$

Secular contributions and private devotion do not change the probability of getting a loan, so I get

$$[g_S]:\quad v_S'(g_S)=M,\qquad [d]:\quad v_d'(d)=p\,M.$$

This gives the first-order conditions in (2.7).

Lemma 3. *The value of a loan Γ is decreasing in bad-season consumption c_b.*

Proof.

$$\Gamma=U(c_b+B)-U(c_b)$$
$$\Rightarrow\quad \frac{\partial\Gamma}{\partial c_b}=U'(c_b+B)-U'(c_b)<0.$$

Since $U(\cdot)$ is concave, $U'(\cdot)$ is decreasing, so $U'(c_b+B)<U'(c_b)$. □

The objective as a function of religious contributions. Let $W(g_R)$ be the L-type's objective (2.6) as a function of g_R alone, where I hold g_S and d fixed at their optimal levels. From the first-order condition, $dW/dg_R=0$, so

$$W'(g_R)=v_R'(g_R)+\pi\lambda q'(g_R)\,\Gamma-M=0. \tag{A.2}$$

Second-order condition. Differentiating (A.2) with respect to g_R and collecting terms,

$$W''(g_R)=\underbrace{v_R''(g_R)}_{(-)}+\underbrace{\pi\lambda q''(g_R)\,\Gamma}_{(-)}$$
$$+\underbrace{(1-\pi)\,U''(c_g)+\pi\big[\lambda q(g_R)\,U''(c_B)+\big(1-\lambda q(g_R)\big)\,U''(c_b)\big]}_{(-)}$$
$$+\underbrace{2\pi\lambda q'(g_R)\big[U'(c_b)-U'(c_B)\big]}_{(+)},$$

by the concavity of v_R, q and U. So I assume the following.

Assumption 1. *$W''(g_R^*) < 0$ at the optimum, for all parameter values considered.*

This holds when v_R, q and U are concave enough. By the implicit function theorem, for any parameter z,

$$\frac{dg_R^*}{dz} = -\frac{\partial W'(g_R)/\partial z}{\partial W'(g_R)/\partial g_R} = -\frac{\partial W'(g_R)/\partial z}{W''(g_R^*)},$$

so the sign of dg_R^*/dz is the sign of $\partial W'(g_R)/\partial z$.

Lemma 4. *Religious contributions rise with the probability of a bad season if and only if the reputation effect is larger than the income effect:*

$$\frac{dg_R^*}{d\pi} > 0 \iff \underbrace{\lambda q'(g_R^*)\,\Gamma}_{\text{reputation effect}} > \underbrace{\lambda q(g_R)\,U'(c_B) + \big[1-\lambda q(g_R)\big]\,U'(c_b) - U'(c_g)}_{\text{income effect}}.$$

Proof. First, the income effect is positive. Since $c_g \geq c_B > c_b$ and $U'(\cdot)$ is decreasing, $U'(c_g) \leq U'(c_B) < U'(c_b)$, so the weighted average $\lambda q(g_R)\,U'(c_B) + [1-\lambda q(g_R)]\,U'(c_b)$ is larger than $U'(c_g)$. Consumption does not depend on π, so

$$\begin{aligned}
\frac{\partial M}{\partial \pi} &= \lambda q(g_R)\,U'(c_B) + \big(1-\lambda q(g_R)\big)\,U'(c_b) - U'(c_g) > 0,\\
\frac{\partial W'(g_R)}{\partial \pi} &= \lambda q'(g_R)\,\Gamma - \Big[\lambda q(g_R)\,U'(c_B) + \big(1-\lambda q(g_R)\big)\,U'(c_b) - U'(c_g)\Big].
\end{aligned}$$

By the implicit function theorem,

$$\begin{aligned}
\frac{dg_R^*}{d\pi} &= -\frac{\partial W'(g_R)/\partial \pi}{\partial W'(g_R)/\partial g_R}\\
&= -\frac{\lambda q'(g_R)\,\Gamma - \Big[\lambda q(g_R)\,U'(c_B) + \big(1-\lambda q(g_R)\big)\,U'(c_b) - U'(c_g)\Big]}{\underbrace{W''(g_R^*)}_{(-)}},
\end{aligned}$$

where $W''(g_R^*) < 0$ by Assumption 1. So the sign of $dg_R^*/d\pi$ depends on the reputation effect minus the income effect, and $dg_R^*/d\pi > 0$ if and only if the reputation effect is larger. □

So a higher chance of a bad season has two effects on religious contributions. It makes consumption more valuable (the income effect). It also makes reputation more valuable.

Religious contributions rise for L-types if the reputation effect is larger than the income effect.

Lemma 5. *Religious contributions rise as resources fall if and only if the need effect is larger than the income effect:*

$$\frac{dg_R^*}{dY} < 0 \iff \underbrace{\pi\lambda q'(g_R)\big[U'(c_b) - U'(c_B)\big]}_{need\ effect} > \underbrace{-\Big[(1-\pi)\,U''(c_g) + \pi\big(\lambda q(g_R)\,U''(c_B) + \big(1-\lambda q(g_R)\big)\,U''(c_b)\big)\Big]}_{income\ effect}.$$

If $\lambda = 0$, the need effect is zero and $dg_R^*/dY > 0$, as in Case 1.

Proof. From Assumption 1, $W''(g_R) < 0$, so I need to find $\partial W'(g_R)/\partial Y$. All three consumption levels rise one-for-one with Y. So,

$$\begin{aligned}
\frac{\partial M}{\partial Y} &= (1-\pi)\,U''(c_g) + \pi\big[\lambda q(g_R)\,U''(c_B) + \big(1-\lambda q(g_R)\big)\,U''(c_b)\big] < 0,\\
\frac{\partial \Gamma}{\partial Y} &= U'(c_B) - U'(c_b) < 0,\\
\frac{\partial W'(g_R)}{\partial Y} &= \pi\lambda q'(g_R)\,\frac{\partial \Gamma}{\partial Y} - \frac{\partial M}{\partial Y}\\
&= \pi\lambda q'(g_R)\big[U'(c_B) - U'(c_b)\big]\\
&\quad - \Big[(1-\pi)\,U''(c_g) + \pi\big(\lambda q(g_R)\,U''(c_B) + \big(1-\lambda q(g_R)\big)\,U''(c_b)\big)\Big]\\
&= -\pi\lambda q'(g_R)\big[U'(c_b) - U'(c_B)\big]\\
&\quad - \Big[(1-\pi)\,U''(c_g) + \pi\big(\lambda q(g_R)\,U''(c_B) + \big(1-\lambda q(g_R)\big)\,U''(c_b)\big)\Big].
\end{aligned}$$

So $\partial W'(g_R)/\partial Y < 0$ if the need effect is larger than the income effect. By the implicit function theorem,

$$\frac{dg_R^*}{dY} = -\frac{\partial W'(g_R)/\partial Y}{\partial W'(g_R)/\partial g_R} = -\frac{\partial W'(g_R)/\partial Y}{\underbrace{\partial W'(g_R)/\partial g_R}_{(-)}},$$

which is negative if and only if the need effect is larger than the income effect. If $\lambda = 0$, the need effect is zero and $\partial W'(g_R)/\partial Y = -[(1-\pi)\,U''(c_g) + \pi\,U''(c_b)] > 0$, so $dg_R^*/dY > 0$. □

Religious contributions are a normal good without reputation, so poorer households contribute less. But with the reputation incentive, reputation is worth more to poorer households, since a loan is worth more to them (Lemma 3). If the need effect dominates, poorer households contribute more to religious institutions.

Lemma 6. *Religious contributions are higher when lenders can lend more:*

$$\frac{dg_R^*}{d\lambda} > 0.$$

Proof. From Assumption 1, $W''(g_R) < 0$. Now,

$$\begin{aligned}
\frac{\partial M}{\partial \lambda} &= \pi q(g_R)\, U'(c_B) - \pi q(g_R)\, U'(c_b) \\
&= \pi q(g_R)\big[U'(c_B) - U'(c_b)\big] < 0, \\
\frac{\partial W'(g_R)}{\partial \lambda} &= \pi q'(g_R)\, \Gamma - \pi q(g_R)\big[U'(c_B) - U'(c_b)\big] > 0.
\end{aligned}$$

By the implicit function theorem,

$$\frac{dg_R^*}{d\lambda} = -\frac{\partial W'(g_R)/\partial \lambda}{\partial W'(g_R)/\partial g_R} = -\frac{(+)}{(-)} > 0. \qquad \square$$

Secular contributions and devotion. These two choices satisfy $v_S'(g_S) = M$ and $v_d'(d) = pM$, so by Lemma 1 each one falls when M rises. Holding g_R fixed, I showed above that $\partial M/\partial \pi > 0$, that $\partial M/\partial Y < 0$, and that $\partial M/\partial \lambda < 0$. So secular contributions and private devotion fall when risk rises, when resources fall and when lenders' capacity falls.

Proof of Proposition 2. While moving from N to D, λ does not change, since $\lambda(N) = \lambda(D) = \bar{\lambda}$.

Step 1. I raise π from π_L^N to π_L^D while holding $Y = Y_L^N$. Under condition (C1), $dg_R^*/d\pi > 0$ at every π along the way (Lemma 4). So g_R^* rises by some positive amount G.

Step 2. Now I lower Y from Y_L^N to Y_L^D while holding $\pi = \pi_L^D$. Under condition

(C2), $dg_R^*/dY < 0$ (Lemma 5), so lowering Y raises g_R^* again. If (C2) does not hold, g_R^* may fall in this step. But dg_R^*/dY is bounded, so the fall shrinks to zero as $Y_L^N - Y_L^D$ shrinks. This follows from my assumptions that U, v_R and q are thrice continuously differentiable, the optimum is an interior solution, and $W''(g_R) < 0$ (Assumption 1). Then $dg_R^*/dY = -(\partial W'/\partial Y)/W''$ is continuous on the closed interval $[Y_L^D, Y_L^N]$, so it is bounded, $|dg_R^*/dY| \leq K$ for some K. By the mean value theorem, the fall in g_R^* in this step is at most $K\,(Y_L^N - Y_L^D)$.

If (C2) holds, both steps raise g_R^*. If (C2) does not hold, the total change is at least $G - K\,(Y_L^N - Y_L^D)$, which is positive when $Y_L^N - Y_L^D < G/K$. So when the fall in resources is small enough, the rise in Step 1 outweighs Step 2. This proves part (a).

For part (b), a drought raises π_L and lowers Y_L, and both raise M. So, holding religious contributions fixed, secular contributions and private devotion fall. Since the H-types' problem is the same as in Case 1, Proposition 1(b) applies. □

Proof of Proposition 3. In a flood, $Y_L^F < Y_L^N$, $\pi_L^F \geq \pi_L^N$ and $\lambda(F) < \bar{\lambda}$. Holding g_S and d fixed, I move from N to F in three steps.

Step 1. I lower λ from $\bar{\lambda}$ to $\lambda(F)$ at $Y = Y_L^N$ and $\pi = \pi_L^N$. By Lemma 6, $dg_R^*/d\lambda > 0$. So g_R^* strictly falls.

Step 2. Now I lower Y from Y_L^N to Y_L^F at $\lambda = \lambda(F)$ and $\pi = \pi_L^N$. By Lemma 5, g_R^* falls if (C2) does not hold, that is, if

$$\begin{aligned}&\pi\lambda(F)\,q'(g_R)\big[U'(c_b) - U'(c_B)\big]\\ &\quad< -\Big[(1-\pi)\,U''(c_g) + \pi\big(\lambda(F)q(g_R)\,U''(c_B) + \big(1 - \lambda(F)q(g_R)\big)\,U''(c_b)\big)\Big].\end{aligned}$$

So g_R^* falls if the need effect is smaller than the income effect.

Step 3. Now I raise π from π_L^N to π_L^F at $\lambda = \lambda(F)$ and $Y = Y_L^F$. By Lemma 4, g_R^* falls if (C1) does not hold, that is, if

$$\lambda(F)\,q'(g_R)\,\Gamma < \lambda(F)q(g_R)\,U'(c_B) + \big[1 - \lambda(F)q(g_R)\big]\,U'(c_b) - U'(c_g).$$

So g_R^* falls if the reputation effect is smaller than the income effect.

A low enough $\lambda(F)$ makes the inequalities in both Step 2 and Step 3 hold. This is because the left-hand sides, the need effect and the reputation effect, are both proportional to $\lambda(F)$. They become zero at $\lambda(F) = 0$ and are very small when $\lambda(F)$ is small. The right-hand sides, the two income effects, on the other hand, are strictly positive and do not go to zero as $\lambda(F) \to 0$. At $\lambda(F) = 0$, they become equal to their values in Case 1, $-[(1-\pi)U''(c_g) + \pi U''(c_b)] > 0$ and $U'(c_b) - U'(c_g) > 0$. So, by continuity, there is a threshold $\hat{\lambda} > 0$ such that for every $\lambda(F) < \hat{\lambda}$, both inequalities hold along the entire path of Steps 2 and 3. Then all three steps lower g_R^*, and Step 1 is strict, so $g_R^{L*}(F) < g_R^{L*}(N)$.

Holding religious contributions fixed, all three changes raise M, so secular contributions and private devotion fall. Since the H-types' problem is the same as in Case 1, Proposition 1(c) applies. □

A.3 Case 3: Intrinsic religiosity as spiritual insurance

For an L-type, there are two lean-season outcomes:

$$\begin{aligned} c_g &= Y - g_R - g_S - pd = Y - g_S - a && \text{with probability } 1 - P, \\ c_b &= c_g - \Delta && \text{with probability } P = \pi\big[1 - s(a)\big], \end{aligned}$$

where $a = g_R + pd$. The L-type household maximizes (2.9). With $s \equiv 0$, this becomes Case 1. Here, let

$$M \equiv (1-P)\,U'(c_g) + P\,U'(c_b), \qquad \Omega \equiv U(c_g) - U(c_b) > 0.$$

First-order conditions. Since $P = \pi\big[1 - s(g_R + pd)\big]$,

$$\frac{\partial P}{\partial g_R} = -\pi s'(a), \qquad \frac{\partial P}{\partial d} = -\pi s'(a)\,p.$$

For religious contributions,

$$
\begin{aligned}
[g_R]: \quad & U'(c_g)(-1) - \frac{\partial P}{\partial g_R}\,U(c_g) + P\,U'(c_g) + P\,U'(c_b)(-1) + \frac{\partial P}{\partial g_R}\,U(c_b) + v'_R(g_R) = 0 \\
\Rightarrow \quad & -U'(c_g)(1-P) + \pi s'(a)\,U(c_g) - P\,U'(c_b) - \pi s'(a)\,U(c_b) + v'_R(g_R) = 0 \\
\Rightarrow \quad & v'_R(g_R) = P\,U'(c_b) + (1-P)\,U'(c_g) - \pi s'(a)\big[U(c_g) - U(c_b)\big] \\
\Rightarrow \quad & v'_R(g_R) = M - \pi s'(a)\,\Omega.
\end{aligned}
$$

For private devotion,

$$
\begin{aligned}
[d]: \quad & (1-P)\,U'(c_g)(-p) - \frac{\partial P}{\partial d}\,U(c_g) + P\,U'(c_b)(-p) + \frac{\partial P}{\partial d}\,U(c_b) + v'_d(d) = 0 \\
\Rightarrow \quad & -p(1-P)\,U'(c_g) + \pi s'(a)\,p\,U(c_g) - pP\,U'(c_b) - \pi s'(a)\,p\,U(c_b) + v'_d(d) = 0 \\
\Rightarrow \quad & v'_d(d) = p\,M - p\,\pi s'(a)\,\Omega.
\end{aligned}
$$

For secular contributions, g_S does not enter a, so

$$[g_S]: \quad v'_S(g_S) = M.$$

I define the net marginal cost of a religious act as

$$\tilde{M} \equiv M - \pi s'(a)\,\Omega.$$

So the first-order conditions are

$$v'_R(g_R) = \tilde{M}, \qquad v'_d(d) = p\,\tilde{M}, \qquad v'_S(g_S) = M,$$

which are the first-order conditions in (2.10).

Lemma 7. *Religious contributions and private devotion are decreasing in the net marginal cost $\tilde{M}$, and secular contributions are decreasing in M.*

Proof. From the first-order conditions, $v'_R(g_R(\tilde{M})) = \tilde{M}$. Differentiating both sides with

respect to $\tilde{M}$, I get

$$\begin{aligned} & v_R''\big(g_R(\tilde{M})\big)\, g_R'(\tilde{M}) = 1 \\ \Rightarrow \quad & g_R'(\tilde{M}) = \frac{1}{v_R''\big(g_R(\tilde{M})\big)} < 0. \end{aligned}$$

Similarly, $v_d'(d(\tilde{M})) = p\tilde{M}$, so $v_d''\big(d(\tilde{M})\big)\, d'(\tilde{M}) = p$ and

$$d'(\tilde{M}) = \frac{p}{v_d''\big(d(\tilde{M})\big)} < 0.$$

For secular contributions, $v_S'(g_S) = M$, so the steps in Lemma 1 give $g_S'(M) = 1/v_S''\big(g_S(M)\big) < 0$. □

Proof of Proposition 4. From the first-order conditions, the monsoon state affects religious contributions and private devotion only through $\tilde{M}$. By Lemma 7, both are decreasing in $\tilde{M}$. So if a change in the monsoon state raises $\tilde{M}$, both fall. If it lowers $\tilde{M}$, both rise. If $\tilde{M}$ does not change, neither does. This holds for both types, each with its own Y, π and Δ. □

How the monsoon state moves $\tilde{M}$. As in Case 2, I hold secular contributions fixed when I study the religious activities, and hold the religious activities fixed when I study secular contributions. Total spending on religious activities is

$$a(\tilde{M}) \equiv g_R(\tilde{M}) + p\, d(\tilde{M}), \qquad a'(\tilde{M}) = \frac{1}{v_R''} + \frac{p^2}{v_d''} < 0.$$

With $c_g = Y - g_S - a(\tilde{M})$, $c_b = c_g - \Delta$ and $P = \pi\big[1 - s(a(\tilde{M}))\big]$, $\tilde{M}$ solves

$$\Phi_3(\tilde{M}; Y, \pi) \equiv M - \pi s'(a)\, \Omega - \tilde{M} = 0.$$

So $\tilde{M}$ is a function of Y and π, and by the implicit function theorem,

$$\frac{d\tilde{M}}{dz} = -\frac{\partial \Phi_3/\partial z}{\partial \Phi_3/\partial \tilde{M}}, \qquad z \in \{Y, \pi\}.$$

$\tilde{M}$ enters Φ_3 directly and through a, so

$$\frac{\partial \Phi_3}{\partial \tilde{M}} = a'(\tilde{M}) \cdot \frac{\partial \big[M - \pi s'(a)\,\Omega\big]}{\partial a} - 1.$$

Raising a lowers both consumption levels one-for-one and lowers P, with $\partial P/\partial a = -\pi s'(a)$. Since $M = U'(c_g) + P\big[U'(c_b) - U'(c_g)\big]$,

$$\begin{aligned}
\frac{\partial M}{\partial a} &= -(1-P)\,U''(c_g) - P\,U''(c_b) + \frac{\partial P}{\partial a}\big[U'(c_b) - U'(c_g)\big] \\
&= -\big[(1-P)\,U''(c_g) + P\,U''(c_b)\big] - \pi s'(a)\big[U'(c_b) - U'(c_g)\big], \\
\frac{\partial \Omega}{\partial a} &= -U'(c_g) + U'(c_b), \\
\frac{\partial \big[\pi s'(a)\,\Omega\big]}{\partial a} &= \pi s''(a)\,\Omega + \pi s'(a)\big[U'(c_b) - U'(c_g)\big], \\
\frac{\partial \big[M - \pi s'(a)\,\Omega\big]}{\partial a} &= -\big[(1-P)\,U''(c_g) + P\,U''(c_b)\big] - \pi s'(a)\big[U'(c_b) - U'(c_g)\big] \\
&\quad - \pi s''(a)\,\Omega - \pi s'(a)\big[U'(c_b) - U'(c_g)\big] \\
&= \underbrace{-\big[(1-P)\,U''(c_g) + P\,U''(c_b)\big]}_{(+)}\underbrace{-\pi s''(a)\,\Omega}_{(+)} \\
&\quad \underbrace{-2\pi s'(a)\big[U'(c_b) - U'(c_g)\big]}_{(-)}.
\end{aligned}$$

The first two terms are positive and the last one is negative, so I assume the following.

Assumption 2. $-\big[(1-P)\,U''(c_g) + P\,U''(c_b)\big] - \pi s''(a)\,\Omega - 2\pi s'(a)\big[U'(c_b) - U'(c_g)\big] > 0$ *at the optimum, for all parameter values considered.*

Under Assumption 2, $\partial \Phi_3/\partial \tilde{M} = (-)(+) - 1 < 0$. This holds when U and s are concave enough, and it plays the same role as Assumption 1 in Case 2.

Lemma 8. *More risk lowers $\tilde{M}$, and so raises both religious activities, if and only if the spiritual effect is larger than the income effect:*

$$\frac{d\tilde{M}}{d\pi} < 0 \iff s'(a)\,\Omega > \big[1 - s(a)\big]\big[U'(c_b) - U'(c_g)\big].$$

If $s \equiv 0$, then $d\tilde{M}/d\pi > 0$, as in Case 1.

Proof. Holding $\tilde{M}$ fixed, a and consumption are also fixed, and π enters only P and the spiritual payoff. Since $\partial P/\partial\pi = 1 - s(a)$ and $M = U'(c_g) + P\big[U'(c_b) - U'(c_g)\big]$,

$$\begin{aligned}
\frac{\partial M}{\partial \pi} &= \big[1 - s(a)\big]\big[U'(c_b) - U'(c_g)\big], \\
\frac{\partial\big[\pi s'(a)\,\Omega\big]}{\partial \pi} &= s'(a)\,\Omega, \\
\frac{\partial \Phi_3}{\partial \pi} &= \big[1 - s(a)\big]\big[U'(c_b) - U'(c_g)\big] - s'(a)\,\Omega.
\end{aligned}$$

By the implicit function theorem,

$$\frac{d\tilde{M}}{d\pi} = -\frac{\big[1 - s(a)\big]\big[U'(c_b) - U'(c_g)\big] - s'(a)\,\Omega}{\underbrace{\partial \Phi_3/\partial \tilde{M}}_{(-)}},$$

which is negative if and only if $[1 - s(a)]\big[U'(c_b) - U'(c_g)\big] - s'(a)\,\Omega < 0$. If $s \equiv 0$, then $\partial\Phi_3/\partial\pi = U'(c_b) - U'(c_g) > 0$ and $d\tilde{M}/d\pi > 0$. □

Lemma 9. *Fewer resources lower $\tilde{M}$, and so raise both religious activities, if and only if the need effect is larger than the income effect:*

$$\frac{d\tilde{M}}{dY} > 0 \iff \pi s'(a)\big[U'(c_b) - U'(c_g)\big] > -\big[(1 - P)\,U''(c_g) + P\,U''(c_b)\big].$$

If $s \equiv 0$, then $d\tilde{M}/dY < 0$, as in Case 1.

Proof. Holding $\tilde{M}$, a, P and g_S fixed, both consumption levels rise one-for-one with Y. So,

$$\begin{aligned}
\frac{\partial M}{\partial Y} &= (1 - P)\,U''(c_g) + P\,U''(c_b), \\
\frac{\partial \Omega}{\partial Y} &= U'(c_g) - U'(c_b) = -\big[U'(c_b) - U'(c_g)\big], \\
\frac{\partial \Phi_3}{\partial Y} &= (1 - P)\,U''(c_g) + P\,U''(c_b) - \Big(- \pi s'(a)\big[U'(c_b) - U'(c_g)\big]\Big) \\
&= (1 - P)\,U''(c_g) + P\,U''(c_b) + \pi s'(a)\big[U'(c_b) - U'(c_g)\big].
\end{aligned}$$

By the implicit function theorem,

$$\frac{d\tilde{M}}{dY} = -\frac{(1-P)\,U''(c_g) + P\,U''(c_b) + \pi s'(a)\big[U'(c_b) - U'(c_g)\big]}{\underbrace{\partial\Phi_3/\partial\tilde{M}}_{(-)}},$$

which is positive if and only if $(1-P)\,U''(c_g) + P\,U''(c_b) + \pi s'(a)\big[U'(c_b) - U'(c_g)\big] > 0$, that is, $\pi s'(a)\big[U'(c_b) - U'(c_g)\big] > -\big[(1-P)\,U''(c_g) + P\,U''(c_b)\big]$. If $s \equiv 0$, then $\partial\Phi_3/\partial Y = (1-\pi)\,U''(c_g) + \pi\,U''(c_b) < 0$ and $d\tilde{M}/dY < 0$. □

A poorer household suffers more from a bad season, since Ω is larger when consumption is lower. So removing part of the risk is worth more to a poorer household. This is similar to Lemma 5 in Case 2, where a loan is worth more to a poorer household.

Proof of Proposition 5. (a) I move from N to D in two steps.

Step 1. I raise π from π_L^N to π_L^D while holding $Y = Y_L^N$. Under (C3), $\tilde{M}$ falls by a positive amount (Lemma 8).

Step 2. Now I lower Y from Y_L^N to Y_L^D while holding $\pi = \pi_L^D$. Under (C4), $\tilde{M}$ falls again (Lemma 9). If (C4) does not hold, $\tilde{M}$ may rise. But by Assumption 2 and since all functions are thrice continuously differentiable, $d\tilde{M}/dY$ is continuous and bounded on $[Y_L^D, Y_L^N]$. So the rise is at most $K\,(Y_L^N - Y_L^D)$, and it cannot undo Step 1 when the fall in resources is small enough.

In both cases $\tilde{M}$ falls, so by Lemma 7, religious contributions and private devotion rise.

Holding religious activities fixed, secular contributions satisfy $v_S'(g_S) = M$. Since $\partial M/\partial\pi = [1 - s(a)]\big[U'(c_b) - U'(c_g)\big] > 0$ and $\partial M/\partial Y = (1-P)\,U''(c_g) + P\,U''(c_b) < 0$, a drought raises M, so secular contributions fall (Lemma 7).

For H-types, $Y_H^D = Y_H^N$ and $\pi_H^D = \pi_H^N = 0$. So nothing in the H-type's problem changes. With $\pi_H = 0$, the spiritual payoff $\pi_H s'(a)\,\Omega$ is zero in both states, so the H-type's choices do not change.

(b) For a type θ, a flood lowers Y_θ and weakly raises π_θ. If the flood raises the type's risk and the conditions in (a) hold for that type, the same two steps as in (a) show that

$\tilde{M}$ falls, so religious contributions and private devotion rise. Holding religious activities fixed, a flood raises M, so secular contributions fall. □

Appendix B

Appendix Figures and Tables

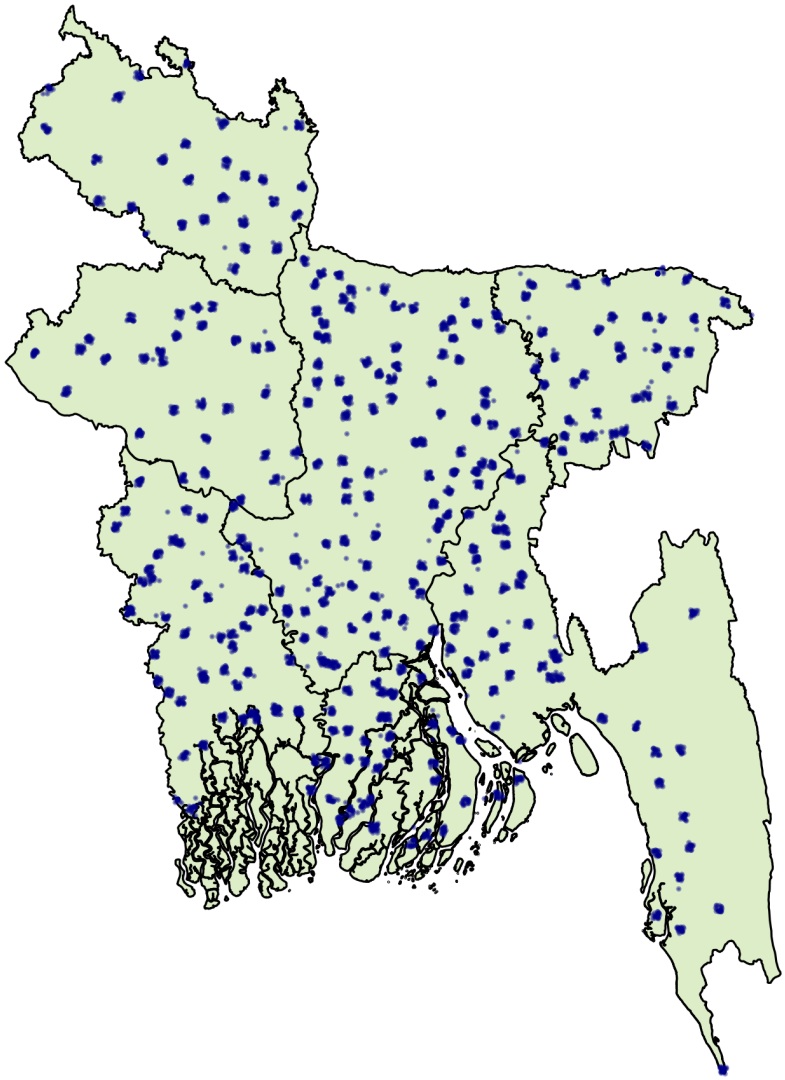


Figure B1: Spatial Distribution of BIHS Household Sample

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.

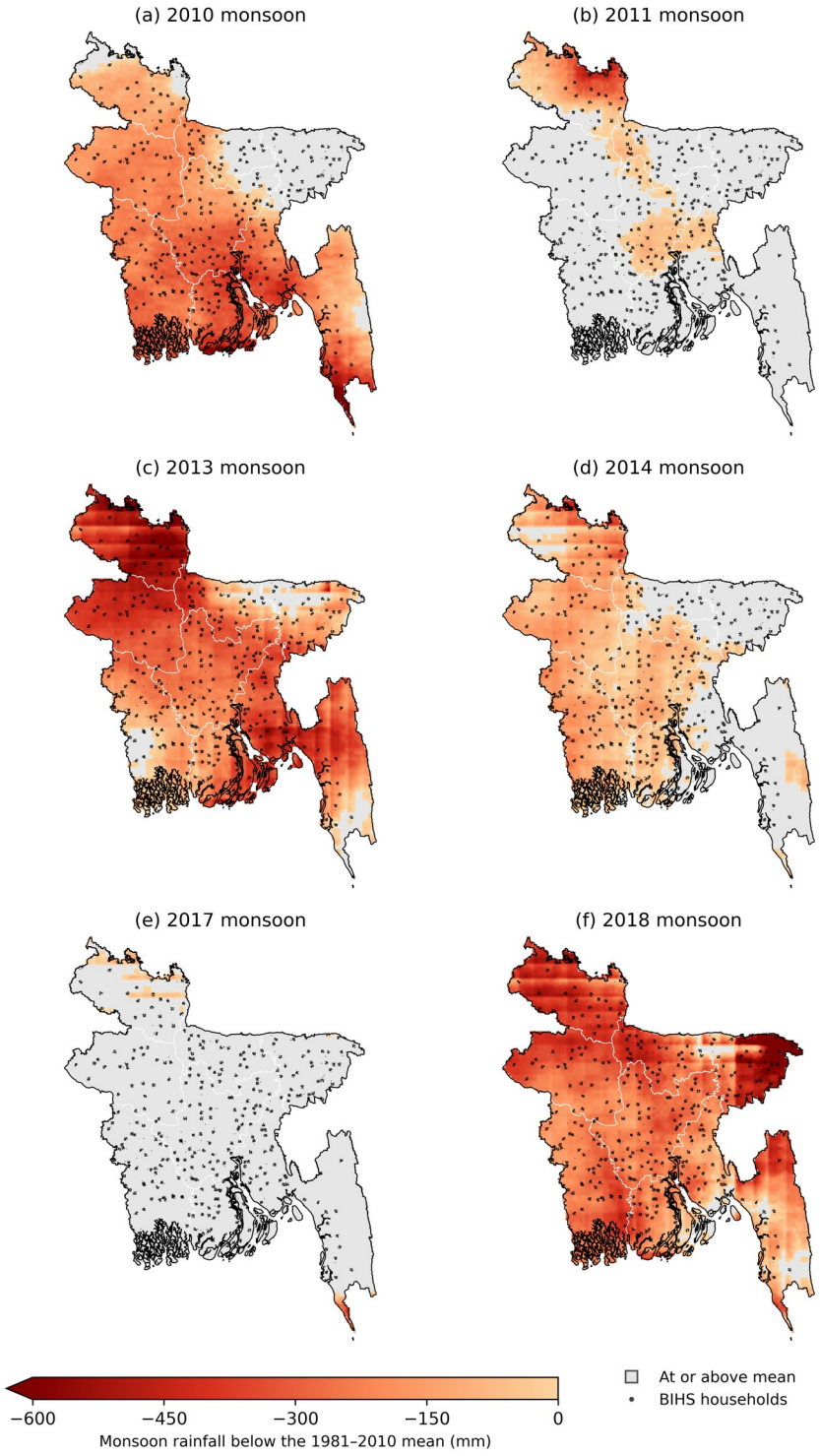


Figure B2: Monsoon Rainfall Deviations from the Long-Run Mean

Source: Figure prepared using CHIRPS monsoon (June–September) rainfall and BIHS household coordinates.
Note: Red shading shows monsoon rainfall below the 1981–2010 mean, with darker shades indicating larger shortfalls. Gray areas received rainfall at or above the mean. Black dots show BIHS sample households. The 2010, 2013 and 2017 monsoons are the lagged shocks for waves 1, 2 and 3, and the 2011, 2014 and 2018 monsoons are the current shocks.

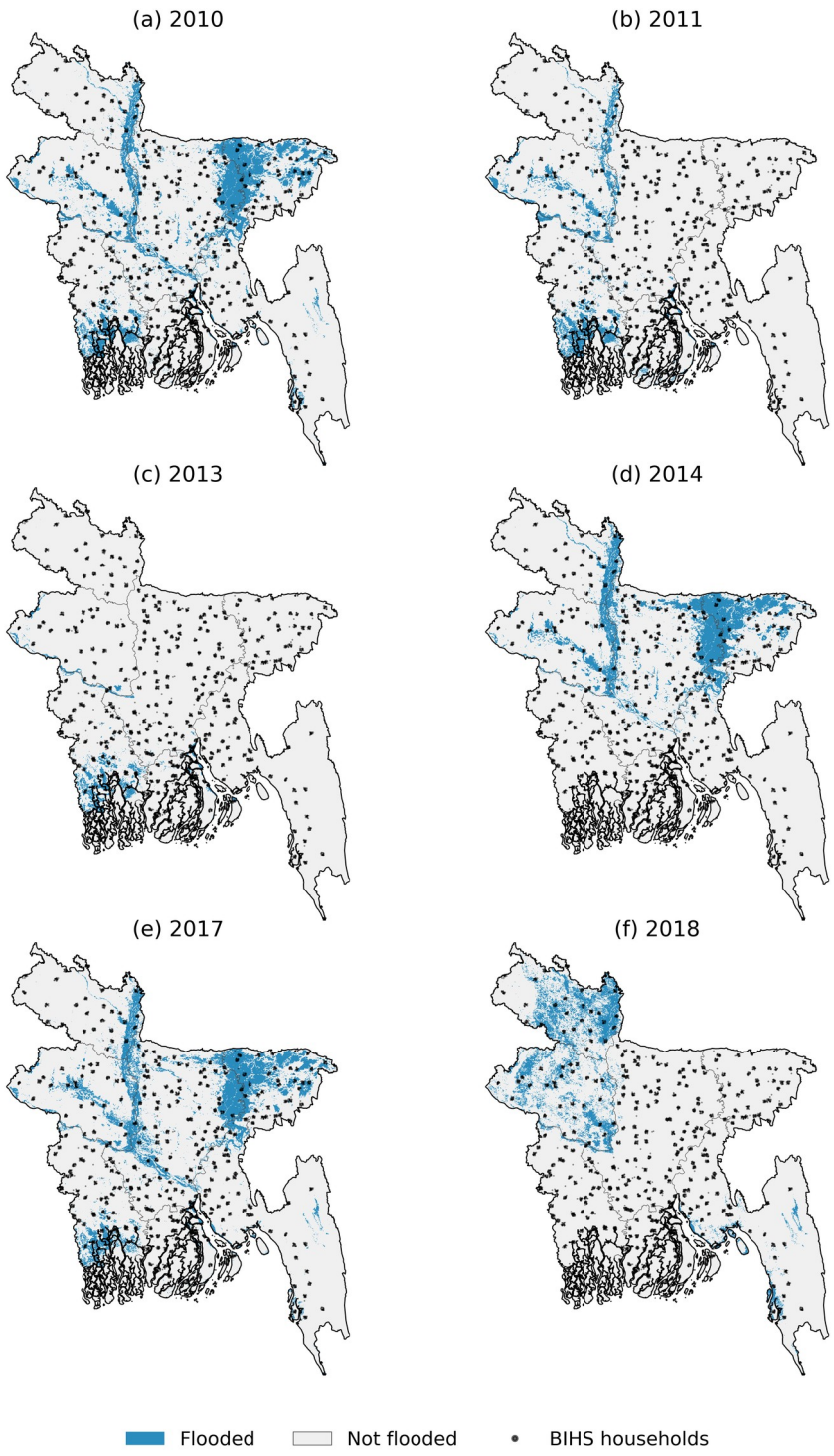
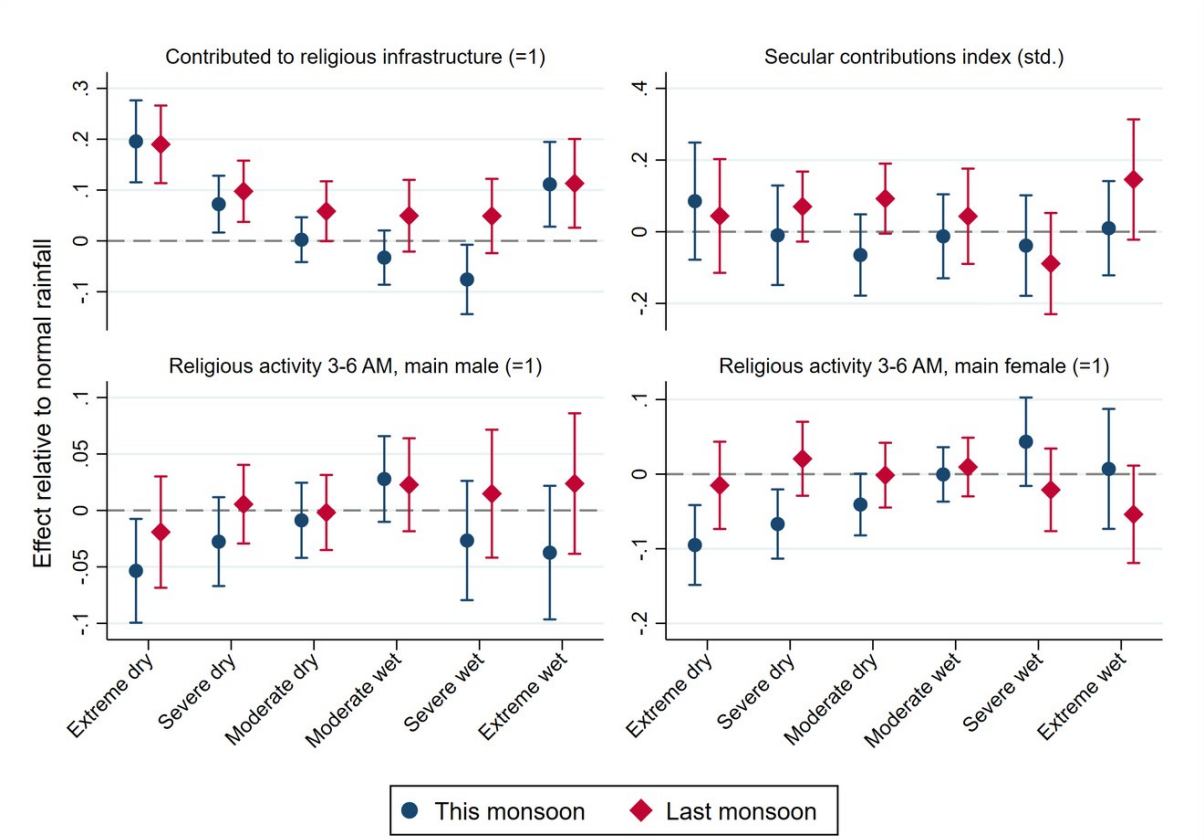


Figure B3: Monsoon Flood Extent

Source: Figure prepared using MODIS flood maps from the Global Flood Database and BIHS household coordinates.
Note: Blue shading shows areas flooded during flood events that began in the June–September monsoon of each year. Permanent water bodies are excluded. Black dots show BIHS sample households. The 2010, 2013 and 2017 monsoons are the lagged shocks for waves 1, 2 and 3, and the 2011, 2014 and 2018 monsoons are the current shocks.

Figure B4: Robustness: Rainfall Bins Instead of the Drought Indicator



Notes: Each panel shows coefficients from one regression in which the drought indicators are replaced by seven bins of the standardized monsoon rainfall in this and the last monsoon: extreme dry ($z \leq -1.5$), severe dry ($-1.5 < z \leq -1$), moderate dry ($-1 < z \leq -0.5$), normal ($-0.5 < z < 0.5$, omitted), moderate wet ($0.5 \leq z < 1$), severe wet ($1 \leq z < 1.5$) and extreme wet ($z \geq 1.5$). The drought indicator in the main specification equals the two driest bins. Regressions include household, wave and interview-month fixed effects and control for share flooded (per one standard deviation), temperature and heat days. Bars show 95 percent confidence intervals based on standard errors clustered by village.

Table B1: Summary Statistics by Wave: 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	6,096	0.88	0.32	5,982	0.89	0.31	4,679
Total members in the HH	4.15	1.54	6,096	4.30	1.70	5,982	4.24	1.78	4,679
Total members under 15	1.52	1.16	6,096	1.47	1.15	5,982	1.40	1.17	4,679
Age of HH head	44.05	13.80	6,096	46.10	13.61	5,982	47.49	13.01	4,679
HH head never went to school (=1)	0.48	0.50	6,096	0.45	0.50	5,982	0.45	0.50	4,679
HH has access to electricity (=1)	0.47	0.50	6,096	0.58	0.49	5,982	0.86	0.35	4,679
HH has access to a bank (=1)	0.42	0.49	6,096	0.29	0.46	5,982	0.45	0.50	4,679
HH has access to an MFI (=1)	0.45	0.50	6,096	0.32	0.47	5,982	0.43	0.50	4,679
HH head engaged in farming activities (=1)	0.52	0.50	6,096	0.48	0.50	5,982	0.41	0.49	4,679
Panel B: Household Income and Expenditures									
Total monthly earned income (BDT)	5,749.85	7,116.26	6,096	6,625.84	7,738.78	5,982	6,973.59	7,247.29	4,679
Total monthly per capita consumption (BDT)	1,529.68	1,039.30	6,096	1,503.62	976.72	5,982	1,579.02	912.67	4,678
Total crop harvest (kg)	2,573.59	5,184.24	6,096	1,832.71	3,876.43	5,982	1,655.90	4,768.95	4,679
Total monthly food expenditure (BDT)	4,745.36	3,198.44	6,096	5,021.92	3,590.93	5,982	5,092.86	3,337.36	4,678
Total monthly non-food expenditure (BDT)	1,358.02	2,623.27	6,096	1,089.47	1,014.87	5,982	1,209.42	956.70	4,679
Panel C: Household Savings and Borrowings									
Cash at hand (BDT)	2,006.41	21,140.19	6,096	1,623.92	6,281.17	5,982	1,232.60	4,698.26	4,679
Total savings (BDT)	14,474.78	54,436.59	6,096	18,596.66	60,807.93	5,982	24,335.70	104,425.42	4,679
HH has savings (=1)	0.58	0.49	6,096	0.63	0.48	5,982	0.65	0.48	4,679
Total borrowings (BDT)	31,882.97	93,041.58	6,096	43,449.26	159,020.01	5,982	50,251.65	96,816.47	4,679
HH has a current loan (=1)	0.65	0.48	6,096	0.69	0.46	5,982	0.71	0.45	4,679
HH borrows from formal channels (=1)	0.18	0.39	6,096	0.13	0.33	5,982	0.10	0.29	4,679
HH borrows from NGOs (=1)	0.28	0.45	6,096	0.36	0.48	5,982	0.41	0.49	4,679
HH borrows from informal channels (=1)	0.38	0.48	6,096	0.42	0.49	5,982	0.46	0.50	4,679
HH borrows from social networks (=1)	0.30	0.46	6,096	0.33	0.47	5,982	0.38	0.49	4,679
HH borrows from moneylenders (=1)	0.07	0.26	6,096	0.12	0.33	5,982	0.11	0.32	4,679
HH borrows from shopkeepers (=1)	0.04	0.21	6,096	0.01	0.09	5,982	0.00	0.04	4,679
Panel D: Religious Activities and Contributions									
Daily minutes spent in religious activities by main HH female	33.13	48.63	6,090	57.78	73.48	5,930	66.33	77.59	4,632
Daily minutes spent in religious activities by main HH male	24.65	57.53	3,162	36.54	68.94	4,962	46.78	81.68	3,859
HH spent on qurbani (=1)[a]	0.25	0.44	5,386	0.30	0.46	5,272	0.30	0.46	4,169
Any HH member is a member of a religious group (=1)	0.07	0.26	6,091	0.17	0.37	5,967	0.31	0.46	4,666
Main HH female is a member of a religious group (=1)	0.02	0.13	6,091	0.12	0.32	5,967	0.25	0.43	4,666
Main HH male is a member of a religious group (=1)	0.06	0.23	6,091	0.05	0.22	5,967	0.10	0.30	4,666
Main HH female joined at least 2 of 5 religious meetings (=1)	0.01	0.12	6,091	0.09	0.29	5,967	0.16	0.37	4,666
Main HH male joined at least 2 of 5 religious meetings (=1)	0.05	0.22	6,091	0.04	0.20	5,967	0.07	0.25	4,666

Notes: N is the number of households. Monetary values are in real 2011 BDT. Time use measures are reported for respondents who completed the time diary.

[a] Muslim households only.

Table B2: Serial Correlation in Monsoon Rainfall and Drought, 1981–2018

	Standardized monsoon rainfall (z)		Drought (=1)	
	(1)	(2)	(3)	(4)
z, last year	-0.232^{***}	0.031^{***}		
	(0.072)	(0.010)		
Drought, last year			-0.114^{**}	-0.054^{***}
			(0.044)	(0.008)
Village FE	Yes	Yes	Yes	Yes
Year FE	No	Yes	No	Yes
Standard errors clustered by	Year	Village	Year	Village
Observations	11,766	11,766	11,766	11,766

Notes: The sample includes 318 BIHS villages from 1981 to 2018. For each household, I measure total monsoon (June–September) rainfall within a 5 km buffer using CHIRPS data and standardize it using the 1981–2010 mean and standard deviation. Village rainfall is the average of this measure across sample households in the village. A village experiences a drought if its rainfall is more than one standard deviation below the mean. Standard errors are in parentheses.* p<0.10, ** p<0.05, *** p<0.01.

Table B3: Wave-1 Characteristics and Later Monsoon Shocks

	Drought		Share flooded	
	2013	2018	2014	2017
	(1)	(2)	(3)	(4)
Age of household head	−0.001**	0.001	−0.000**	−0.000
	(0.000)	(0.001)	(0.000)	(0.000)
Head never attended school (=1)	0.042***	−0.018	0.015***	0.012*
	(0.015)	(0.015)	(0.006)	(0.007)
Female head (=1)	−0.077***	−0.048**	−0.016**	−0.002
	(0.022)	(0.023)	(0.008)	(0.010)
Household size	−0.023***	−0.017**	0.006**	0.009***
	(0.006)	(0.007)	(0.002)	(0.003)
Head is Muslim (=1)	0.056	0.036	0.002	−0.003
	(0.054)	(0.054)	(0.027)	(0.031)
Head's main occupation is farming (=1)	−0.015	−0.025	0.034***	0.042***
	(0.017)	(0.018)	(0.010)	(0.011)
Land owned (acres)	−0.009	−0.024***	0.020***	0.019***
	(0.006)	(0.009)	(0.006)	(0.006)
Wealth quintile (1–5)	0.026***	0.029***	−0.018***	−0.020***
	(0.008)	(0.010)	(0.005)	(0.006)
Electricity connection (=1)	0.056**	−0.037	−0.004	−0.019
	(0.028)	(0.033)	(0.014)	(0.017)
Number of livestock	−0.000	−0.000	−0.000**	−0.000*
	(0.000)	(0.000)	(0.000)	(0.000)
Has a current loan (=1)	0.020	−0.084***	−0.001	−0.013
	(0.020)	(0.025)	(0.010)	(0.014)
Has access to an MFI (=1)	−0.035	0.085***	0.005	0.010
	(0.028)	(0.030)	(0.014)	(0.017)
Distance to market (km)	−0.005	−0.003	0.004	0.001
	(0.007)	(0.008)	(0.005)	(0.005)
Monthly earned income (1,000 BDT)	−0.000	0.002	−0.000	−0.001
	(0.001)	(0.001)	(0.000)	(0.001)
Monthly per capita consumption (1,000 BDT)	−0.031***	−0.019	0.013***	0.019***
	(0.010)	(0.012)	(0.005)	(0.006)
Contributed to religious infrastructure (=1)	−0.031	0.004	−0.039***	−0.045***
	(0.023)	(0.029)	(0.013)	(0.015)
Borrows from informal sources (=1)	−0.005	0.024	0.043***	0.044***
	(0.023)	(0.027)	(0.013)	(0.014)
Religious expenditure, past 12 months (1,000 BDT)	0.000	0.001	−0.000*	−0.000
	(0.001)	(0.001)	(0.000)	(0.000)
Joint test, all characteristics (p-value)	0.000	0.006	0.008	0.004
Mean of shock	0.51	0.56	0.09	0.12
Households	5,879	4,612	5,879	4,612

Notes: Each column reports one regression of the indicated monsoon shock on all wave-1 household characteristics, with division fixed effects. All shocks occur after the wave-1 interview: drought in 2013 and share flooded in 2014 are measured for wave-2 households, and drought in 2018 and share flooded in 2017 for wave-3 households. Monetary values are in thousands of real 2011 BDT. The joint test reports the p-value of an F-test that all coefficients equal zero. Standard errors clustered by village in parentheses. * p<0.10, ** p<0.05, *** p<0.01.

Table B4: Monsoon Shocks with Wave-Specific Effects of Wave-1 Characteristics

	Contributed to religious infrastructure (=1) (1)	Early morning religious activity, men (=1) (2)	Early morning religious activity, women (=1) (3)	Secular giving index (4)
A. Main specification				
Drought, this monsoon	0.081***	−0.033**	−0.026	0.010
	(0.023)	(0.016)	(0.017)	(0.052)
Drought, last monsoon	0.074***	−0.000	0.013	0.011
	(0.019)	(0.013)	(0.016)	(0.034)
Share flooded, this monsoon (1 SD)	0.001	−0.017***	0.003	−0.065***
	(0.009)	(0.006)	(0.007)	(0.018)
Share flooded, last monsoon (1 SD)	0.014	−0.018***	0.002	0.006
	(0.011)	(0.006)	(0.007)	(0.024)
B. Adding wave-1 characteristics × wave				
Drought, this monsoon	0.090***	−0.032**	−0.025	0.024
	(0.023)	(0.015)	(0.017)	(0.053)
Drought, last monsoon	0.068***	−0.001	0.016	0.012
	(0.019)	(0.013)	(0.016)	(0.034)
Share flooded, this monsoon (1 SD)	0.002	−0.018***	0.001	−0.063***
	(0.009)	(0.006)	(0.007)	(0.018)
Share flooded, last monsoon (1 SD)	0.014	−0.019***	0.003	0.006
	(0.011)	(0.006)	(0.007)	(0.024)
Mean of outcome	0.78	0.16	0.22	0.00
Observations	16,456	10,489	16,380	16,456

Notes: Panel A is the main specification with household, wave and interview-month fixed effects and temperature controls. Panel B adds wave dummies interacted with the 13 household characteristics in Table B3 (all rows except the wave-1 outcomes). Both panels use the same households. Share flooded is in standard deviations. Early morning religious activity equals one for any religious activity between 3:00 and 6:00 AM in the time diary. The secular giving index is a standardized index of contributions to wells, roads and town development. All columns are estimated by OLS. Standard errors clustered by village in parentheses. * p<0.10, ** p<0.05, *** p<0.01.

Table B5: Next-Wave Monsoon Shocks and Current Outcomes

	Contributed to religious infrastructure (=1) (1)	Early morning religious activity, men (=1) (2)	Early morning religious activity, women (=1) (3)	Secular giving index (4)
Drought, next wave	0.032	0.024	−0.012	−0.049
	(0.034)	(0.022)	(0.027)	(0.062)
Share flooded, next wave (1 SD)	−0.003	0.005	−0.006	−0.070*
	(0.015)	(0.011)	(0.012)	(0.039)
Joint test, both leads (p-value)	0.634	0.490	0.785	0.145
Mean of outcome	0.75	0.14	0.19	−0.00
Observations	9,074	5,142	9,014	9,074

Notes: Sample is waves 1 and 2. Each column adds drought and share flooded in the next survey wave to the main specification with household, wave and interview-month fixed effects, current and lagged shocks and temperature controls. Because drought was rare in the 2011 and 2014 monsoons, the drought lead mainly captures exposure to the 2018 drought. Share flooded is in standard deviations. The joint test reports the p-value of a test that both lead coefficients equal zero. Standard errors clustered by village in parentheses. * p<0.10, ** p<0.05, *** p<0.01.

Table B6: Monsoon Shocks and the Household Economy: Division-by-Wave Fixed Effects

A. Income and consumption				
	Monthly earned income	Monthly per capita consumption	Monthly food expenditure	Monthly non-food expenditure
	(1)	(2)	(3)	(4)
Drought, this monsoon	0.024	−0.000	−0.038	0.136**
	(0.039)	(0.023)	(0.023)	(0.056)
Drought, last monsoon	0.042	0.032**	0.031*	0.078**
	(0.038)	(0.016)	(0.019)	(0.035)
Share flooded, this monsoon (1 SD)	−0.011	0.003	0.017	−0.088***
	(0.017)	(0.010)	(0.012)	(0.030)
Share flooded, last monsoon (1 SD)	−0.010	0.025**	0.019	−0.029
	(0.017)	(0.011)	(0.012)	(0.024)
Mean of outcome (BDT)	6,504	1,534	4,941	1,221
Observations	16,498	16,755	16,755	16,756

B. Savings and borrowing			
	Total amount of current loans	Amount currently saved	Cash at hand
	(5)	(6)	(7)
Drought, this monsoon	0.140	0.090	−0.100
	(0.103)	(0.145)	(0.132)
Drought, last monsoon	0.146**	−0.082	−0.025
	(0.066)	(0.102)	(0.100)
Share flooded, this monsoon (1 SD)	−0.007	0.005	−0.144**
	(0.042)	(0.058)	(0.057)
Share flooded, last monsoon (1 SD)	−0.030	−0.049	−0.064
	(0.041)	(0.062)	(0.055)
Mean of outcome (BDT)	46,704	22,441	1,698
Observations	14,759	13,962	16,316

Notes: Each column is a separate Poisson pseudo-maximum likelihood regression with household, division-by-wave and interview-month fixed effects, controlling for current and lagged average monsoon temperature and days above 35°C. Coefficients are proportional effects; the percent effect is $100 \times (\exp(\beta) - 1)$. Monetary values are in real 2011 BDT. Share flooded is in standard deviations. Standard errors clustered by village in parentheses. * p<0.10, ** p<0.05, *** p<0.01.

Table B7: Monsoon Shocks and Rice: Production, Sales, Consumption and Stock

	Aman (monsoon)		Boro (dry season)	
	HH + wave FE (1)	HH + division × wave FE (2)	HH + wave FE (3)	HH + division × wave FE (4)
A. Production				
Drought, this monsoon	0.005	−0.050	−0.069	−0.054
	(0.072)	(0.077)	(0.063)	(0.062)
Drought, last monsoon	−0.005	−0.058	0.019	−0.039
	(0.046)	(0.060)	(0.039)	(0.044)
Share flooded, this monsoon (1 SD)	−0.041**	−0.099***	0.005	−0.018
	(0.021)	(0.030)	(0.021)	(0.028)
Share flooded, last monsoon (1 SD)	0.118***	0.084**	−0.028	−0.045*
	(0.044)	(0.041)	(0.021)	(0.025)
Mean of outcome (kg)	774.36	774.36	1,313.68	1,313.68
Observations	8,780	8,780	8,376	8,376
B. Sold				
Drought, this monsoon	0.397**	0.278*	−0.090	−0.089
	(0.156)	(0.161)	(0.097)	(0.092)
Drought, last monsoon	0.174	−0.068	−0.045	−0.198**
	(0.109)	(0.124)	(0.068)	(0.079)
Share flooded, this monsoon (1 SD)	0.027	−0.040	−0.002	−0.049
	(0.045)	(0.054)	(0.029)	(0.040)
Share flooded, last monsoon (1 SD)	0.233**	0.207**	−0.033	−0.065*
	(0.095)	(0.086)	(0.030)	(0.034)
Mean of outcome (kg)	484.56	484.56	894.89	894.89
Observations	4,180	4,180	5,290	5,290
C. Consumed by the household				
Drought, this monsoon	0.140	−0.119	−0.029	−0.058
	(0.117)	(0.116)	(0.059)	(0.066)
Drought, last monsoon	0.327***	−0.019	−0.012	−0.065
	(0.093)	(0.087)	(0.037)	(0.047)
Share flooded, this monsoon (1 SD)	0.012	−0.116*	−0.005	−0.018
	(0.050)	(0.063)	(0.023)	(0.028)
Share flooded, last monsoon (1 SD)	0.123*	0.079	−0.028	−0.036
	(0.071)	(0.059)	(0.025)	(0.027)
Mean of outcome (kg)	207.46	207.46	470.03	470.03
Observations	8,292	8,292	8,613	8,613
D. In stock at the time of the interview				
Drought, this monsoon	−0.140	−0.170	−0.510**	−0.199
	(0.121)	(0.116)	(0.239)	(0.227)
Drought, last monsoon	−0.480***	−0.130	−0.223	−0.240
	(0.127)	(0.116)	(0.210)	(0.197)
Share flooded, this monsoon (1 SD)	−0.199**	−0.286***	−0.133	−0.035
	(0.091)	(0.100)	(0.094)	(0.110)
Share flooded, last monsoon (1 SD)	0.054	0.032	0.117	0.206*
	(0.087)	(0.090)	(0.127)	(0.110)
Mean of outcome (kg)	315.48	315.48	230.36	230.36
Observations	6,951	6,951	2,555	2,555

Notes: Each coefficient is from a separate Poisson pseudo-maximum likelihood regression of the outcome in kilograms. Columns (1) and (3) include household, wave and interview-month fixed effects; columns (2) and (4) replace the wave fixed effects with division-by-wave fixed effects. All regressions control for current and lagged average monsoon temperature and days above 35°C. Aman is the rice crop grown during the monsoon; Boro is the dry-season rice crop, which is mostly irrigated. Stock is the amount held at the time of the interview. Share flooded is in standard deviations. Standard errors clustered by village in parentheses. * p<0.10, ** p<0.05, *** p<0.01.

Table B8: Monsoon Shocks and Family and Hired Labor on Rice

	Family labor		Hired labor	
	HH + wave FE (1)	HH + division × wave FE (2)	HH + wave FE (3)	HH + division × wave FE (4)
A. Aman (monsoon), planting				
Drought, this monsoon	0.029	0.009	−0.002	−0.103
	(0.083)	(0.080)	(0.096)	(0.082)
Drought, last monsoon	0.022	−0.035	−0.194*	−0.155**
	(0.067)	(0.079)	(0.099)	(0.079)
Share flooded, this monsoon (1 SD)	0.028	0.014	−0.049	−0.083**
	(0.039)	(0.051)	(0.033)	(0.039)
Share flooded, last monsoon (1 SD)	−0.019	−0.052	0.033	−0.031
	(0.042)	(0.046)	(0.055)	(0.051)
Mean of outcome (hours)	15.10	15.10	34.41	34.41
Observations	7,411	7,411	6,638	6,638
B. Aman (monsoon), harvesting				
Drought, this monsoon	−0.185	−0.368***	0.084	−0.005
	(0.142)	(0.141)	(0.102)	(0.112)
Drought, last monsoon	−0.031	−0.075	0.093	−0.039
	(0.150)	(0.168)	(0.075)	(0.078)
Share flooded, this monsoon (1 SD)	−0.008	−0.052	−0.043	−0.095**
	(0.045)	(0.061)	(0.031)	(0.042)
Share flooded, last monsoon (1 SD)	0.037	−0.037	0.174***	0.105*
	(0.058)	(0.060)	(0.066)	(0.061)
Mean of outcome (hours)	17.69	17.69	35.97	35.97
Observations	7,255	7,255	6,524	6,524
C. Boro (dry season), planting				
Drought, this monsoon	0.081	0.110	0.104	0.102
	(0.080)	(0.083)	(0.107)	(0.109)
Drought, last monsoon	0.086	0.012	0.082	−0.029
	(0.073)	(0.088)	(0.066)	(0.083)
Share flooded, this monsoon (1 SD)	0.029	0.010	−0.006	−0.054
	(0.036)	(0.040)	(0.030)	(0.039)
Share flooded, last monsoon (1 SD)	0.042	0.030	−0.015	−0.079**
	(0.040)	(0.040)	(0.034)	(0.038)
Mean of outcome (hours)	15.05	15.05	38.94	38.94
Observations	6,696	6,696	6,989	6,989
D. Boro (dry season), harvesting				
Drought, this monsoon	0.019	0.052	0.078	0.060
	(0.098)	(0.098)	(0.083)	(0.094)
Drought, last monsoon	0.037	0.016	0.071	−0.029
	(0.127)	(0.097)	(0.075)	(0.087)
Share flooded, this monsoon (1 SD)	0.027	0.013	0.020	−0.013
	(0.055)	(0.069)	(0.028)	(0.039)
Share flooded, last monsoon (1 SD)	0.095*	0.049	0.018	−0.032
	(0.057)	(0.055)	(0.033)	(0.039)
Mean of outcome (hours)	15.74	15.74	46.45	46.45
Observations	6,780	6,780	6,853	6,853

Notes: Each coefficient is from a separate Poisson pseudo-maximum likelihood regression of hours of family or hired labor used on the household's own plots. Columns (1) and (3) include household, wave and interview-month fixed effects; columns (2) and (4) replace the wave fixed effects with division-by-wave fixed effects. All regressions control for current and lagged average monsoon temperature and days above 35°C. Share flooded is in standard deviations. Standard errors clustered by village in parentheses. * p<0.10, ** p<0.05, *** p<0.01.

Table B9: Monsoon Shocks and Wage Labor: Division-by-Wave Fixed Effects

	Agricultural day labor		Daily-wage work (any sector)		
	Any member (=1)	Total days, past 7 days	Any member (=1)	Total days, past 7 days	Daily agricultural wage (BDT)
	(1)	(2)	(3)	(4)	(5)
Drought, this monsoon	0.014	0.096	−0.020	−0.039	−0.054
	(0.013)	(0.094)	(0.015)	(0.066)	(0.034)
Drought, last monsoon	−0.017*	−0.096	−0.028**	−0.093*	0.010
	(0.009)	(0.075)	(0.011)	(0.050)	(0.024)
Share flooded, this monsoon (1 SD)	0.004	0.002	−0.004	−0.034	0.009
	(0.007)	(0.042)	(0.007)	(0.029)	(0.012)
Share flooded, last monsoon (1 SD)	0.002	−0.025	−0.001	−0.028	−0.019
	(0.008)	(0.046)	(0.007)	(0.031)	(0.012)
Estimator	LPM	PPML	LPM	PPML	PPML
Mean of outcome	0.17	2.77	0.29	3.46	210.11
Observations	16,756	4,941	16,756	7,787	1,725

Notes: All regressions include household, division-by-wave and interview-month fixed effects and control for current and lagged average monsoon temperature and days above 35°C. Columns (1) and (3) are estimated as linear probability models; columns (2), (4) and (5) by Poisson pseudo-maximum likelihood. Days of work are summed across all household members over the 7 days before the interview. The daily agricultural wage is the average wage of household members who did agricultural day labor and is observed only for households with an agricultural day laborer. Share flooded is in standard deviations. Standard errors clustered by village in parentheses. * p<0.10, ** p<0.05, *** p<0.01.

Table B10: Monsoon Shocks and Households Dependent on Agricultural Day Labor

	Monthly earned income (BDT) (1)	Agricultural earnings (BDT) (2)	Non-agricultural earnings (BDT) (3)	Days of wage work (4)	Monthly per capita consumption (BDT) (5)
A. Household and wave fixed effects					
Drought, this monsoon	0.032	0.143**	−0.052	0.155**	−0.039*
	(0.041)	(0.060)	(0.047)	(0.078)	(0.023)
Drought, this monsoon × ag. laborer HH	−0.089	−0.315***	0.426***	−0.453***	0.026
	(0.058)	(0.083)	(0.109)	(0.100)	(0.029)
Drought, last monsoon	0.025	−0.018	0.056	−0.164***	0.041**
	(0.034)	(0.047)	(0.044)	(0.059)	(0.016)
Drought, last monsoon × ag. laborer HH	−0.069*	−0.064	−0.017	0.175**	−0.052**
	(0.039)	(0.058)	(0.100)	(0.077)	(0.025)
Share flooded, this monsoon (1 SD)	0.026*	0.045**	0.014	−0.040	0.005
	(0.015)	(0.019)	(0.021)	(0.034)	(0.010)
Share flooded, this monsoon × ag. laborer HH	−0.038	−0.009	−0.111**	0.022	−0.001
	(0.027)	(0.040)	(0.055)	(0.056)	(0.013)
Share flooded, last monsoon (1 SD)	−0.012	−0.028	0.008	−0.111***	0.025**
	(0.017)	(0.020)	(0.028)	(0.039)	(0.011)
Share flooded, last monsoon × ag. laborer HH	0.009	0.079*	−0.159**	0.147***	−0.017
	(0.027)	(0.042)	(0.068)	(0.053)	(0.013)
Net drought effect, ag. laborer HH, this monsoon	−0.056	−0.172	0.374	−0.297	−0.014
p-value	0.307	0.040	0.000	0.001	0.637
Net drought effect, ag. laborer HH, last monsoon	−0.044	−0.082	0.039	0.011	−0.011
p-value	0.238	0.093	0.672	0.842	0.642
Mean of outcome	6,501.09	2,951.19	4,985.84	3.45	1,534.08
Observations	16,476	15,479	12,321	7,781	16,733
B. Household and division × wave fixed effects					
Drought, this monsoon	0.042	0.135**	−0.040	0.162*	−0.003
	(0.042)	(0.063)	(0.049)	(0.084)	(0.024)
Drought, this monsoon × ag. laborer HH	−0.095*	−0.351***	0.433***	−0.443***	0.022
	(0.057)	(0.084)	(0.108)	(0.100)	(0.029)
Drought, last monsoon	0.050	−0.029	0.094*	−0.168**	0.037**
	(0.040)	(0.053)	(0.054)	(0.066)	(0.017)
Drought, last monsoon × ag. laborer HH	−0.059	−0.078	0.002	0.195**	−0.046*
	(0.037)	(0.059)	(0.100)	(0.077)	(0.025)
Share flooded, this monsoon (1 SD)	−0.003	0.004	−0.008	−0.048	0.003
	(0.018)	(0.025)	(0.025)	(0.040)	(0.011)
Share flooded, this monsoon × ag. laborer HH	−0.033	−0.000	−0.105*	0.021	−0.002
	(0.027)	(0.041)	(0.056)	(0.055)	(0.013)
Share flooded, last monsoon (1 SD)	−0.014	−0.059**	0.019	−0.112***	0.030**
	(0.019)	(0.024)	(0.029)	(0.041)	(0.012)
Share flooded, last monsoon × ag. laborer HH	0.007	0.087**	−0.158**	0.145***	−0.020
	(0.028)	(0.043)	(0.068)	(0.053)	(0.014)
Net drought effect, ag. laborer HH, this monsoon	−0.053	−0.216	0.393	−0.282	0.018
p-value	0.349	0.013	0.000	0.002	0.561
Net drought effect, ag. laborer HH, last monsoon	−0.009	−0.107	0.096	0.026	−0.009
p-value	0.833	0.055	0.313	0.673	0.725
Mean of outcome	6,501.09	2,951.19	4,985.84	3.45	1,534.08
Observations	16,476	15,479	12,321	7,781	16,733

Notes: Each column is a separate Poisson pseudo-maximum likelihood regression. Drought and share flooded (in standard deviations), this monsoon and last monsoon, are each interacted with an indicator for households in which a member did agricultural day labor in the 7 days before the wave-1 interview. All regressions control for current and lagged share flooded (in standard deviations), current and lagged average monsoon temperature and days above 35°C, and interview-month fixed effects. Monetary values are in real 2011 BDT. Standard errors clustered by village in parentheses. * p<0.10, ** p<0.05, *** p<0.01.

Table B11: Expenses in Religious Rituals: Division-by-Wave Fixed Effects

	Paid or spent on (=1)				Total religious expenditure (BDT)
	Religious functions, puja/milad	Sadaqa	Zakat†	Fitra†	Past 12 months
	(1)	(2)	(3)	(4)	(5)
Drought, this monsoon	0.035	−0.034	−0.007	0.024	0.052
	(0.029)	(0.035)	(0.010)	(0.022)	(0.132)
Drought, last monsoon	0.042*	0.006	0.024***	0.078***	0.149*
	(0.023)	(0.029)	(0.007)	(0.019)	(0.077)
Share flooded (1 SD), this monsoon	−0.050***	0.009	−0.003	−0.017	−0.099**
	(0.016)	(0.015)	(0.004)	(0.012)	(0.049)
Share flooded (1 SD), last monsoon	−0.005	0.009	−0.000	−0.007	−0.054
	(0.017)	(0.014)	(0.003)	(0.012)	(0.066)
Estimator	LPM	LPM	LPM	LPM	PPML
Mean of outcome	0.35	0.55	0.04	0.59	3,514.92
Observations	16,756	16,756	14,826	14,826	16,171

Notes: This table repeats Table 5 with division-by-wave fixed effects in place of wave fixed effects. Each column is a separate regression with household, division-by-wave and interview-month fixed effects and controls for temperature and heat days in this and the last monsoon. Columns 1–4 are linear probability models. Column 5 is estimated by Poisson pseudo-maximum likelihood, so coefficients are approximately proportional effects, $\exp(\beta) - 1$. Flood effects are for a one standard deviation increase in the share flooded. †Muslim households only. Standard errors clustered by village in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table B12: Expenses in Religious Rituals by Wave–1 Wealth

	Paid or spent on (=1)				Total religious expenditure (BDT)
	Religious functions, puja/milad	Sadaqa	Zakat†	Fitra†	Past 12 months
	(1)	(2)	(3)	(4)	(5)
A. Household and wave fixed effects					
Drought, this monsoon	0.071**	0.020	−0.018**	0.071***	0.426***
	(0.028)	(0.035)	(0.009)	(0.024)	(0.109)
× Richer	−0.030	−0.050*	−0.004	−0.109***	−0.477***
	(0.027)	(0.027)	(0.013)	(0.025)	(0.142)
Drought, last monsoon	0.032	0.034	0.007	0.037**	0.123
	(0.022)	(0.030)	(0.006)	(0.018)	(0.092)
× Richer	0.051**	0.055**	0.025**	0.036**	−0.034
	(0.021)	(0.022)	(0.010)	(0.017)	(0.119)
Share flooded (1 SD), this monsoon	0.004	0.011	0.002	0.001	0.017
	(0.017)	(0.016)	(0.003)	(0.014)	(0.057)
× Richer	−0.010	−0.015	−0.007	−0.020	−0.084
	(0.016)	(0.018)	(0.006)	(0.014)	(0.071)
Share flooded (1 SD), last monsoon	0.023	0.026	−0.002	−0.005	0.004
	(0.017)	(0.016)	(0.003)	(0.013)	(0.065)
× Richer	−0.016	0.004	0.004	−0.007	−0.070
	(0.017)	(0.017)	(0.006)	(0.015)	(0.096)
Estimator	LPM	LPM	LPM	LPM	PPML
Mean of outcome, poorer	0.30	0.50	0.02	0.45	1,528.50
Mean of outcome, richer	0.42	0.63	0.08	0.80	6,377.58
Observations	16,750	16,750	14,820	14,820	16,165
B. Household and division-by-wave fixed effects					
Drought, this monsoon	0.044	−0.012	−0.004	0.068***	0.414***
	(0.029)	(0.037)	(0.009)	(0.025)	(0.135)
× Richer	−0.019	−0.053**	−0.006	−0.105***	−0.464***
	(0.026)	(0.026)	(0.013)	(0.025)	(0.143)
Drought, last monsoon	0.025	−0.021	0.015**	0.063***	0.170*
	(0.024)	(0.032)	(0.006)	(0.021)	(0.093)
× Richer	0.042**	0.067***	0.023**	0.036**	−0.029
	(0.021)	(0.022)	(0.010)	(0.017)	(0.118)
Share flooded (1 SD), this monsoon	−0.045***	0.015	0.000	−0.010	−0.034
	(0.017)	(0.017)	(0.003)	(0.014)	(0.056)
× Richer	−0.011	−0.013	−0.008	−0.015	−0.080
	(0.014)	(0.017)	(0.006)	(0.014)	(0.065)
Share flooded (1 SD), last monsoon	−0.002	0.009	−0.002	−0.008	−0.016
	(0.016)	(0.016)	(0.003)	(0.013)	(0.063)
× Richer	−0.012	−0.000	0.004	0.001	−0.049
	(0.015)	(0.015)	(0.006)	(0.015)	(0.086)
Estimator	LPM	LPM	LPM	LPM	PPML
Mean of outcome, poorer	0.30	0.50	0.02	0.45	1,528.50
Mean of outcome, richer	0.42	0.63	0.08	0.80	6,377.58
Observations	16,750	16,750	14,820	14,820	16,165

Notes: Panel A includes household, wave and interview-month fixed effects; Panel B replaces wave fixed effects with division-by-wave fixed effects. All regressions control for temperature and heat days in this and the last monsoon. Each shock is interacted with an indicator for richer households (top two quintiles of the wave-1 wealth index). Columns 1–4 are linear probability models. Column 5 is estimated by Poisson pseudo-maximum likelihood. †Muslim households only. Flood effects are per one standard deviation in the share flooded. Standard errors clustered by village in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table B13: Religious Contributions, Secular Contributions and Private Devotion: Division-by-Wave Fixed Effects

	Contributions		Private devotion			
	Religious infrastructure (=1)	Secular index (std.)	Religious activity 3–6 AM (=1)		Religious activity in Fajr window (=1)†	
			Main male	Main female	Main male	Main female
	(1)	(2)	(3)	(4)	(5)	(6)
Drought, this monsoon	0.014	−0.086	−0.014	−0.026	0.005	−0.020
	(0.025)	(0.056)	(0.018)	(0.018)	(0.022)	(0.021)
Drought, last monsoon	0.036*	−0.037	−0.004	0.010	0.026	0.004
	(0.020)	(0.033)	(0.015)	(0.019)	(0.018)	(0.021)
Share flooded (1 SD), this monsoon	0.005	−0.042**	−0.023***	0.002	−0.007	0.012
	(0.011)	(0.020)	(0.007)	(0.008)	(0.011)	(0.010)
Share flooded (1 SD), last monsoon	−0.005	−0.017	−0.017**	0.003	0.010	0.010
	(0.012)	(0.020)	(0.007)	(0.008)	(0.010)	(0.011)
Estimator	LPM	OLS	LPM	LPM	LPM	LPM
Mean of outcome	0.78	−0.00	0.16	0.22	0.26	0.37
Observations	16,709	16,709	10,586	16,632	7,932	13,336

Notes: This table repeats Table 6 with division-by-wave fixed effects in place of wave fixed effects. Each column is a separate regression with household, division-by-wave and interview-month fixed effects and controls for temperature and heat days in this and the last monsoon. The secular contributions index is the standardized mean of standardized contributions to wells, roads and town development. †Muslim households only, days on which the Fajr window is fully observed in the diary. Flood effects are for a one standard deviation increase in the share flooded. Standard errors clustered by village in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table B14: Religious Contributions, Secular Contributions and Private Devotion by Wave–1 Wealth: Division-by-Wave Fixed Effects

	Contributions		Private devotion			
	Religious infrastructure (=1)	Secular index (std.)	Religious activity 3–6 AM (=1)		Religious activity in Fajr window (=1)†	
			Main male	Main female	Main male	Main female
	(1)	(2)	(3)	(4)	(5)	(6)
Drought, this monsoon	0.051*	−0.066	−0.033*	−0.037*	−0.017	−0.009
	(0.028)	(0.054)	(0.019)	(0.020)	(0.023)	(0.023)
× Richer	−0.093***	−0.052	0.047**	0.026	0.052**	−0.030
	(0.022)	(0.064)	(0.020)	(0.021)	(0.024)	(0.024)
Drought, last monsoon	0.043*	−0.061*	−0.024	0.000	0.015	0.014
	(0.022)	(0.035)	(0.017)	(0.020)	(0.019)	(0.023)
× Richer	−0.018	0.059	0.046**	0.023	0.027	−0.026
	(0.018)	(0.046)	(0.019)	(0.016)	(0.025)	(0.019)
Share flooded (1 SD), this monsoon	0.007	−0.053**	−0.023***	−0.006	−0.006	0.008
	(0.012)	(0.023)	(0.008)	(0.008)	(0.012)	(0.011)
× Richer	−0.001	0.034	0.000	0.021*	−0.006	0.009
	(0.010)	(0.036)	(0.010)	(0.011)	(0.014)	(0.015)
Share flooded (1 SD), last monsoon	−0.012	−0.031	−0.009	0.003	0.015	0.012
	(0.013)	(0.021)	(0.007)	(0.008)	(0.011)	(0.013)
× Richer	0.025**	0.044	−0.026**	−0.003	−0.019	−0.005
	(0.011)	(0.039)	(0.011)	(0.012)	(0.016)	(0.016)
Estimator	LPM	OLS	LPM	LPM	LPM	LPM
Mean of outcome, poorer	0.73	−0.10	0.13	0.20	0.20	0.33
Mean of outcome, richer	0.86	0.15	0.20	0.26	0.33	0.44
Observations	16,703	16,703	10,580	16,626	7,926	13,330

Notes: This table repeats Table 7 with division-by-wave fixed effects in place of wave fixed effects. Each column is a separate regression with household, division-by-wave and interview-month fixed effects and temperature controls. Each shock is interacted with an indicator for richer households (top two quintiles of the wave-1 wealth index). The shock rows give the effect for poorer households, and the "× Richer" rows the difference between richer and poorer households. The secular contributions index is the standardized mean of standardized contributions to wells, roads and town development. Private devotion is from the 24-hour time-use diary of the main male and main female. †Muslim households, days with the Fajr window fully observed. Flood effects are per one standard deviation in the share flooded. Standard errors clustered by village in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table B15: Borrowing by Source after Droughts and Floods

A. Borrowed from each type of lender (=1)						
	Formal lender		NGO		Any informal lender	
	(1)	(2)	(3)	(4)	(5)	(6)
Drought, this monsoon	−0.011	−0.002	0.041**	0.057***	−0.015	0.016
	(0.011)	(0.012)	(0.017)	(0.019)	(0.021)	(0.022)
Drought, last monsoon	0.004	−0.013	0.014	0.023*	0.032**	−0.012
	(0.010)	(0.011)	(0.011)	(0.012)	(0.015)	(0.015)
Share flooded (1 SD), this monsoon	−0.001	0.002	−0.011*	−0.020***	0.004	−0.008
	(0.006)	(0.006)	(0.007)	(0.007)	(0.009)	(0.010)
Share flooded (1 SD), last monsoon	−0.003	−0.002	−0.008	−0.011	0.008	0.000
	(0.006)	(0.007)	(0.008)	(0.008)	(0.009)	(0.011)
Mean of outcome	0.14	0.14	0.34	0.34	0.41	0.41
Division × wave FE	No	Yes	No	Yes	No	Yes
Observations	16,756	16,756	16,756	16,756	16,756	16,756

B. Borrowed from each informal lender (=1)						
	Social network (friends, relatives, employers)		Moneylender		Shopkeeper	
	(7)	(8)	(9)	(10)	(11)	(12)
Drought, this monsoon	−0.017	−0.004	−0.001	0.010	0.004	0.022*
	(0.019)	(0.019)	(0.011)	(0.012)	(0.009)	(0.012)
Drought, last monsoon	0.020	−0.022	0.019**	0.027**	0.015**	−0.002
	(0.014)	(0.014)	(0.009)	(0.011)	(0.007)	(0.007)
Share flooded (1 SD), this monsoon	−0.007	−0.012	0.005	0.004	−0.001	−0.012*
	(0.008)	(0.009)	(0.006)	(0.008)	(0.006)	(0.007)
Share flooded (1 SD), last monsoon	0.008	0.006	−0.004	−0.007	0.004	−0.002
	(0.008)	(0.009)	(0.008)	(0.008)	(0.005)	(0.005)
Mean of outcome	0.33	0.33	0.10	0.10	0.02	0.02
Division × wave FE	No	Yes	No	Yes	No	Yes
Observations	16,756	16,756	16,756	16,756	16,756	16,756

Notes: Each column is a separate linear probability model with household and interview-month fixed effects and temperature controls. Odd-numbered columns include wave fixed effects; even-numbered columns replace them with division-by-wave fixed effects. Any informal lender includes social networks, moneylenders and shopkeepers. Flood effects are per one standard deviation in the share flooded. Standard errors clustered by village in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table B16: Borrowing from Informal Lenders by Wave-1 Wealth: Division-by-Wave Fixed Effects

	Borrowed from (=1)			
	Any informal lender	Social network	Moneylender	Shopkeeper
	(1)	(2)	(3)	(4)
Drought, this monsoon	0.001	−0.019	0.014	0.019
	(0.024)	(0.021)	(0.014)	(0.012)
× Richer	0.037	0.037*	−0.012	0.007
	(0.023)	(0.021)	(0.014)	(0.007)
Drought, last monsoon	−0.009	−0.025	0.032***	0.001
	(0.017)	(0.016)	(0.012)	(0.007)
× Richer	−0.005	0.008	−0.012	−0.008
	(0.020)	(0.019)	(0.011)	(0.005)
Share flooded (1 SD), this monsoon	−0.011	−0.015	0.005	−0.015**
	(0.011)	(0.010)	(0.009)	(0.007)
× Richer	0.006	0.009	−0.003	0.007
	(0.013)	(0.012)	(0.008)	(0.005)
Share flooded (1 SD), last monsoon	−0.004	0.000	−0.008	0.000
	(0.011)	(0.009)	(0.009)	(0.005)
× Richer	0.015	0.019	0.006	−0.008
	(0.015)	(0.013)	(0.009)	(0.005)
Mean of outcome, poorer	0.40	0.31	0.12	0.02
Mean of outcome, richer	0.43	0.37	0.07	0.02
Observations	16,750	16,750	16,750	16,750

Notes: This table repeats Table 8 with division-by-wave fixed effects in place of wave fixed effects. Each column is a separate linear probability model with household, division-by-wave and interview-month fixed effects and temperature controls. Each shock is interacted with an indicator for richer households (top two quintiles of the wave-1 wealth index). Any informal lender includes social networks (friends, relatives and employers), moneylenders and shopkeepers. Flood effects are per one standard deviation in the share flooded. Standard errors clustered by village in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table B17: Religious Group Membership after Droughts and Floods

	Member of a religious group (=1)			Attended 2+ of last 5 religious-group meetings (=1)	
	Any household member	Main male	Main female	Main male	Main female
	(1)	(2)	(3)	(4)	(5)
A. Household and wave fixed effects					
Drought, this monsoon	0.018	0.014	0.010	0.021*	−0.006
	(0.025)	(0.014)	(0.021)	(0.011)	(0.018)
Drought, last monsoon	0.047***	0.020**	0.036***	0.011	0.038***
	(0.015)	(0.008)	(0.013)	(0.007)	(0.011)
Share flooded (1 SD), this monsoon	0.003	−0.011*	0.010	−0.010**	0.003
	(0.011)	(0.006)	(0.009)	(0.005)	(0.008)
Share flooded (1 SD), last monsoon	0.007	−0.014**	0.018*	−0.013***	0.013*
	(0.011)	(0.005)	(0.009)	(0.005)	(0.008)
Mean of outcome	0.17	0.07	0.12	0.05	0.08
Observations	16,709	16,709	16,709	16,709	16,709
B. Household and division-by-wave fixed effects					
Drought, this monsoon	−0.030	−0.004	−0.028	0.008	−0.041**
	(0.028)	(0.016)	(0.024)	(0.012)	(0.021)
Drought, last monsoon	0.064***	0.016**	0.055***	0.006	0.052***
	(0.016)	(0.008)	(0.014)	(0.007)	(0.012)
Share flooded (1 SD), this monsoon	−0.014	−0.010*	−0.007	−0.008	−0.011
	(0.010)	(0.006)	(0.008)	(0.006)	(0.007)
Share flooded (1 SD), last monsoon	−0.018*	−0.020***	−0.002	−0.017***	−0.003
	(0.010)	(0.005)	(0.009)	(0.005)	(0.008)
Mean of outcome	0.17	0.07	0.12	0.05	0.08
Observations	16,709	16,709	16,709	16,709	16,709

Notes: Each column is a separate linear probability model with interview-month fixed effects and controls for temperature and heat days in this and the last monsoon. Panel A includes household and wave fixed effects; Panel B replaces wave fixed effects with division-by-wave fixed effects. Group membership and meeting attendance come from the WEAI module, answered by the main male and the main female. Flood effects are per one standard deviation in the share flooded. Standard errors clustered by village in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table B18: Past Donors and Religious Group Members after a Drought: Division-by-Wave Fixed Effects

	Borrowed from (=1)			Received any charity (=1)
	Social network	Moneylender	Shopkeeper	
	(1)	(2)	(3)	(4)
A. Contributed to religious infrastructure in the previous wave				
Past donor	−0.019	−0.020	0.006	0.019
	(0.022)	(0.018)	(0.004)	(0.013)
Drought, this monsoon	−0.024	−0.063*	0.012**	0.047*
	(0.040)	(0.034)	(0.006)	(0.028)
× Past donor	0.060	0.078**	−0.014**	−0.024
	(0.040)	(0.033)	(0.006)	(0.025)
Drought, last monsoon	0.048	0.012	0.007	−0.027
	(0.036)	(0.032)	(0.006)	(0.024)
× Past donor	−0.023	0.031	−0.002	−0.024
	(0.032)	(0.026)	(0.006)	(0.022)
Mean of outcome	0.36	0.12	0.01	0.05
Observations	9,074	9,074	9,074	9,074
B. Member of a religious group in the previous wave				
Group member	0.016	−0.036	0.001	−0.022
	(0.035)	(0.023)	(0.005)	(0.015)
Drought, this monsoon	0.037	−0.005	0.001	0.015
	(0.025)	(0.018)	(0.003)	(0.026)
× Group member	−0.076	0.039	0.004	0.082**
	(0.048)	(0.032)	(0.006)	(0.034)
Drought, last monsoon	0.035	0.028	0.006	−0.044***
	(0.028)	(0.025)	(0.004)	(0.017)
× Group member	−0.102*	0.042	0.005	0.062**
	(0.060)	(0.030)	(0.009)	(0.026)
Mean of outcome	0.36	0.12	0.01	0.05
Observations	9,074	9,074	9,074	9,074

Notes: This table repeats Table 9 with division-by-wave fixed effects in place of wave fixed effects. Each column is a separate linear probability model with household, division-by-wave and interview-month fixed effects and controls for temperature and floods (per one standard deviation in the share flooded) in this and the last monsoon. Panel A interacts drought with contributing to religious infrastructure in the previous wave; Panel B with membership in a religious group in the previous wave. Since both measures come from the previous wave, the sample is waves 2 and 3. Social networks include friends, relatives and employers. Standard errors clustered by village in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table B19: Do Past Donors Borrow More? Controlling for Wave-1 Wealth and Borrowing

	Borrowed from (=1)					
	Social network		Moneylender		Shopkeeper	
	(1)	(2)	(3)	(4)	(5)	(6)
Past donor	−0.016	−0.015	−0.022	−0.021	0.006	0.006
	(0.022)	(0.022)	(0.018)	(0.018)	(0.004)	(0.004)
Drought, this monsoon	−0.044	−0.049	−0.061**	−0.053	0.006	0.005
	(0.042)	(0.043)	(0.029)	(0.032)	(0.006)	(0.007)
× Past donor	0.036	0.048	0.085***	0.079**	−0.013**	−0.015**
	(0.040)	(0.040)	(0.032)	(0.034)	(0.006)	(0.006)
Drought, last monsoon	0.056	0.033	−0.002	0.006	0.001	0.000
	(0.040)	(0.042)	(0.027)	(0.033)	(0.005)	(0.006)
× Past donor	−0.033	−0.025	0.035	0.033	−0.003	−0.004
	(0.033)	(0.033)	(0.027)	(0.028)	(0.007)	(0.007)
Mean of outcome	0.36	0.36	0.12	0.12	0.01	0.01
Division × wave FE	No	Yes	No	Yes	No	Yes
Observations	9,070	9,070	9,070	9,070	9,070	9,070

Notes: Each column is a separate linear probability model with household and interview-month fixed effects and temperature and flood controls. Odd-numbered columns include wave fixed effects; even-numbered columns replace them with division-by-wave fixed effects. All columns also control for drought in this and the last monsoon interacted with wave-1 wealth (top two quintiles) and with wave-1 borrowing. A past donor is a household that contributed to religious infrastructure in the previous wave. Standard errors clustered by village in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table B20: Robustness: Conley Standard Errors for Religious Contributions, Secular Contributions and Private Devotion

	Contributions		Private devotion: religious activity 3–6 AM (=1)	
	Religious infrastructure (=1)	Secular index (std.)	Main male	Main female
	(1)	(2)	(3)	(4)
A. Household and wave fixed effects				
Drought, this monsoon	0.084	0.011	−0.032	−0.026
SE, clustered by village	(0.023)***	(0.052)	(0.016)**	(0.016)
Conley SE, 50 km	[0.031]***	[0.054]	[0.017]*	[0.019]
Conley SE, 150 km	[0.035]**	[0.055]	[0.019]*	[0.019]
Conley SE, 300 km	[0.039]**	[0.061]	[0.018]*	[0.016]
Drought, last monsoon	0.077	0.006	0.001	0.014
SE, clustered by village	(0.019)***	(0.035)	(0.013)	(0.016)
Conley SE, 50 km	[0.024]***	[0.040]	[0.015]	[0.017]
Conley SE, 150 km	[0.025]***	[0.044]	[0.017]	[0.019]
Conley SE, 300 km	[0.025]***	[0.042]	[0.017]	[0.019]
Share flooded (1 SD), this monsoon	0.001	−0.064	−0.018	0.003
SE, clustered by village	(0.009)	(0.018)***	(0.006)***	(0.007)
Conley SE, 50 km	[0.011]	[0.019]***	[0.007]***	[0.008]
Conley SE, 150 km	[0.013]	[0.021]***	[0.006]***	[0.008]
Conley SE, 300 km	[0.014]	[0.019]***	[0.006]***	[0.007]
Share flooded (1 SD), last monsoon	0.014	0.007	−0.018	0.003
SE, clustered by village	(0.011)	(0.024)	(0.006)***	(0.007)
Conley SE, 50 km	[0.013]	[0.028]	[0.007]***	[0.008]
Conley SE, 150 km	[0.013]	[0.029]	[0.007]***	[0.008]
Conley SE, 300 km	[0.012]	[0.028]	[0.006]***	[0.007]
Observations	16,709	16,709	10,586	16,632
B. Household and division-by-wave fixed effects				
Drought, this monsoon	0.014	−0.086	−0.014	−0.026
SE, clustered by village	(0.025)	(0.056)	(0.018)	(0.018)
Conley SE, 50 km	[0.028]	[0.055]	[0.019]	[0.020]
Conley SE, 150 km	[0.028]	[0.056]	[0.020]	[0.020]
Conley SE, 300 km	[0.028]	[0.054]	[0.020]	[0.019]
Drought, last monsoon	0.036	−0.037	−0.004	0.010
SE, clustered by village	(0.020)*	(0.033)	(0.015)	(0.019)
Conley SE, 50 km	[0.024]	[0.035]	[0.016]	[0.019]
Conley SE, 150 km	[0.021]*	[0.031]	[0.018]	[0.021]
Conley SE, 300 km	[0.017]**	[0.030]	[0.019]	[0.021]
Share flooded (1 SD), this monsoon	0.005	−0.042	−0.023	0.002
SE, clustered by village	(0.011)	(0.020)**	(0.007)***	(0.008)
Conley SE, 50 km	[0.014]	[0.021]**	[0.007]***	[0.009]
Conley SE, 150 km	[0.015]	[0.021]**	[0.008]***	[0.008]
Conley SE, 300 km	[0.014]	[0.020]**	[0.007]***	[0.008]
Share flooded (1 SD), last monsoon	−0.005	−0.017	−0.017	0.003
SE, clustered by village	(0.012)	(0.020)	(0.007)**	(0.008)
Conley SE, 50 km	[0.014]	[0.022]	[0.007]**	[0.008]
Conley SE, 150 km	[0.013]	[0.024]	[0.007]**	[0.008]
Conley SE, 300 km	[0.011]	[0.024]	[0.007]**	[0.007]
Observations	16,709	16,709	10,586	16,632

Notes: This table repeats Table 6 and its division-by-wave version with standard errors that allow for spatial correlation (Conley 1999). Parentheses: standard errors clustered by village. Brackets: Conley standard errors with a Bartlett kernel and cutoffs of 50, 150 and 300 km, allowing correlation across villages within a wave and within a village across waves. Stars on each standard error use that standard error. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table B21: Robustness: Conley Standard Errors for Responses by Wave-1 Wealth

	Contributions		Private devotion: religious activity 3–6 AM (=1)	
	Religious infrastructure (=1)	Secular index (std.)	Main male	Main female
	(1)	(2)	(3)	(4)
A. Household and wave fixed effects				
Drought, this monsoon	0.123	0.043	−0.051	−0.037
SE, clustered by village	(0.026)***	(0.052)	(0.016)***	(0.018)**
Conley SE, 50 km	[0.034]***	[0.054]	[0.017]***	[0.020]*
Conley SE, 150 km	[0.038]***	[0.051]	[0.018]***	[0.018]**
Conley SE, 300 km	[0.041]***	[0.054]	[0.017]***	[0.015]**
Drought, this monsoon × Richer	−0.100	−0.080	0.046	0.028
SE, clustered by village	(0.022)***	(0.066)	(0.019)**	(0.021)
Conley SE, 50 km	[0.026]***	[0.068]	[0.021]**	[0.022]
Conley SE, 150 km	[0.030]***	[0.064]	[0.019]**	[0.020]
Conley SE, 300 km	[0.029]***	[0.066]	[0.019]**	[0.017]*
Drought, last monsoon	0.084	−0.017	−0.023	0.003
SE, clustered by village	(0.022)***	(0.035)	(0.015)	(0.017)
Conley SE, 50 km	[0.027]***	[0.039]	[0.016]	[0.017]
Conley SE, 150 km	[0.030]***	[0.048]	[0.018]	[0.019]
Conley SE, 300 km	[0.031]***	[0.048]	[0.016]	[0.019]
Drought, last monsoon × Richer	−0.018	0.056	0.055	0.024
SE, clustered by village	(0.018)	(0.048)	(0.018)***	(0.016)
Conley SE, 50 km	[0.020]	[0.051]	[0.019]***	[0.016]
Conley SE, 150 km	[0.026]	[0.055]	[0.018]***	[0.014]*
Conley SE, 300 km	[0.029]	[0.054]	[0.018]***	[0.014]*
Observations	16,703	16,703	10,580	16,626
B. Household and division-by-wave fixed effects				
Drought, this monsoon	0.051	−0.066	−0.033	−0.037
SE, clustered by village	(0.028)*	(0.054)	(0.019)*	(0.020)*
Conley SE, 50 km	[0.032]	[0.054]	[0.019]*	[0.021]*
Conley SE, 150 km	[0.030]*	[0.053]	[0.018]*	[0.020]*
Conley SE, 300 km	[0.029]*	[0.052]	[0.018]*	[0.018]**
Drought, this monsoon × Richer	−0.093	−0.052	0.047	0.026
SE, clustered by village	(0.022)***	(0.064)	(0.020)**	(0.021)
Conley SE, 50 km	[0.027]***	[0.067]	[0.021]**	[0.022]
Conley SE, 150 km	[0.032]***	[0.064]	[0.020]**	[0.020]
Conley SE, 300 km	[0.031]***	[0.068]	[0.020]**	[0.017]
Drought, last monsoon	0.043	−0.061	−0.024	0.000
SE, clustered by village	(0.022)*	(0.035)*	(0.017)	(0.020)
Conley SE, 50 km	[0.027]	[0.036]*	[0.018]	[0.020]
Conley SE, 150 km	[0.025]*	[0.039]	[0.019]	[0.021]
Conley SE, 300 km	[0.022]**	[0.038]	[0.018]	[0.021]
Drought, last monsoon × Richer	−0.018	0.059	0.046	0.023
SE, clustered by village	(0.018)	(0.046)	(0.019)**	(0.016)
Conley SE, 50 km	[0.021]	[0.049]	[0.020]**	[0.016]
Conley SE, 150 km	[0.027]	[0.055]	[0.019]**	[0.014]*
Conley SE, 300 km	[0.028]	[0.055]	[0.019]**	[0.014]*
Observations	16,703	16,703	10,580	16,626

Notes: This table repeats Table 7 and its division-by-wave version with standard errors that allow for spatial correlation (Conley 1999). The shock rows give the effect for poorer households, and the "× Richer" rows the difference between richer and poorer households. Flood interactions are included in the regressions but not shown. Parentheses: standard errors clustered by village. Brackets: Conley standard errors with a Bartlett kernel and cutoffs of 50, 150 and 300 km. Stars on each standard error use that standard error. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table B22: Robustness: Balanced Panel

	Contributions		Private devotion: religious activity 3–6 AM (=1)	
	Religious infrastructure (=1)	Secular index (std.)	Main male	Main female
	(1)	(2)	(3)	(4)
A. Household and wave fixed effects				
Drought, this monsoon	0.083***	0.001	−0.032**	−0.025
	(0.023)	(0.053)	(0.016)	(0.017)
Drought, last monsoon	0.089***	0.028	0.002	0.005
	(0.020)	(0.038)	(0.013)	(0.017)
Share flooded (1 SD), this monsoon	0.002	−0.064***	−0.017***	0.006
	(0.009)	(0.020)	(0.006)	(0.008)
Share flooded (1 SD), last monsoon	0.015	0.006	−0.019***	0.008
	(0.011)	(0.026)	(0.007)	(0.008)
Mean of outcome	0.80	−0.01	0.16	0.22
Observations	13,613	13,613	9,886	13,544
B. Household and division-by-wave fixed effects				
Drought, this monsoon	0.012	−0.095*	−0.013	−0.022
	(0.025)	(0.055)	(0.018)	(0.018)
Drought, last monsoon	0.031	−0.027	−0.003	0.009
	(0.021)	(0.035)	(0.015)	(0.021)
Share flooded (1 SD), this monsoon	0.006	−0.042**	−0.019***	0.004
	(0.012)	(0.021)	(0.007)	(0.009)
Share flooded (1 SD), last monsoon	−0.003	−0.017	−0.015**	0.009
	(0.012)	(0.022)	(0.007)	(0.008)
Mean of outcome	0.80	−0.01	0.16	0.22
Observations	13,613	13,613	9,886	13,544

Notes: This table repeats Table 6 for households observed in all three waves. Panel A includes household, wave and interview-month fixed effects; Panel B replaces wave fixed effects with division-by-wave fixed effects. All regressions control for temperature and heat days in this and the last monsoon. Columns 1 and 3–4 are linear probability models; column 2 is estimated by OLS. Flood effects are per one standard deviation in the share flooded. Standard errors clustered by village in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table B23: Robustness: Balanced Panel, Responses by Wave-1 Wealth

	Contributions		Private devotion: religious activity 3–6 AM (=1)	
	Religious infrastructure (=1)	Secular index (std.)	Main male	Main female
	(1)	(2)	(3)	(4)
A. Household and wave fixed effects				
Drought, this monsoon	0.118***	0.031	−0.049***	−0.035**
	(0.026)	(0.053)	(0.017)	(0.018)
× Richer	−0.088***	−0.075	0.043**	0.024
	(0.022)	(0.068)	(0.020)	(0.021)
Drought, last monsoon	0.097***	0.011	−0.021	0.002
	(0.023)	(0.039)	(0.015)	(0.019)
× Richer	−0.020	0.040	0.052***	0.007
	(0.020)	(0.050)	(0.019)	(0.018)
Share flooded (1 SD), this monsoon	0.003	−0.070***	−0.018***	−0.001
	(0.011)	(0.026)	(0.006)	(0.007)
× Richer	0.001	0.020	0.002	0.016
	(0.012)	(0.037)	(0.010)	(0.013)
Share flooded (1 SD), last monsoon	0.007	−0.006	−0.011*	0.010
	(0.012)	(0.026)	(0.006)	(0.007)
× Richer	0.027**	0.035	−0.026**	−0.010
	(0.012)	(0.044)	(0.011)	(0.013)
Mean of outcome	0.80	−0.01	0.16	0.22
Observations	13,607	13,607	9,880	13,538
B. Household and division-by-wave fixed effects				
Drought, this monsoon	0.045	−0.077	−0.030	−0.032
	(0.027)	(0.055)	(0.019)	(0.020)
× Richer	−0.084***	−0.047	0.043**	0.022
	(0.022)	(0.066)	(0.020)	(0.022)
Drought, last monsoon	0.040*	−0.042	−0.021	0.006
	(0.024)	(0.038)	(0.017)	(0.022)
× Richer	−0.024	0.038	0.043**	0.006
	(0.020)	(0.048)	(0.020)	(0.018)
Share flooded (1 SD), this monsoon	0.009	−0.050*	−0.019**	−0.002
	(0.014)	(0.026)	(0.008)	(0.009)
× Richer	−0.005	0.025	−0.000	0.017
	(0.011)	(0.037)	(0.010)	(0.013)
Share flooded (1 SD), last monsoon	−0.008	−0.028	−0.008	0.010
	(0.013)	(0.023)	(0.007)	(0.008)
× Richer	0.018	0.036	−0.026**	−0.006
	(0.012)	(0.043)	(0.011)	(0.013)
Mean of outcome	0.80	−0.01	0.16	0.22
Observations	13,607	13,607	9,880	13,538

Notes: This table repeats Table 7 for households observed in all three waves. Panel A includes household, wave and interview-month fixed effects; Panel B replaces wave fixed effects with division-by-wave fixed effects. Each shock is interacted with an indicator for richer households (top two quintiles of the wave-1 wealth index). Flood effects are per one standard deviation in the share flooded. Standard errors clustered by village in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.