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**Consumption Smoothing and the Welfare Cost of  
Uncertainty**

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## **Abstract**

What is the effect of income uncertainty on individual well-being? Combining individual-level panel data from rural Ethiopia with high-resolution meteorological data, we estimate that mean-preserving increases in rainfall variability are associated with reductions in objective consumption and subjective well-being. We show that the reductions in consumption, through precautionary savings, explain only 14-21% of the total effect on individual well-being. Increased uncertainty has a direct effect on individual well-being, above and beyond its effects on consumption. These findings suggest that the gains from further consumption smoothing are likely greater than estimates based solely on realized consumption fluctuations.

**Keywords:** Income Uncertainty, consumption smoothing, subjective well-being, anticipatory utility, rainfall variability

**JEL codes:** I31; O13; Q12; Q56

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# 1 Introduction

Economists have long recognized that an individual’s sense of well-being depends not only on their average income or expenditures, but on the risk they face as well. In the presence of insurance and credit market failures, households are exposed to consumption risk and must rely on imperfect risk-sharing mechanisms. This is especially true for those living in rural parts of developing countries, most of whom depend on risky rain-fed agriculture for their livelihoods. The dominant risk in these settings is unpredictable rainfall (Townsend, 1994a; Giné et al., 2007). Where households are unable to perfectly smooth consumption, welfare gains exist from further consumption smoothing (Paxson, 1992; Townsend, 1994b; Udry, 1994; Morduch, 1995; Fafchamps and Lund, 2003; Jayachandran, 2006; Suri, 2011; Porter, 2012; Morten, 2013; Bryan et al., 2014; Dercon and Porter, 2014; Kinnan, 2017). However, evidence to date on the returns to further consumption smoothing is based on the effects of *ex post* income shocks. The gains to further consumption will be underestimated if *ex ante* effects of income uncertainty are empirically relevant.

This paper provides early evidence, showing that income uncertainty has direct effects on individual well-being beyond its effects through consumption. Using individual and household panel data from rural Ethiopia combined with high-resolution meteorological data, we measure and identify the effects of income uncertainty on measures of subjective and objective well-being. To identify the effects of income uncertainty we exploit within-village variation in a 5-year moving-average of the coefficient of variation of rainfall, controlling for non-linear rainfall and temperature realizations over the same period – a proxy for mean-preserving changes in income uncertainty.

We document that increases in inter-annual rainfall variability are associated with reductions in consumption, consistent with a precautionary savings response. We also estimate significant effects of rainfall variability on life satisfaction. In the standard expected utility framework current utility depends only on anticipated future utility through its effects on consumption. Greater uncertainty reduces contemporaneous consumption due to precautionary savings. However, uncertainty about future income may also have a direct effect on individual well-being. The degree to which it does can be framed through the concept of anticipatory utility. Anticipatory utility has been a widely debated subject in academic and policy circles dating back to the time of Hume (1711–1776), Bentham (1789), Marshall (1891) and Jevons (1905). Recently, work in behavioral economics has formalized the potential contribution of anticipatory utility on decision-making (Lowenstein, 1987; Geanakoplos et al., 1989; Caplin and Leahy, 2001; Yariv, 2001; Brunnermeier and Parker, 2005; Dillenberger, 2010; Brunnermeier et al., 2017; Strzalecki, 2013; Ely et al., 2015). If anticipatory utility is

empirically relevant in this context then income uncertainty should have a direct effect on individual utility, above and beyond the indirect effect effects through current consumption. Reductions in consumption through the precautionary savings will no longer characterize the gains from further consumption smoothing.

To estimate the direct effect we identify the average controlled direct effect, following [Acharya et al. \(2016\)](#). We estimate that only 14-21% of the total effect of rainfall variability on life satisfaction is driven by consumption. Rainfall variability has a direct effect on individual well-being above and beyond the effects on realized consumption, consistent with models of anticipatory utility. As such, the returns to further consumption smoothing are likely much greater than estimates based solely on observed consumption fluctuations and sufficient statistic approaches ([Chetty and Looney, 2006](#); [Chetty, 2009](#)).

We note caveats. First, the main empirical challenge is separately identifying the effects of income uncertainty from realized income shocks. There are two possible ways to interpret changes in rainfall variability. One is that increases in rainfall variability capture an increase in income uncertainty. Alternatively, it is possible that residual variation in realized income shocks could drive any effects. We present direct evidence that rainfall variability is a reasonable proxy for income uncertainty in this context. We show that rainfall variability is uncorrelated with historical, contemporaneous, and future rainfall realizations. Rainfall variability is not systematically correlated with more or less rainfall, attenuating the possibility of a direct income effect. Increases in rainfall variability are mean-preserving. Consistent with this we show that rainfall variability has no effect on a broad range of income, wealth, and agricultural production outcomes. Collectively, these findings support the premise that rainfall variability is not having an effect through agricultural markets or income. It stands to reason that if increased rainfall variability was picking up residual income shocks then these shocks should have an effect on income and agricultural outcomes. While we cannot rule out the total absence of any direct income effects, our results suggest that any residual variation in income shocks are unlikely to be a first-order explanation for our results. Second, our decomposition of the direct and indirect effects of income uncertainty may be affected by measurement error in consumption. If so, the indirect effect will be attenuated. However, even if the effect of consumption on life satisfaction was attenuated by a factor of 5 the estimated direct effect would still account for 30% of the total effect, i.e., the return to further consumption smoothing would be 50% higher than based solely on the reduction in consumption. Third, subjective well-being is not utility. It is possible that consumption is sufficient for utility, but individuals have different utility functions over consumption that lead them to report different levels of well-being conditional on utility. In such a case, our finding that income uncertainty is empirically relevant remains important.

Our findings make three contributions. First, we provide early evidence that the returns to further consumption smoothing in rural areas of developing countries are likely to be substantially greater than estimates based solely on consumption fluctuations and realized shocks, contributing to the literature on consumption smoothing (Paxson, 1992; Townsend, 1994b; Udry, 1994; Morduch, 1995; Fafchamps and Lund, 2003; Jayachandran, 2006; Suri, 2011; Porter, 2012; Morten, 2013; Bryan et al., 2014; Dercon and Porter, 2014; Kinnan, 2017). This finding also has relevance to the broader literature on the returns to insurance provision. Recent work has highlighted the potential benefits of health insurance on mental health and well-being (Finkelstein et al., 2012; Haushofer et al., 2020). Further work exploring the degree to which access to other types of insurance, in developed and developing countries, contribute to mental health and well-being, above and beyond their primary purpose of providing protection against unexpected consumption drops presents promising opportunities for future research.

Second, we contribute to the literature on anticipatory utility. A large theoretical literature has posited the importance of anticipation and beliefs in affecting utility (Lowenstein, 1987; Geanakoplos et al., 1989; Caplin and Leahy, 2001; Yariv, 2001; Brunnermeier and Parker, 2005; Dillenberger, 2010; Brunnermeier et al., 2017; Strzalecki, 2013; Ely et al., 2015). More recently, there has been laboratory experiments that have provided empirical support for anticipatory utility in economics (Mayraz, 2013; Falk and Zimmerman, 2017) and from fMRI experiments in Neuroscience (Berns et al., 2006; Schmitz and Grillon, 2012; Engelmann et al., 2015, 2019). However, there has been little evidence documenting the empirical consequences of anxiety, or anticipation utility, in real world settings. We provide early evidence that anxiety through anticipation about the future may have empirical relevance in the real world. Given the empirical relevance of anxiety on individual well-being, future research should seek to understand the economic consequences of anxiety in other real world, high-stakes, settings and evaluate the returns to programs that directly target anxiety and mental health.

Third, we highlight that the inclusion of subjective welfare measures, alongside objective measures, can be useful in helping researchers and policymakers to understand the economic lives of the poor and evaluate the broader welfare effects associated with policy interventions, important for cost-benefit analysis. We contribute to the rapidly growing literature that uses subjective measures of well-being to elicit measures of experienced utility (Kahneman et al., 1997; Frey and Stutzer, 2002; Layard, 2005; Kahneman and Krueger, 2006; Dolan and Kahneman, 2008; Benjamin et al., 2012; Aghion et al., 2015; De Neve et al., 2015), to value non-market goods (Welsch, 2002, 2006; Rehdanz and Maddison, 2011; Carroll et al., 2009; Frey et al., 2010; Levinson, 2012; Feddersen et al., 2015; Baylis, 2016), and to evaluate

government policy (Gruber and Mullainathan, 2005; Diener et al., 2009; Dolan et al., 2011; Levinson, 2013). Our findings demonstrate that the inclusion of subjective well-being measures, alongside objective measures of well-being, can help to provide a deeper understanding of individual welfare than objective measures could provide alone.

The remainder of the paper is structured as follows: section 2 presents a conceptual framework; section 3 presents the data and economic context; section 4 presents the empirical strategy and provides supporting evidence for the premise that rainfall variability is a reasonable proxy for income uncertainty; section 5 presents our results; the final section concludes.

## 2 Conceptual Framework

In this section we show that, in the standard economic framework, income uncertainty only has an effect on utility through consumption. However, if anxiety about increased income uncertainty enters the utility function directly through anticipatory utility, consumption drops associated with an increase in income uncertainty are no longer sufficient for describing the returns to further consumption smoothing. The return to further consumption smoothing will be underestimated.

### Basic environment

In the conventional model of life-cycle consumption under uncertainty (Hall, 1978), agents choose the consumption path that maximizes,

$$U(c_0, c_1, \dots) = \sum_{t=0}^{\infty} \beta^t \mathbb{E}[u(c_t)]$$

subject to the budget constraint,

$$a_{t+1} = Ra_t + y_t - c_t$$

If we assume that  $\beta R = 1$ , we obtain the Euler equation,

$$\mathbb{E}u'(c_{t+1}) = u'(c_t)$$

Rational agents will optimally choose to smooth consumption over time. If we assume that households have quadratic utility, then optimal consumption becomes,

$$c_t = \left( \frac{r}{1+r} \right) \left[ a_t + \sum_{j=0}^{\infty} \left( \frac{1}{1+r} \right)^j \mathbb{E}(y_{t+j}) \right]$$

Consumption equals permanent income, i.e., the annuity value of human and financial wealth. This is the permanent income hypothesis.

### The effects of a mean-preserving increase in income uncertainty

Within this model we can ask what happens to consumption in period  $t$  if there is a mean-preserving increase in income uncertainty. We define income,

$$\tilde{y}_t = \bar{y} + \epsilon_t$$

where  $\bar{y}$  is average income and  $\epsilon_t$  the stochastic component, with  $\mathbb{E}(\epsilon_t) = 0$  and  $\text{var}(\epsilon_t) = \sigma_\epsilon$ . In this case, the optimal consumption path can be rewritten,

$$\begin{aligned} c_t &= \left( \frac{r}{1+r} \right) \left[ a_t + \sum_{j=0}^{\infty} \left( \frac{1}{1+r} \right)^j \bar{y} + \mathbb{E}(\epsilon_{t+j}) \right] \\ &= \left( \frac{r}{1+r} \right) \left[ a_t + \sum_{j=0}^{\infty} \left( \frac{1}{1+r} \right)^j \bar{y} \right] \end{aligned}$$

With quadratic utility the variance and higher moments of the income-generating process do not matter for the determination of consumption.<sup>1</sup> If households are able to perfectly smooth consumption, increased income uncertainty will have no effect on individual well-being .

### The effects of a mean-preserving increase in income uncertainty in the presence of borrowing constraints

If households are unable to borrow then,

$$c_t = \begin{cases} \mathbb{E}(c_{t+1}) & \text{if } a_{t+1} > 0 \\ y_t + a_t & \text{if } a_{t+1} = 0 \end{cases}$$

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<sup>1</sup>The famous [Rothschild and Stiglitz \(1970\)](#) result arises from the concavity of the utility function.

where the second line follows from the budget constraint  $a_{t+1} = Ra_t + y_t - c_t$  when the constraint is binding. If we assume that  $a_t = 0$ , then the optimal level of unconstrained consumption is,

$$c_t^* = \bar{y} + \frac{r}{1+r} \epsilon_t$$

total resources are  $y_t = \bar{y} + \epsilon_t$ . If a negative shock occurs, then the agent would like to consume  $c_t > y_t$  to smooth consumption, but is constrained at  $c_t = y_t$ . A mean-preserving increase in income uncertainty makes low realizations of  $y_{t+1}$  more likely, which makes the borrowing constraint more likely to bind, reducing the value of  $\mathbb{E}(c_{t+1})$ . Thus, even if the borrowing constraint is not already binding, it may become binding in the future, reducing consumption in period  $t$ . In the presence of borrowing constraints agents fear receiving consecutive bad income realizations, which would push them towards the borrowing constraint and force them to consume their income without the ability to smooth consumption. To reduce the likelihood of this situation occurring, they save for self-insurance – a precautionary savings motive.<sup>2</sup>

In this standard framework current utility only depends on anticipated future utility through its effect on current consumption,  $c_t$ . As such, to the degree that increased rainfall variability reduces individual well-being the conventional model predicts that the effect should be driven entirely by the drop in consumption. With risk neutral agents the drop in consumption is a sufficient statistic for the welfare gains associated with further consumption smoothing. [Chetty and Looney \(2006\)](#) show that with risk averse individuals the welfare gains to further consumption smoothing are captured by the product of the coefficient of absolute risk aversion and the consumption drop.

However, if increased uncertainty has a direct effect on well-being through increased anxiety, then anticipation about future events enters the utility function indirectly, alongside the consequences of current events,

$$U_t = U_t(c_t, c_{t+1}, \dots, c_{t+j})$$

The anticipation of future unpleasant events, such as the risk of lower future income,

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<sup>2</sup>Borrowing constraints are not the only way that precautionary savings can be induced. If we relax the quadratic utility assumption and assume decreasing absolute risk aversion, such that marginal utility is convex ( $u''' > 0$ ) then individuals will behave “prudently”. A rise in income uncertainty will lead to a reduction in consumption. As such, evidence of precautionary savings should not be interpreted as proof of borrowing constraints. We assume quadratic utility for ease of exposition. The purpose of this paper, that income uncertainty could have a direct effect on utility above and beyond the effects of precautionary savings, holds irrespective of the driving force underlying any precautionary savings choices.

causes a decrease in current utility.<sup>3</sup> To the degree that anxiety through anticipatory utility is empirically relevant the reductions in consumption through the precautionary savings will no longer fully capture the returns to further consumption smoothing – the welfare gains from further consumption smoothing will be underestimated.

### 3 Data

The analysis conducted in this paper uses household survey data from rural Ethiopia. We use two rounds of a panel data set – the Ethiopian Rural Household Survey (ERHS) – that covers households from 15 villages in rural Ethiopia. The ERHS was conducted by Addis Ababa University in collaboration with the Centre for the Study of African Economies (CSAE) at the University of Oxford and the International Food Policy Research Institute (IFPRI) in seven rounds between 1989 and 2009. Households from six villages affected by drought in central and southern Ethiopia were surveyed for the first time in 1989. In 1994 the sample was expanded to cover 15 villages across the major regions of Ethiopia (Tigray, Amhara, Oromia, and Southern Nations Nationalities and People’s Region), representing 1,477 households. Further rounds were completed in 1995, 1997, 1999, 2004, and 2009. This paper makes use of the final two rounds (2004 and 2009) as only these years contain questions on subjective well-being. The additional villages incorporated in the sample were chosen to account for the diversity in farming systems throughout the country.

**Data Collection** The sampling was constructed carefully to represent the major agro-ecological zones of Ethiopia. Consequently, the location of each village is dispersed through Ethiopia, some being more than 1,000km apart. The sampling frame for the villages was strictly stratified across these zones and sub-zones, with one to three villages selected per strata.

A list of households was constructed in 1994. Within each village, stratified random sampling was used based on whether households have male or female heads. Sample sizes represent the population of each main farming system. Consequently, the data are not nationally representative, but can be considered representative of households in non-pastoralist farming systems. Attrition in the sample has also been very low. The attrition rate between 1994 and 2004 was 13.2 percent or 1.3 percent per year ([Dercon and Hoddinott, 2011](#)).

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<sup>3</sup>Insofar as there is discounting of anticipated future events, the discount rate will depend on the distance in time to the event, as well as the probability that the event occurs.

**Weather Data** In addition to the household survey data, rainfall and temperature data has been constructed from 6-hourly precipitation reanalysis data at the village level from the ERA-Interim data archive supplied by the European Centre for Medium-Term Weather Forecasting (ECMWF).<sup>4</sup> Previous studies have relied on the use of meteorological data provided by the Ethiopian meteorological service and the number of missing observations is a concern. This has been exacerbated by the serious decline in the past few decades in the number of weather stations around the world that are reporting. Lorenz and Kuntsmann (2012) show that, since 1990, the number of reporting weather stations in Africa has fallen from around 3,500 to around 500. With 54 countries in the continent, this results in an average of fewer than 10 weather stations per country.<sup>5</sup>

The ERA-Interim reanalysis data archive provides 6-hourly measurements for a very rich set of atmospheric parameters, from 1<sup>st</sup> January, 1979 until the present day, on a global grid of quadrilateral cells defined by parallels and meridians at a resolution of 0.25 x 0.25 degrees (equivalent to 28km x 28km at the equator).<sup>6</sup> Reanalysis data is constructed through a process whereby climate scientists use available observations as inputs into climate models to produce a physically consistent record of atmospheric parameters over time (Auffhammer et al., 2013). This results in an estimate of the climate system that is separated uniformly across a grid, making it more uniform in quality and realism than observations alone, and one that is closer to the state of existence than any model would provide alone. This provides a consistent measure of atmospheric parameters over time and space. This type of data is increasingly being used by economists, since it fills in the data gap apparent in developing countries, where the collection of consistent weather data is lower down the priority list in governmental budgets (see Dell et al. (2014) for a review of its recent applications in the literature).

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<sup>4</sup>See [Dee et al. \(2011\)](#) for a detailed discussion of the ERA-Interim data.

<sup>5</sup>Looking at publicly available data, the number of stations in Ethiopia included by the National Oceanic and Atmospheric Administration's (NOAA) National Climatic Data Centre (NCDC) is 18; however, if we were to apply a selection rule that required observations for 365 days, this would yield a database with zero observations. For the two years for which we have economic data (2004 and 2009), weather station data is available for 50 days in Addis Ababa in 2004 and is available for all 18 stations for an average of 200 days (minimum of 67 days, maximum of 276 days) in 2009. This is likely to result in a huge increase in measurement error when this data is used to interpolate across the 63 zones and 529 woredas (districts) reported in 2008. If this measurement error is classical, i.e., uncorrelated with the actual level of rainfall measured, then our estimates of the effect of these variables will be biased towards zero. However, given the sparsity of stations across Ethiopia (an average of 0.03 stations per woreda), the placement of stations is likely to be correlated with agricultural output; that is, weather stations are placed in more agriculturally productive areas, where the need for weather information is higher. As a result, we might expect that estimates using weather stations are systematically biased upwards. For these reasons, the use of remote-sensing data on a uniform grid has great value in areas with low station density.

<sup>6</sup>To convert degrees to km, multiply 28 by the cosine of the latitude, e.g, at 40 degrees latitude 0.25 x 0.25 degree cells are  $28 \times \cos(40) = 21.4$  km x 21.4 km.

**Sample Construction** By combining the household data with the ERA-interim data, we create a panel that allows for microeconomic analysis of weather and climate in rural Ethiopia. Summary statistics can be found in Table 1.

The outcome variables of interest from the economic data are objective real per capita consumption in adult equivalent units,  $C_{ht}$ , and subjective life satisfaction,  $\mathcal{W}_{it}$ , asked of both the household head and the spouse of the household head.

Real per capita consumption is constructed in the following way. First, all food consumption in the past 7 days is valued and scaled up to a month. In addition, expenditures on items purchased by the household in a typical month are added. On top of this, the value of own production is imputed by multiplying the quantity produced by the median price paid by other households in the same district. Finally, consumption expenditures are spatially deflated to ensure comparability over time and space. This is very important given the significant inflation observed between 2004 and 2009 due to rapid increases in world grain prices and internal monetary policy ([Alem and Söderbom, 2012](#); [Durevall et al., 2013](#)), with average inflation peaking at 55.2% and food price inflation at 92% ([Central Statistics Agency, The Federal Democratic Republic of Ethiopia, 2009](#)).

Our measure of subjective well-being in rural Ethiopia is constructed using individual responses (from the household head and spouse) corresponding to the level of agreement with the following statement as the dependent variable: “I am satisfied with my life.” A score of one is described as “Very Dissatisfied” and a score of seven is described as “Very Satisfied”. These questions are similar to the standard questions used in cross-country surveys such as the World Values Survey and the Eurobarometer Survey. We also demonstrate the robustness of our results to alternative measures of subjective well-being.

Using the weather data described above we construct our proxy for income uncertainty – rainfall variability. We start with a measure of total annual rainfall for each village, and then calculate the coefficient of variation for rainfall (CV), measured as the standard deviation divided by the mean for the previous five years, the time between survey rounds, to ensure that variation is round-specific.

In addition, we construct linear and non-linear measures of historical rainfall and temperature realizations to control for realized income shocks. As the first moment and second moment of the rainfall distribution are correlated, it is important to control for first-moment effects to isolate the effects of income uncertainty, to the degree that it is empirically relevant, from realized income effects. The following section explores the degree to which rainfall variability can be considered a reasonable proxy for income uncertainty, in light of the correlation between these measures. Across all outcomes we restrict our analysis sample to households that report data on agricultural production.

## 4 Empirical Strategy

To analyze the effects of income uncertainty on individual well-being we exploit variation in rainfall variability between survey rounds. However, to begin with we first examine the effects of rainfall variability on consumption. The effect of uncertainty on contemporaneous consumption is an empirical question: consumption expenditures may increase if farmers increase their spending on inputs that mitigate the economic consequences of future rainfall shocks (to the degree that such investments are available); consumption may decrease if farmers exhibit decreasing absolute risk aversion and engage in precautionary saving (to the degree that saving is possible); or uncertainty about future income may have no effect on present consumption if farmers are unable to smooth consumption over time. We explore the empirical relevance of these effects using the following specification,

$$\log C_{ht} = \beta \text{RAINFALL VARIABILITY}_{vt,\dots,t-4} + \gamma f(\bar{w}_{vt,\dots,t-4}) + \alpha_h + \alpha_m + \alpha_t + \epsilon_{hvt} \quad (1)$$

where  $\text{RAINFALL VARIABILITY}_{vt,\dots,t-4}$  is the variable of interest – our proxy for income uncertainty –, and  $f(\bar{w}_{vt,\dots,t-4})$  is a function of historical rainfall and temperature variables defined over the previous 5 years (the time period over which our measure of rainfall variability is measured). The weather variables included vary across specifications. In the least rigorous specification we do not include any weather controls. In the most rigorous specification we include linear and quadratic controls for rainfall and temperature over the previous 5 years and interactions between rainfall and temperature. In addition, we control for household ( $\alpha_h$ ), year ( $\alpha_t$ ), and month of survey ( $\alpha_m$ ) fixed effects.

In addition to estimating the effects of income uncertainty on objective consumption, we also examine the effects of income uncertainty on subjective well-being,

$$\mathcal{W}_{it} = \beta \text{RAINFALL VARIABILITY}_{vt,\dots,t-4} + \gamma f(\bar{w}_{vt,\dots,t-4}) + \alpha_i + \alpha_m + \alpha_t + \epsilon_{iwt} \quad (2)$$

where  $\mathcal{W}_{iwt}$  is a measure of subjective well-being, which has been standardized to aid comparisons across alternative measures of subjective well-being recorded on different scales. As for our analysis of consumption,  $\text{RAINFALL VARIABILITY}_{vt,\dots,t-4}$  is the variable of interest, and  $f(\bar{w}_{vt,\dots,t-4})$  is a function of historical rainfall and temperature variables defined over the previous 5 years described above (the time period over which our measure of rainfall variability is measured).

Individual fixed effects,  $\alpha_i$ , allow us to address any issues associated with time-invariant

unobserved individual heterogeneity, which has been shown to be an important determinant of subjective well-being (Argyle, 1999; Diener and Lucas, 1999; Ferrer-i Carbonell and Frijters, 2004). In addition to individual fixed effects, we control for year fixed effects,  $\alpha_t$ , to control for aggregate shocks, economic development, and macroeconomic policies. We also include survey month fixed effects,  $\alpha_m$ , to control for seasonal variation in the timing of the survey.

The last term in equations 1 and 2 is the stochastic error term,  $\epsilon_{iwt}$ . Standard errors are clustered at the village level, and are robust to employing the wild cluster bootstrap-t procedure to account for the small number of clusters in our sample (Cameron et al., 2008). Results are also robust to following the approach of Hsiang (2010) by assuming that the error term may be heteroskedastic and serially correlated within a district over time (Newey and West, 1987) and spatially correlated across contemporaneous villages (Conley, 1999). However, standard errors are substantially smaller.

## 4.1 Identification Assumptions

One of the attractive properties of rainfall realizations are that they are exogenous. As such, there are unlikely to be other confounding factors that are correlated both with rainfall variability and our outcomes of interest. Our key identifying assumption is the zero conditional mean assumption,  $\mathbb{E}(\epsilon_{ihvt} | \overline{rain}_{vt, \dots, t-4}, \alpha_v, \alpha_t) = 0$ . However, it is important to note that we are not trying to identify rainfall variability, rather we are using rainfall variability as a proxy for income uncertainty. As such, even though the exogeneity of rainfall variability means that the estimate will in all likelihood be identified, it is unclear how it should be interpreted. This is true of any treatment effect that could affect outcomes through multiple channels.

There are two possible interpretations for an identified rainfall variability coefficient  $\beta_1$  1) rainfall variability is capturing the effects of income uncertainty; 2) there is no change in income uncertainty and rainfall variability is simply picking up the residual effects of past or contemporaneous income shocks.

To capture the effects of uncertainty, it is important that increases in rainfall variability are mean-preserving. Consequently, the key assumption for identifying the effects of income uncertainty, rather than rainfall variability more broadly, is that rainfall variability is uncorrelated with past, contemporaneous, or expected future, rainfall shocks. A second requirement for an income uncertainty interpretation is that there is both a change in the underlying rainfall distribution and that beliefs about the underlying rainfall distribution also change. Looking at the data one observes that, on average, there is a significant reduction in

5-year rainfall variability between rounds, rather than a stable distribution over time (Figure 1). Prior to the 2004 round rainfall variability was, on average, at a markedly higher level. After 2004, rainfall variability dropped and remained at a lower level for the next 5 years. This suggests that there are medium run changes in the underlying distribution of rainfall and that consequently, there is scope for individuals to change their beliefs in response to changes in rainfall variability across rounds. Unfortunately, data limitations do not allow us to test whether beliefs change directly. This is an important assumption because if beliefs don't change there should be no change in outcomes, unless driven by residual variation in income shocks. Below we provide supporting evidence for these identification assumptions, suggesting that a residual shocks interpretation is unlikely to be a first-order concern in this context.

#### 4.1.1 Supporting Evidence: The Mean-Preserving Nature of Rainfall Variability

We begin by directly assessing whether rainfall variability is mean-preserving by evaluating the effects of rainfall variability on historical and future rainfall realizations, using the full sample of weather data described above (1979–2012). If rainfall variability is not mean-preserving and affects historical weather realizations, then our measure of income uncertainty may simply capture any residual contemporaneous or persistent impacts of realized rainfall shocks. If rainfall variability is associated with contemporaneous or historical income shocks (which could have persistent effects), these could drive our main results. Furthermore, if rainfall variability is not mean-preserving and farmers update their expectations about future rainfall realizations based on changes in rainfall variability, then increases in rainfall variability may simply capture expectations about future income. To explore these considerations, we regress rainfall, measured in mm, in period  $t$  on rainfall variability in the previous 5 years – the time between survey rounds – using the following specification,

$$\begin{aligned} \text{RAINFALL}_{vt} &= \beta \text{RAINFALL VARIABILITY}_{vt,\dots,t-4} + \gamma f(\bar{w}_{vt,\dots,t-4}) \\ &+ \alpha_v + \alpha_t + \epsilon_{vt} \end{aligned} \tag{3}$$

The results of this exercise are presented in Table A16. We find no evidence of rainfall variability having a meaningful statistical or economic effect on historical, contemporaneous, or future rainfall realizations. This supports the premise that rainfall variability is mean-preserving and so should not have a direct income or wealth effect, other than through behavioral responses to changes in uncertainty. Indeed, the absence of direct effects on

rainfall realizations significantly attenuates the mechanism through which direct income effects might arise.

Consequently, it is unlikely that increases in rainfall variability capture contemporaneous income effects, the persistent effects of historical income shocks, or expectations about future income realizations. While we can never rule out any residual correlation between rainfall variability and realized events, these results suggest that first-order concerns should be alleviated.

#### 4.1.2 Supporting Evidence: The Absence of Rainfall Variability Effects on Income-related Outcomes

In addition, to demonstrating the mean-preserving properties of rainfall variability we also explore the consequences of rainfall variability on a broad set of income-related outcomes.

Using data on each household's agricultural production, we calculate agricultural yields, defined as the cultivated production of each crop divided by its cultivated area.<sup>7</sup> However, exploring the effects of rainfall variability on yields is not sufficient to rule out a change in income. While yields and income are correlated, prices, wages, and consequently labor supply decisions may also be affected (Foster and Rosenzweig, 2004; Jayachandran, 2006; Kaur, 2019; Colmer, 2020). If the price that households receive for their crops changes, or wages change, then income may still be affected. Consequently, in addition to examining the effects of rainfall variability on yields, we explore the effects of rainfall variability on the share of crop sold – an evaluation of the degree to which households respond to price effects in the event of their existence – as well as directly examining the effects of rainfall variability on price, which is available for households that sell their produce.

Using this data, we estimate crop-specific effects of rainfall variability on yield, share sold, and price,

$$\begin{aligned} \log(Y_{chvt}) = & \beta \text{RAINFALL VARIABILITY}_{vt,\dots,t-4} + \gamma f(\bar{w}_{vt,\dots,t-4}) \\ & + \alpha_{ch} + \alpha_m + \alpha_t + \epsilon_{chvt} \end{aligned} \quad (4)$$

where  $\text{RAINFALL VARIABILITY}_{vt,\dots,t-4}$  is my proxy for income uncertainty – the coefficient of variation for rainfall measured over the previous 5 years – and  $f(\bar{w}_{vt,\dots,t-4})$  is a function of historical weather variables measured over the previous 5 years. The weather variables included vary across specifications. In the least rigorous specification we do not include any

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<sup>7</sup>The crops used are maize, wheat, white teff, barley, sorghum, black teff, coffee, chat and enset, constituting the major staple crops and cash crops of Ethiopia.

weather controls. In the most rigorous specification we include linear and quadratic controls for rainfall and temperature over the previous 5 years and interactions between rainfall and temperature.  $\alpha_{ch}$  captures crop–household fixed effects,  $\alpha_t$  captures year fixed effects, and  $\alpha_m$  captures month-of-survey fixed effects.<sup>8</sup>

In Appendix A.1 we provide an initial examination of the relationship between rainfall and yields, to underscore the importance of rainfall for the livelihoods of smallholder farmers in Ethiopia, and to shed some light on potential structure of the functional form underlying the relationship within this context. Table A1 presents the results of various specifications, all demonstrating that rainfall appears to have a positive and relatively linear relationship with yields; i.e., more rainfall is better.

In addition to looking at agricultural outcomes, we also explore how rainfall variability may affect farm-input choices such as the number of crops planted, the share of the main crop. In addition, we evaluate the potential for wage and labor supply effects, examining the average daily wage of hired farm labor, the number of worker days employed conditional on hiring labor, and whether the household hired any workers.

As well as on-farm labor decisions that affect cost, we also explore off-farm labor decisions as an alternative income-generating activity. We examine whether individuals are engaged in off-farm work, whether they are engaged in work outside of the village – a proxy for migratory behavior – and the number of days that they work off-farm. Finally, we explore whether household assets are likely to be affected through an examination of livestock – the most important marketable asset in Ethiopia, accounting for more than 90% of the total value of assets (Dercon, 2004). We examine whether households make any changes to the number of livestock they own or whether they sell or slaughter any livestock.

These outcomes are evaluated at the household level,

$$\begin{aligned} \log(Y_{hvt}) = & \beta \text{RAINFALL VARIABILITY}_{vt,\dots,t-4} + \gamma f(\bar{w}_{vt,\dots,t-4}) \\ & + \alpha_h + \alpha_m + \alpha_t + \epsilon_{hvt} \end{aligned} \quad (5)$$

except for livestock outcomes, which are evaluated at the livestock–household level.<sup>9</sup>

$$\begin{aligned} \log(Y_{lhvt}) = & \beta \text{RAINFALL VARIABILITY}_{vt,\dots,t-4} + \gamma f(\bar{w}_{vt,\dots,t-4}) \\ & + \alpha_{lh} + \alpha_m + \alpha_t + \epsilon_{lhvt} \end{aligned} \quad (6)$$

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<sup>8</sup>Results are robust to estimating the model at the household level, aggregating across crops.

<sup>9</sup>13 types of livestock are included in the analysis: Calves, Bulls, Oxen, Heifer, Cows, Sheep, Goats, Horses, Donkeys, Mules, Camels, Young Bulls, and Chicken

Tables 3, 4, 5, 6, and 7 present the results of these exercises. Across all specifications we find no effects of rainfall variability. These results are robust to excluding or including historical weather controls, accounting for non-linearities in the rainfall and temperature distribution, and accounting for interactions between temperature and rainfall. The estimated effects are both statistically insignificant and economically small in magnitude. Appendix A.2 presents additional results that highlight the robustness of these findings to alternative measures and time definitions of rainfall variability. Combined, these findings provide compelling support for the premise that rainfall variability has no direct effect on income.

These results provide two key insights. First, they provide additional support for the premise that rainfall variability is capturing a measure of income uncertainty rather than realized rainfall shocks. This is further supported by the results in Appendix A.1, which highlight the importance of rainfall for the livelihoods of smallholder farmers in Ethiopia. The magnitude of our coefficients for rainfall variability are substantially smaller than the effects of rainfall realizations (as they should be). Of course, the argument in support of interpreting our results as capturing uncertainty than the consequences of a realized income shock relies on evidence in support of the null. This leaves open the possibility that other unobservables could be affected. However, to the degree that these unobservables are affected they do not appear to have a meaningful effect on yields, or other income sources and so we argue that they are likely to be second-order.

Second, conditional on accepting that rainfall variability is capturing the effects of income uncertainty, our findings suggest that farmers have limited opportunities to manage the consequences of changes in income uncertainty. Researchers have shown that expectations about rainfall realizations result in changes to irrigation choices, crop choices, and other planting decisions (Kurukulasuriya and Mendelsohn, 2008; Deressa et al., 2009; Kurukulasuriya et al., 2011; Miller, 2013; Rosenzweig and Udry, 2013; Gine et al., 2015; Kala, 2017; Taraz, 2017). However, this work is largely based on work in which farmers are provided with increased information about future realizations, which while reducing uncertainty is less likely to be mean-preserving. It is unclear how farmers should respond to a mean-preserving change in rainfall variability. Bryan (2017) shows that ambiguity aversion can be an important barrier to adopting risky technologies and so farmers may have limited means to manage increases in uncertainty.

## 5 Main Results

In this section we examine the effects of rainfall variability, our proxy for income uncertainty, on real consumption per capita and life satisfaction. First we examine the effect

of income uncertainty on real consumption per capita – an objective measure of household welfare. In the theoretical motivation we discussed that a mean-preserving increase in income uncertainty will result in a reduction in contemporaneous consumption in the presence of borrowing constraints or prudence. The results in Table 8 show that greater rainfall variability is associated with significant reductions in real per capita consumption. In the most rigorous specification (column 5), we estimate that a one standard deviation increase in rainfall variability (3.031 points) is associated with a 10% reduction in real per capita consumption.<sup>10</sup> Taken at face value, these findings suggest that households would be willing to pay at least 10% of consumption to reduce rainfall variability by one standard deviation. This inference is robust to applying the wild cluster bootstrap-t procedure to account for the small number of clusters, presented in brackets, to alternative timing definitions for rainfall variability and alternative measure of rainfall variability (Appendix A.3), and to a randomization inference approach, highlighting that the results are unlikely to be driven by sampling variability (Appendix A.4).

We are also interested in understanding whether uncertainty has broader effects on individual well-being. If uncertainty affects individual well-being above and beyond the effects of consumption then the returns to further consumption smoothing are likely greater than implied by the estimated reductions in consumption. In this case, current utility will depend on anticipated future utility through its effects on consumption and directly. The consumption drop will not fully characterize the gains from further consumption smoothing.

We begin by examining the effects of rainfall variability on life satisfaction, an evaluative, forward-looking, measure of subjective well-being. If anxiety about the future enters the utility function through anticipatory utility then rainfall variability may have a direct effect on individual well-being, above and beyond the effects captured by reductions in consumption.

Panel A of Table 9 presents the results of our analysis, exploring the effects of rainfall variability on life satisfaction. In the most rigorous specification (column 5) we estimate that a one standard deviation increase in rainfall variability (2.39 points) is associated with a 0.077 standard deviation reduction in life satisfaction, around 15% of the within-individual standard deviation. Again, this inference is robust to adjusting for the small number of clusters, using the wild cluster bootstrap-t procedure, to robustness tests related to the timing of rainfall variability and alternative measure of rainfall variability (Appendix A.3), and to a randomization inference approach (Appendix A.4). We also explore the robustness of our findings to alternative measures of subjective well-being (Appendix A.5). Within the subjective well-being literature, it is generally considered that questions based on the

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<sup>10</sup>True WTP will depend on the coefficient of absolute risk aversion (Chetty and Looney, 2006) and the empirical relevance of any direct effects.

life satisfaction scale are more evaluative measures, whereas questions related to happiness are a better measure of present affect (Benjamin et al., 2013; Levinson, 2013). While both measures of subjective well-being are highly correlated ( $\rho = 0.425$ ), we might expect that rainfall variability should have a smaller effect on happiness (contemporaneous well-being) than life satisfaction (evaluative well-being) if it is capturing the effects of income uncertainty. We show that while rainfall variability has similar effects on other evaluative measures of subjective well-being there are smaller effects on contemporaneous happiness.

However, to understand whether the reductions in consumption fully capture the returns to further consumption smoothing we need to evaluate how much of the variation in life satisfaction is driven by the consumption drop. To explore whether rainfall variability has a direct effect on life satisfaction, above and beyond the effects captured by consumption, we decompose the total effect of rainfall variability on life satisfaction into the consumption effect and the residual direct effect, e.g., anxiety. If rainfall variability has a direct effect on life satisfaction then the welfare gains from further consumption smoothing likely exceed the gains implied by the observed consumption response.

## 5.1 Identifying the Direct Effects of Uncertainty – A Sequential-g Estimation Approach

A mean-preserving increase in income uncertainty only affects utility through consumption when interpreted through the lens of conventional economic models. Rainfall variability should have no effect on utility other than through consumption. A graphical representation of this model is shown in Figure 1a. Having controlled for historical weather shocks, and other fixed effects, ( $Z$ ), rainfall variability, ( $D$ ), only affects life satisfaction, ( $U$ ), through consumption ( $C$ ). However, if anxiety about the possibility of future income shocks affects current utility through an anticipation effect, then rainfall variability ( $D$ ) may also have a direct effect on life satisfaction, ( $U$ ) (Figure 1b). We want to decompose the total effect of rainfall variability on life satisfaction into its indirect effect (consumption) and any residual direct effect (e.g., anxiety).

We can rewrite the data generating process from Figure 1b as being captured by the following set of equations, where  $\epsilon_1$  and  $\epsilon_2$ , represent the error terms,

$$U = \alpha_1 + \beta_1 D + \gamma_1 C + \delta_1 Z + \epsilon_1 \quad (7)$$

$$C = \alpha_2 + \beta_2 D + \delta_2 Z + \epsilon_2 \quad (8)$$

If we substitute equation (8) into equation (7), we can compute, the direct effect, the indirect effect, and the total effect,

$$U = (\alpha_1 + \gamma\alpha_2) + D(\beta_1 + \gamma_1\beta_2) + Z(\delta_1 + \gamma_1\delta_2) + (\epsilon_1 + \gamma_1\epsilon_2) \quad (9)$$

The total effect is then calculated as,

$$\text{Total Effect} = \frac{\partial U}{\partial D} = \beta_1 + \gamma_1\beta_2 \quad (10)$$

which can be decomposed into the direct effect,  $\beta_1$  and the indirect effect  $\gamma_1\beta_2$ . A simple approach to evaluating the direct effects of rainfall variability on individual well-being would be to control directly for the real consumption per capita. However, as a post-treatment outcome consumption is a bad control (Angrist and Pischke, 2009). Simply conditioning on “post-treatment” variables can result in a biased estimate of the direct effect. To estimate the direct effect we use the the sequential g-estimation approach discussed in Acharya et al. (2016). The sequential g-estimation approach is conducted in two-steps. First we transform the dependent variable by removing the effect of the mediator (consumption). Second we estimates the effect of rainfall variability on the demediated outcome.

To identify the direct effect we have to assume sequential unconfoundedness, which represents two separate “no omitted variables” assumptions. First, we assume that there are no omitted variables that affect the identification of rainfall variability on our measures of subjective well-being. This is reasonable given the plausible exogeneity of rainfall variability. Second, we have to assume that there are no omitted variables for the effect of consumption on subjective well-being. This is a stronger assumption, however, following Acharya et al. (2016) we directly evaluate how sensitive our results are to violations of this assumption.

**First Step** In the first stage of sequential g-estimation we estimate the effect of consumption on our outcome of interest, conditional on all other variables,

$$\mathcal{W}_{it} = \beta \text{RAINFALL VARIABILITY}_{vt,\dots,t-4} + \gamma f(\bar{w}_{vt,\dots,t-4}) + \delta \log C_{ht} + \alpha_i + \alpha_m + \alpha_t + \epsilon_{ivt} \quad (11)$$

The model implies a parametric formulation of the demediation function,

$$\gamma(\log C_{ht}; \delta) = \delta \log C_{ht} \quad (12)$$

**Second Step** In the second stage of sequential g-estimation we use our estimate of the demediated function to estimate the average CDE. First we demediate the outcome,

$$\tilde{\mathcal{W}}_{it} = \mathcal{W}_{it} - \hat{\gamma}(\log C_{ht}; \hat{\delta}) \quad (13)$$

We then estimate the average CDE by regressing this demediated outcome on the treatment controlling for ,

$$\tilde{\mathcal{W}}_{it} = \alpha + \beta \text{RAINFALL VARIABILITY}_{vt, \dots, t-4} + \gamma f(\bar{w}_{vt, \dots, t-4}) + \alpha_i + \alpha_m + \alpha_t + \epsilon_{ivt} \quad (14)$$

In Panel B of Table 9 we present the results of this analysis. The sequential-g estimator provides an estimate of the ACDE which accounts for 79-86% of the reduced form effect of rainfall variability on life satisfaction. This suggests that uncertainty has effects on well-being that are not explained through consumption. As such, the welfare gains from further consumption smoothing are likely much greater than estimates based solely on consumption fluctuations. Our estimates based on the effects of rainfall variability suggest that marginal willingness to pay to reduce uncertainty is on average, around 10% of real per capita consumption. The direct effect is four times larger than the consumption effect. Pricing the direct effect in consumption terms, by linearly extrapolating, our results suggest that marginal willingness to pay to reduce uncertainty in consumption terms could be 50% of real per capita consumption.

We note caveats. First, identification of the ACDE requires that the sequential unconfoundedness assumption holds. While this seems plausible for the first step, it is unlikely to be the case for the second step. Our estimate of the ACDE will be biased if unmeasured confounders for the relationship between consumption and life satisfaction exist. To explore the sensitivity of our results to this assumption we follow the approach taken by [Acharya et al. \(2016\)](#) who derive, and provide a sensitivity test to evaluate the bias of the sequential g-estimate of the ACDE when the sequential unconfoundedness assumption is violated. The results of this sensitivity test are presented in Figure 3. The x-axis represents the residual bias-inducing correlation between real per capita consumption and life satisfaction after accounting for controls. The y-axis is the estimated ACDE under the amount of unmeasured confounding variation. It is most plausible that real consumption and life satisfaction are positively correlated. As such the ACDE is decreasing with any positive residual correlation. We estimate that the direct effect is still empirically relevant until  $\rho = 0.5$ . This would constitute a substantial residual correlation between consumption and life satisfaction. Second, if consumption is measured with error this will attenuate its effect on life satisfaction and in turn attenuate its contribution as an indirect effect. However, even if the effect of consumption on life satisfaction in the first step of the sequential-g estimation was attenuated

by a factor of 5 the estimated direct effect would still account for 30% of the total effect, suggesting that marginal willingness to pay to avoid uncertainty would be around 15% of real per capita consumption.

## 6 Conclusion

The ability to manage consumption risk is a significant determinant of individual and household welfare in developing countries, where households live in an uncertain environment with limited access to formal financial markets. While the effects of realized income shocks are well understood, this paper has explored the empirical relevance of income uncertainty to the individual welfare of smallholder farmers in rural Ethiopia.

We find evidence that increases in rainfall variability, our proxy for income uncertainty, have a direct effect on individual well-being, above and beyond the effects through consumption. Consequently, the returns to further consumption smoothing are likely to be substantially greater than estimates based solely on consumption fluctuations and realized shocks.

We note caveats. First, it is possible that part of these estimated effects could be driven by residual variation in income shocks rather than income uncertainty. Supporting evidence suggests that this is very unlikely to be the case; however, we can never rule out the possibility. Second, if consumption is measured with error, which it almost certainly is, we will overestimate the direct effects of uncertainty on well-being. Third, subjective well-being is not utility. It is possible that consumption is sufficient for utility, but individuals have different utility functions over consumption that lead them to report different levels of well-being conditional on utility. In such a case, our finding that income uncertainty is empirically relevant remains important. Finally, these findings may not hold in other contexts. However, we note that recent work has highlighted that potential benefits of access to insurance on mental health and well-being, even in developed country contexts ([Finkelstein et al., 2012](#); [Haushofer et al., 2020](#)).

To the degree that these findings capture the effects of income uncertainty we argue that it is important to understand how expectations about future states of the world affect economic behavior, as well as the consequences of realized change. Moreover, we argue that the inclusion of subjective well-being measures can help to provide insights about individual well-being, that objective measures such as income, wealth, and consumption may not capture. Consequently, incorporating these measures into academic research and policy evaluation can be helpful in developing a broader understanding of the economic lives of the poor.

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Table 1: Descriptive Statistics

	MEAN	STD. DEV. (within)	STD. DEV. (between)	OBS.
<b>Panel A: Consumption</b>				
REAL CONSUMPTION PER CAPITA (Birr)	75.733	69.544	28.682	2,686
<b>Panel B: Subjective Well-Being</b>				
LIFE SATISFACTION (score/max)	0.572	0.135	0.223	4,033
HAPPY (score/max)	0.622	0.113	0.191	4,033
<b>Panel C: Weather Data</b> (Village level):				
RAINFALL VARIABILITY ( $\sigma/\mu$ )	18.590	7.200	10.908	30
TOTAL RAINFALL (mm)	1,452	243	471	30
AVERAGE TEMPERATURE ( $^{\circ}\text{C}$ )	19.187	0.329	1.873	30
<b>Panel D: Agricultural Production</b> (Crop level):				
YIELD (kg/Ha)	1,109.769	474.883	5,751.648	3,812
SHARE SOLD	0.230	0.111	0.331	3,812
PRICE (Birr/kg)	7.352	13.170	32.746	1,546
<b>Panel E: Crop Choice</b> (Household level):				
CROPS PLANTED	2.402	0.634	1.157	2,072
MAIN CROP SHARE	0.458	0.079	0.263	2,072
<b>Panel F: Farm Inputs</b> (Household-level):				
AVERAGE DAY WAGE (Birr)	42.420	30.640	67.362	683
HIRED WORKER DAYS	57.394	204.922	250.671	2,053
HIRED ANY WORKERS (0/1)	0.365	0.234	0.428	2,053
<b>Panel G: Livestock</b> (Livestock-type level):				
NUMBER OWNED	0.865	0.939	2.119	33,286
NUMBER SOLD	0.145	0.424	0.644	33,286
NUMBER SLAUGHTERED	0.081	0.242	0.462	33,286
<b>Panel H: Other Income Activities</b> (Individual-level):				
OFF-FARM WORK (0/1)	0.122	0.143	0.305	1,039
OUT OF VILLAGE WORK (0/1)	0.130	0.148	0.311	1,037
DAYS WORKED (Previous 4 months)	27.215	10.843	32.697	536

NOTES: Calculated from the 2004 and 2009 rounds of the Ethiopian Rural Household Survey (ERHS).

Table 2: Disentangling realized Income Events from Income Uncertainty: The Effects of Rainfall Variability on Rainfall realizations

OUTCOME VARIABLE	TREATMENT VARIABLE: Rainfall Variability ( $\sigma/\mu$ )					DEP. VAR. MEAN
	(1)	(2)	(3)	(4)	(5)	
ANNUAL RAINFALL (t+4)	2.142 (1.693) [0.234]	2.550 (2.031) [0.268]	2.462 (1.986) [0.266]	3.039 (1.931) [0.154]	2.805 (1.996) [0.232]	1,376.497
ANNUAL RAINFALL (t+3)	2.286 (1.645) [0.194]	2.406 (1.836) [0.242]	2.361 (1.550) [0.162]	2.594* (1.383) [0.060]	2.760* (1.411) [0.062]	1,383.802
ANNUAL RAINFALL (t+2)	2.368 (2.194) [0.334]	2.270 (2.159) [0.342]	3.087 (2.037) [0.206]	3.823 (2.282) [0.168]	4.192* (2.253) [0.156]	1,384.363
ANNUAL RAINFALL (t+1)	0.622 (2.226) [0.774]	0.139 (2.127) [0.940]	0.970 (1.594) [0.548]	1.169 (1.702) [0.478]	1.925 (1.687) [0.280]	1,376.004
ANNUAL RAINFALL (t)	3.911** (1.727) [0.080]	2.211 (1.335) [0.176]	1.847 (1.141) [0.154]	1.502 (1.071) [0.186]	1.762 (1.066) [0.146]	1,347.258
ANNUAL RAINFALL (t-1)	1.873 (1.812) [0.408]	0.171 (0.874) [0.964]	0.217 (1.036) [0.922]	0.121 (0.959) [0.982]	0.393 (1.084) [0.808]	1,342.532
ANNUAL RAINFALL (t-2)	1.520 (1.697) [0.428]	-1.253 (0.717) [0.166]	-0.846 (0.873) [0.412]	-0.768 (0.766) [0.406]	-0.688 (0.851) [0.468]	1,344.297
ANNUAL RAINFALL (t-3)	2.002 (1.635) [0.262]	-1.143 (1.163) [0.454]	-1.048 (0.991) [0.418]	-0.719 (1.004) [0.586]	-0.979 (1.018) [0.450]	1,346.462
ANNUAL RAINFALL (t-4)	2.064 (1.946) [0.298]	-0.484 (1.478) [0.888]	-0.483 (1.556) [0.818]	-0.545 (1.549) [0.816]	-1.088 (1.839) [0.656]	1,350.294
OBSERVATIONS	495	495	495	495	495	
TREATMENT STD. DEV.	9.058	8.947	8.382	8.419	8.163	
FIXED EFFECTS	VILLAGE, MONTH, AND YEAR					
WEATHER CONTROLS	NO	YES	YES	YES	YES	
QUADRATIC WEATHER CONTROLS	NO	NO	NO	YES	YES	
WEATHER INTERACTIONS	NO	NO	YES	NO	YES	

NOTES: Significance levels are indicated as \* 0.10 \*\* 0.05 \*\*\* 0.01. The unit of analysis is at the village level. Each coefficient relates to an individual regression. Rainfall variability is defined as the coefficient of variation for rainfall. Historical measures of atmospheric parameters correspond to the time period, over which rainfall variability is measured. Historical rainfall is measured in hundreds of mm. historical temperature is measured in °C. Cluster robust standard errors are reported in parentheses. Wild Cluster Bootstrap-t p-values (null-imposed, 1,000 replications) are reported underneath in brackets, addressing concerns relating to the small number of clusters (Cameron, Gelbach, Miller, 2008).

Table 3: Disentangling realized Income Events from Income Uncertainty: The Effects of Rainfall Variability on Agricultural Yields, Share Sold, and Prices

	(1) log YIELDS	(2) log YIELDS	(3) log YIELDS	(4) log YIELDS	(5) log YIELDS
Rainfall Variability ( $\sigma/\mu$ )	-0.0189 (0.0123) [0.300]	-0.00837 (0.0113) [0.688]	-0.00727 (0.0112) [0.726]	-0.00841 (0.0143) [0.984]	-0.00230 (0.00773) [0.848]
exp(DEP. VAR. MEAN)	1,109.769	1,109.769	1,109.769	1,109.769	1,109.769
TREATMENT STD. DEV.	2.854	2.207	2.203	2.046	1.692
OBSERVATIONS	3,812	3,812	3,812	3,812	3,812
FIXED EFFECTS	CROP $\times$ HOUSEHOLD, MONTH, AND YEAR				
	SHARE SOLD	SHARE SOLD	SHARE SOLD	SHARE SOLD	SHARE SOLD
Rainfall Variability ( $\sigma/\mu$ )	-0.00175 (0.00170) [0.336]	-0.00284* (0.00151) [0.198]	-0.00262 (0.00149) [0.218]	-0.00289* (0.00162) [0.292]	-0.00194 (0.00137) [0.308]
DEP. VAR. MEAN	0.230	0.230	0.230	0.230	0.230
TREATMENT STD. DEV.	2.854	2.207	2.203	2.046	1.692
OBSERVATIONS	3,812	3,812	3,812	3,812	3,812
FIXED EFFECTS	CROP $\times$ HOUSEHOLD, MONTH, AND YEAR				
	log PRICE	log PRICE	log PRICE	log PRICE	log PRICE
Rainfall Variability ( $\sigma/\mu$ )	0.0154 (0.0128) [0.390]	-0.00207 (0.00838) [0.834]	0.00357 (0.0117) [0.860]	0.00302 (0.00624) [0.634]	-0.0119 (0.0158) [0.492]
exp(DEP. VAR. MEAN)	7.352	7.352	7.352	7.352	7.352
TREATMENT STD. DEV.	1.799	1.554	1.504	1.491	0.804
OBSERVATIONS	1,546	1,546	1,546	1,546	1,546
FIXED EFFECTS	CROP $\times$ HOUSEHOLD, MONTH, AND CROP $\times$ YEAR				
WEATHER CONTROLS	No	YES	YES	YES	YES
QUADRATIC WEATHER CONTROLS	No	No	No	YES	YES
WEATHER INTERACTIONS	No	No	YES	No	YES

NOTES: Significance levels are indicated as \* 0.10 \*\* 0.05 \*\*\* 0.01. Rainfall variability is defined as the coefficient of variation for rainfall, measured over the previous 5 years, the time period between each survey round. Historical measures of atmospheric parameters correspond to this period. Historical rainfall is measured in hundreds of mm. Historical temperature is measured in  $^{\circ}\text{C}$ . Cluster robust standard errors are reported in parentheses. Wild Cluster Bootstrap-t p-values (null-imposed, 1,000 replications) are reported underneath in brackets, addressing concerns relating to the small number of clusters (Cameron, Gelbach, Miller, 2008).

Table 4: Disentangling realized Income Events from Income Uncertainty: The Effects of Rainfall Variability on Crop Decisions

	(1) CROP COUNT	(2) CROP COUNT	(3) CROP COUNT	(4) CROP COUNT	(5) CROP COUNT
Rainfall Variability ( $\sigma/\mu$ )	-0.00580 (0.00421)	0.00216 (0.00566)	0.00134 (0.00546)	-0.00782** (0.00348)	-0.00917 (0.00544)
	[0.206]	[0.698]	[0.782]	[0.054]	[0.130]
exp(DEP. VAR. MEAN)	2.402	2.402	2.402	2.402	2.402
TREATMENT STD. DEV.	3.88	2.846	2.840	2.653	2.154
OBSERVATIONS	2,072	2,072	2,072	2,072	2,072
	MAIN CROP SHARE	MAIN CROP SHARE	MAIN CROP SHARE	MAIN CROP SHARE	MAIN CROP SHARE
Rainfall Variability ( $\sigma/\mu$ )	-0.000164 (0.00129)	-0.00146 (0.00163)	-0.00136 (0.00158)	0.000181 (0.00129)	0.00181 (0.00208)
	[0.936]	[0.530]	[0.520]	[0.944]	[0.482]
exp(DEP. VAR. MEAN)	0.458	0.458	0.458	0.458	0.458
TREATMENT STD. DEV.	3.88	2.846	2.840	2.653	2.154
OBSERVATIONS	2,072	2,072	2,072	2,072	2,072
FIXED EFFECTS			HOUSEHOLD, MONTH, AND YEAR		
WEATHER CONTROLS	NO	YES	YES	YES	YES
QUADRATIC WEATHER	NO	NO	NO	YES	YES
WEATHER INTERACTIONS	NO	NO	YES	NO	YES

NOTES: Significance levels are indicated as \* 0.10 \*\* 0.05 \*\*\* 0.01. Rainfall variability is defined as the coefficient of variation for rainfall, measured over the previous 5 years, the time period between each survey round. Historical measures of atmospheric parameters correspond to this period. Historical rainfall is measured in hundreds of mm. Historical temperature is measured in  $^{\circ}\text{C}$ . Cluster robust standard errors are reported in parentheses. Wild Cluster Bootstrap-t p-values (null-imposed, 1,000 replications) are reported underneath in brackets, addressing concerns relating to the small number of clusters (Cameron, Gelbach, Miller, 2008).

Table 5: Disentangling realized Income Events from Income Uncertainty: The Effects of Rainfall Variability on Farm Wages and Hired labor

	(1) log AVG. WAGE	(2) log AVG. WAGE	(3) log AVG. WAGE	(4) log AVG. WAGE	(5) log AVG. WAGE
Rainfall Variability ( $\sigma/\mu$ )	0.0109 (0.0290)	0.0115 (0.0247)	0.0234 (0.0294)	0.0125 (0.0239)	0.0270 (0.0287)
	[0.721]	[0.713]	[0.553]	[0.691]	[0.499]
exp(DEP. VAR. MEAN)	42.420	42.420	42.420	42.420	42.420
TREATMENT STD. DEV.	1.816	1.741	1.455	1.739	1.398
OBSERVATIONS	683	683	683	683	683
	log WORKER DAYS (Hired)	log WORKER DAYS (Hired)	log WORKER DAYS (Hired)	log WORKER DAYS (Hired)	log WORKER DAYS (Hired)
Rainfall Variability ( $\sigma/\mu$ )	0.0121 (0.0306)	-0.00830 (0.0286)	-0.0175 (0.0279)	-0.00839 (0.0276)	-0.0314 (0.0268)
	[0.667]	[0.737]	[0.571]	[0.791]	[0.361]
exp(DEP. VAR. MEAN)	57.394	57.394	57.394	57.394	57.394
TREATMENT STD. DEV.	1.873	1.805	1.506	1.804	1.445
OBSERVATIONS	727	727	727	727	727
	HIRED ANY WORKERS	HIRED ANY WORKERS	HIRED ANY WORKERS	HIRED ANY WORKERS	HIRED ANY WORKERS
Rainfall Variability ( $\sigma/\mu$ )	0.000404 (0.00239) [0.936]	0.000744 (0.00320) [0.850]	0.000958 (0.00325) [0.812]	0.00466** (0.00160) [0.022]	0.00416 (0.00308) [0.226]
exp(DEP. VAR. MEAN)	0.365	0.365	0.365	0.365	0.365
TREATMENT STD. DEV.	3.891	2.848	2.842	2.658	2.159
OBSERVATIONS	2,053	2,053	2,053	2,053	2,053
FIXED EFFECTS	HOUSEHOLD, MONTH, AND YEAR				
WEATHER CONTROLS	NO	YES	YES	YES	YES
QUADRATIC WEATHER	NO	NO	NO	YES	YES
WEATHER INTERACTIONS	NO	NO	YES	NO	YES

NOTES: Significance levels are indicated as \* 0.10 \*\* 0.05 \*\*\* 0.01. Rainfall variability is defined as the coefficient of variation for rainfall, measured over the previous 5 years, the time period between each survey round. Historical measures of atmospheric parameters correspond to this period. Historical rainfall is measured in hundreds of mm. Historical temperature is measured in  $^{\circ}\text{C}$ . Cluster robust standard errors are reported in parentheses. Wild Cluster Bootstrap-t p-values (null-imposed, 1,000 replications) are reported underneath in brackets, addressing concerns relating to the small number of clusters (Cameron, Gelbach, Miller, 2008).

Table 6: Disentangling realized Income Events from Income Uncertainty: The Effects of Rainfall Variability on Livestock Assets

	(1) log LIVESTOCK	(2) log LIVESTOCK	(3) log LIVESTOCK	(4) log LIVESTOCK	(5) log LIVESTOCK
Rainfall Variability ( $\sigma/\mu$ )	-0.000383 (0.00191)	0.00281 (0.00209)	0.00291 (0.00223)	0.00243 (0.00249)	0.000672 (0.00285)
Wild Cluster Bootstrap-t p-value	[0.906]	[0.280]	[0.320]	[0.454]	[0.846]
exp(DEP. VAR. MEAN)	1.273	1.273	1.273	1.273	1.273
TREATMENT STD. DEV.	3.975	2.435	2.433	2.240	2.116
OBSERVATIONS	10,397	10,397	10,397	10,397	10,397
	OWN ANY LIVESTOCK	OWN ANY LIVESTOCK	OWN ANY LIVESTOCK	OWN ANY LIVESTOCK	OWN ANY LIVESTOCK
Rainfall Variability ( $\sigma/\mu$ )	0.000705 (0.000508)	0.00141 (0.000972)	0.00117 (0.00104)	0.000452 (0.00119)	0.00232** (0.000915)
Wild Cluster Bootstrap-t p-value	[0.512]	[0.270]	[0.448]	[0.830]	[0.212]
Dep. Var. Mean	0.296	0.298	0.298	0.298	0.298
TREATMENT STD. DEV.	5.695	3.309	3.295	2.960	2.701
OBSERVATIONS	34,863	34,863	34,863	34,863	34,863
FIXED EFFECTS	LIVESTOCK $\times$ HOUSEHOLD, MONTH, AND LIVESTOCK $\times$ YEAR				
WEATHER CONTROLS	NO	YES	YES	YES	YES
QUADRATIC WEATHER	NO	NO	NO	YES	YES
WEATHER INTERACTIONS	NO	NO	YES	NO	YES

NOTES: Significance levels are indicated as \* 0.10 \*\* 0.05 \*\*\* 0.01. Rainfall variability is defined as the coefficient of variation for rainfall, measured over the previous 5 years, the time period between each survey round. Historical measures of atmospheric parameters correspond to this period. Historical rainfall is measured in hundreds of mm. Historical temperature is measured in  $^{\circ}\text{C}$ . Cluster robust standard errors are reported in parentheses. Wild Cluster Bootstrap-t p-values (null-imposed, 1,000 replications) are reported underneath in brackets, addressing concerns relating to the small number of clusters (Cameron, Gelbach, Miller, 2008).

Table 7: Disentangling realized Income Events from Income Uncertainty: The Effects of Rainfall Variability on Adult Non-Farm Work

	(1) ENGAGED IN OFF-FARM WORK	(2) ENGAGED IN OFF-FARM WORK	(3) ENGAGED IN OFF-FARM WORK	(4) ENGAGED IN OFF-FARM WORK	(5) ENGAGED IN OFF-FARM WORK
Rainfall Variability ( $\sigma/\mu$ )	-0.00391* (0.00197)	-0.00571 (0.00489)	-0.00629 (0.00448)	-0.00490 (0.00534)	-0.00881 (0.00570)
Wild Cluster Bootstrap-t p-value	[0.830]	[0.402]	[0.336]	[0.496]	[0.366]
exp(DEP. VAR. MEAN)	0.122	0.122	0.122	0.122	0.122
TREATMENT STD. DEV.	4.641	2.130	2.101	1.946	1.829
OBSERVATIONS	1,039	1,039	1,039	1,039	1,039
	ENGAGED IN OUT OF VILLAGE WORK				
Rainfall Variability ( $\sigma/\mu$ )	0.00113 (0.000991)	-0.00162 (0.00397)	0.000181 (0.00423)	-0.00442* (0.00234)	-0.00409 (0.00372)
Wild Cluster Bootstrap-t p-value	[0.348]	[0.700]	[0.932]	[0.098]	[0.348]
exp(DEP. VAR. MEAN)	0.130	0.130	0.130	0.130	0.130
TREATMENT STD. DEV.	4.646	2.132	2.103	1.948	1.831
OBSERVATIONS	1,037	1,037	1,037	1,037	1,037
	log DAYS WORKED (Off-Farm)				
Rainfall Variability ( $\sigma/\mu$ )	0.0325* (0.0181)	0.0205 (0.0153)	0.0156 (0.0143)	0.0676 (0.0414)	0.0421 (0.0445)
Wild Cluster Bootstrap-t p-value	[0.452]	[0.394]	[0.388]	[0.320]	[0.458]
exp(DEP. VAR. MEAN)	27.215	27.215	27.215	27.215	27.215
TREATMENT STD. DEV.	2.441	1.479	1.470	0.762	0.736
OBSERVATIONS	536	536	536	536	536
FIXED EFFECTS			INDIVIDUAL, MONTH, AND YEAR		
WEATHER CONTROLS	No	Yes	Yes	Yes	Yes
QUADRATIC WEATHER	No	No	No	Yes	Yes
WEATHER INTERACTIONS	No	No	Yes	No	Yes

NOTES: Significance levels are indicated as \* 0.10 \*\* 0.05 \*\*\* 0.01. Rainfall variability is defined as the coefficient of variation for rainfall, measured over the previous 5 years, the time period between each survey round. Historical measures of atmospheric parameters correspond to this period. Historical rainfall is measured in hundreds of mm. Historical temperature is measured in  $^{\circ}\text{C}$ . Cluster robust standard errors are reported in parentheses. Wild Cluster Bootstrap-t p-values (null-imposed, 1,000 replications) are reported underneath in brackets, addressing concerns relating to the small number of clusters (Cameron, Gelbach, Miller, 2008).

Table 8: RAINFALL VARIABILITY AND CONSUMPTION

	LOG REAL CONSUMPTION PER CAPITA				
	(1)	(2)	(3)	(4)	(5)
Rainfall Variability ( $\sigma/\mu$ )	-0.0189*** (0.00307) [0.032]	-0.0139*** (0.00457) [0.026]	-0.0120** (0.00529) [0.072]	-0.0183*** (0.00588) [0.060]	-0.0326*** (0.00485) [0.016]
FIXED EFFECTS					
WEATHER CONTROLS	No	YES	YES	YES	YES
QUADRATIC WEATHER CONTROLS	No	No	No	YES	YES
WEATHER INTERACTIONS	No	No	YES	No	YES
exp(Dep. Var. Mean)	55.257	55.257	55.257	55.257	55.257
Treatment Std. Dev.	5.930	3.463	3.434	3.087	3.031
Observations	2,686	2,686	2,686	2,686	2,686

NOTES: Significance levels are indicated as \* 0.10 \*\* 0.05 \*\*\* 0.01. The unit of analysis is at the household level. Our proxy for uncertainty is the coefficient of variation for rainfall, measured over the previous 5 years, the time period between each survey round. Historical measures of atmospheric parameters correspond to this period. Contemporaneous and historical rainfall is measured in hundreds of mm. Contemporaneous and historical temperature is measured in °C. Cluster robust standard errors are reported in parentheses. Results are robust to clustering following the bootstrap procedure to account for concerns relating to the small number of clusters (Cameron, Gelbach, Miller, 2008).

Table 9: RAINFALL VARIABILITY AND LIFE SATISFACTION

	LIFE SATISFACTION (Standardized)				
	(1)	(2)	(3)	(4)	(5)
<b>Panel A:</b>					
Rainfall Variability ( $\sigma/\mu$ ) (Total Effect)	-0.0192*** (0.00455) [0.114]	-0.0145** (0.00672) [0.102]	-0.0132* (0.00687) [0.144]	-0.0213** (0.00786) [0.068]	-0.0323*** (0.00569) [0.002]
<b>Panel B:</b>					
Rainfall Variability ( $\sigma/\mu$ ) (Direct Effect)	-0.0152*** (0.00451) [0.202]	-0.0116 (0.00684) [0.170]	-0.0108 (0.00684) [0.220]	-0.0180** (0.00773) [0.110]	-0.0278*** (0.00618) [0.004]
DIRECT EFFECT SHARE (%)	79	80	81	84	86
FIXED EFFECTS					
WEATHER CONTROLS	No	YES	YES	YES	YES
QUADRATIC WEATHER CONTROLS	No	No	No	YES	YES
WEATHER INTERACTIONS	No	No	YES	No	YES
TREATMENT STD. DEV.	5.217	3.093	3.057	2.742	2.390
Observations	4,033	4,033	4,033	4,033	4,033

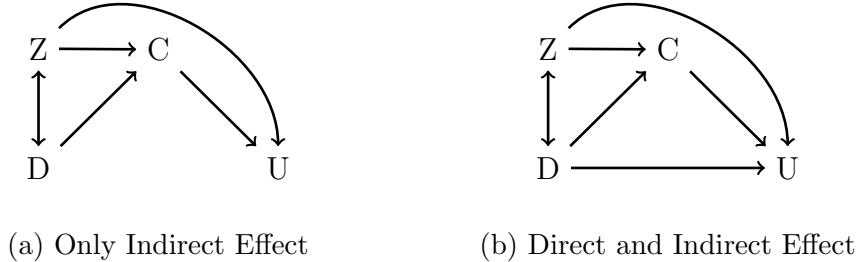
NOTES: Significance levels are indicated as \* 0.10 \*\* 0.05 \*\*\* 0.01. The unit of analysis is the individual. Rainfall variability is defined as the coefficient of variation for rainfall, measured over the previous 5 years, the time period between each survey round. Historical measures of atmospheric parameters correspond to this period. Historical rainfall is measured in hundreds of mm. Historical temperature is measured in  $^{\circ}\text{C}$ . All regressions include linear, quadratic, rainfall and temperature controls, as well as interactions between rainfall and temperature measures. The Direct Effect Share is calculated as the rainfall variability effect in Panel B divided by the rainfall variability effect in Panel A. Cluster robust standard errors are reported in parentheses. Wild Cluster Bootstrap-t p-values (null-imposed, 1,000 replications) are reported underneath in brackets, addressing concerns relating to the small number of clusters (Cameron, Gelbach, Miller, 2008).

Figure 1: Changes in Rainfall Variability Over Time



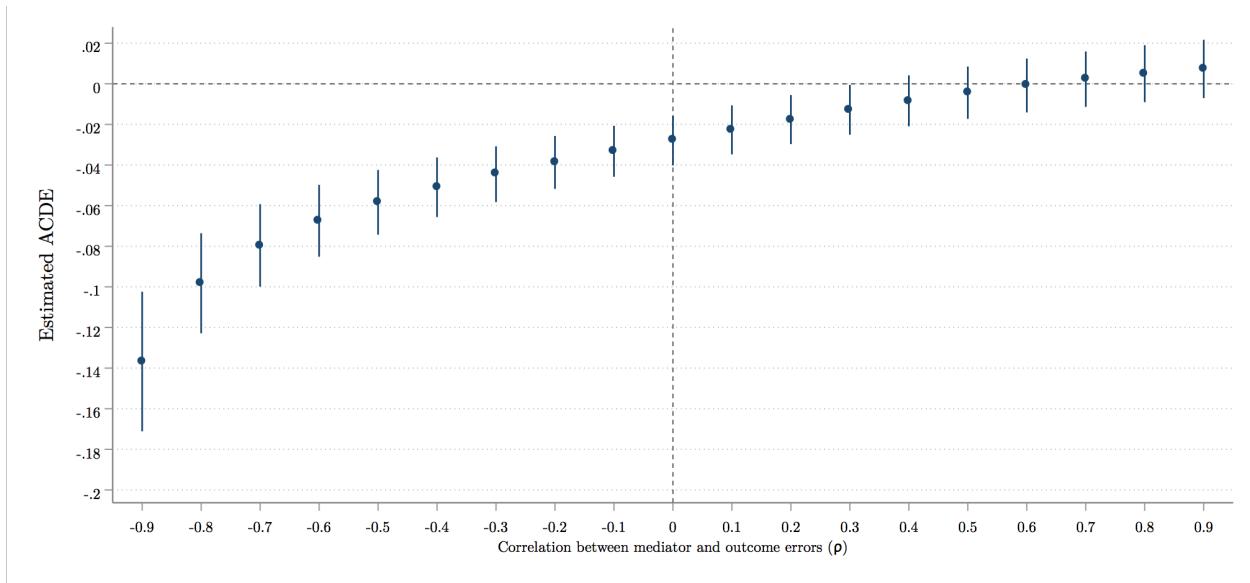
Notes: This figure graphically represents a 5-year moving average of the coefficient of variation for rainfall for the period 2000–2009. Between 2000 and 2004 we observe that rainfall variability was, on average, systematically higher than between 2005 and 2009. The dashed lines represent the mean rainfall variability over these periods.

Figure 2: Directed Acyclic Graphs Documenting Direct, Total and Indirect Effects



Notes: Figure 1a provides a graphical representation of the data generating process for a world in which uncertainty (D) only has an indirect effect on utility (U) through consumption (C). Figure 1b provides a graphical representation of the data generating process for a world in which uncertainty (D) has an indirect effect on utility (U) through consumption (C), but also has a direct effect on utility (U).

Figure 3: Sensitivity of Results to Violation of Sequential Unconfoundedness Assumption



Notes: Vertical lines represent 95% confidence intervals. The y-axis presents direct effect estimates under different assumptions about the amount of unmeasured confounding variation between the mediator variable and outcome errors, i.e., the residual bias-inducing correlation between real per capita consumption and life satisfaction after accounting for controls. It is most plausible that real consumption and life satisfaction are positively correlated. As such the ACDE is decreasing with any positive residual correlation. We estimate that the direct effect is still empirically relevant until  $\rho = 0.5$ . This would constitute a substantial residual correlation between consumption and life satisfaction.

# Online Appendices – Not for Publication

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# A Additional Results and Robustness Tests

## A.1 The Agricultural Production Function

As the focus of this article is to understand the effects of income variability, using rainfall variability as a proxy, it is important to demonstrate the relevance of rainfall realizations as a driver of agricultural production. In addition this exercise sheds light the functional form through which rainfall affects production.

Table A1 presents the results of this analysis. Across all specification we find evidence to suggest that more rainfall is better, with suggestive but limited evidence of diminishing returns. Column 1 shows that a 1 percent increase in rainfall is associated with a 2.157 percent increase in yields, highlighting the elastic responsiveness of yields to rainfall realizations. In column 2 and 3 we explore the level effect of rainfall, finding that a 100mm increase in rainfall is associated with an 18.2% increase in yields. Column 3 shows that non-linearities through a quadratic term do not appear to be too important.

Table A1: Disentangling Realized Income Events from Income Uncertainty: The Agricultural Production Function

	(1) log YIELDS	(2) log YIELDS	(3) log YIELDS
log Rainfall	2.157*** (0.638) [0.021]		
Rainfall (100 mm)		0.182*** (0.0549) [0.128]	0.254** (0.0856) [0.126]
Rainfall <sup>2</sup>			-0.00327 (0.00209) [0.306]
exp(DEP. VAR. MEAN)	1,109.769	1,109.769	1,109.769
OBSERVATIONS	3,812	3,812	3,812
FIXED EFFECTS	CROP $\times$ HOUSEHOLD, MONTH, AND YEAR		
TEMPERATURE CONTROLS	YES	YES	YES

NOTES: Significance levels are indicated as \* 0.10 \*\* 0.05 \*\*\* 0.01. Daily average temperature controls are included in specification (1), while quadratic controls are included in specifications (2-3). Cluster robust standard errors are reported in parentheses. Wild Cluster Bootstrap-t p-values (null-imposed, 1,000 replications) are reported underneath, addressing concerns relating to the small number of clusters (Cameron, Gelbach, Miller, 2008).

## A.2 Rainfall Variability and Income Uncertainty

### A.2.1 Alternative Timing Definitions

The main specification used throughout the article defines rainfall variability over 5 years. The reason for this choice is that 5 years is the time between survey rounds. This ensures that there is no cross-over in the variation being exploited between rounds, e.g., for the 2009 round, rainfall variability is measured using rainfall data from 2008, 2007, 2006, 2005 and 2004. As the number of years increases there is less round-specific variation as the same years are being used to define the variability measure. For example if rainfall variability is defined over 7 years then there is a 2 year overlap in the definition of rainfall variability for the two rounds, e.g. for the 2009 round, rainfall variability would be measured using rainfall data from 2008, 2007, 2006, 2005, 2004, 2003 and 2002. The 2003 and 2002 rainfall data would also be used to define rainfall variability for the 2004 round.

Measured over shorter periods of time there will be less of a signal associated with variability after controlling for historical weather events. Indeed, we should not expect individuals to internalize changes in rainfall variability measured over very short time-frames. Furthermore, given the time between survey rounds we won't be fully controlling for weather conditions between rounds. Measured over longer time periods there is less real variation introduced into the data. However, there is no other reason to restrict rainfall variability to the 5 year period and if applied to other contexts the choice of a 5-year time period would certainly be considered ad hoc.

In this appendix we test the robustness of the results to this decision-rule table. As discussed above there are reasons that shorter or longer-time periods are less preferable; however, it is interesting to understand the robustness of our findings to alternative specifications. In the tables below we see that across all specifications results are broadly consistent with the findings presented in the main text.

**Agricultural Production** Using crop  $\times$  household level data we explore the effects of rainfall variability on agricultural yields, the share sold of each crop and the price received for each crop, for households that sold a share of their crop.

First and foremost, there is less variation in the within-village standard deviation of rainfall variability when measured over shorter and longer periods. The maximum variation is provided when rainfall variability is over the 5-year time period, providing support for the decision rule.

In Table A2 we explore the effects of rainfall variability on agricultural yields, finding that across all time periods there is no robust relationship. The magnitude of the effect

is very small and the coefficient sign is not consistent across time periods. These findings are robust to using the standard deviation of rainfall over the defined time-period as an alternative measure of rainfall variability (Table A17).

Table A3 presents our findings of the effects of rainfall variability on the share of production that is sold. Again there is no robust relationship and the magnitude of the coefficients are small. Again, these findings are robust to using the standard deviation of rainfall over the defined time-period as an alternative measure of rainfall variability (Table A18)

Table A4 explores the effects of rainfall variability on crop prices, for the subset of households that sell their crop. Here we observe that there are statistically significant declines in price measured over a 2-year time period. However, over longer time periods there are no effects of rainfall variability on price. The magnitude of the effects are small given the low baseline value and the small values of the residualized within-village standard deviation of rainfall variability for this sub-sample. As with the other outcomes of interest, these findings are robust to using the standard deviation of rainfall over the defined time-period as an alternative measure of rainfall variability (Table A19)

Tables A5 and A6 explore the effects of rainfall variability on the number of crops planted by the household and the share of the land that is allocated to the main crop (defined as the crop that has the largest share of land). Across all time definitions we find very limited evidence of changes to the number of crops or the share of the main crop. One exception is when rainfall variability is defined over a 4-year period. In this case we find that a one standard deviation increase in rainfall variability is associated with a 0.03 crop increase, a very small effect and so does not likely affect input costs in a considerable way. Given the lack of consistency across definitions and the small magnitude of this effect this effect should not be a major concern. Furthermore, this effect is not reflected in changes to yields, prices, or the share sold and so unlikely directly affects income. Results are robust to using the standard deviation of rainfall (Tables A20 and A21).

**Hired Labor and Wages** Tables A7 and A8, explore the effects of rainfall variability on the wages of hired labor and the number of workers hired by the household for the small subset of households that report hiring paid labor. Across all specification we find limited evidence of an effect of rainfall variability on wages or the number of worker days hired. The only exception to this is when rainfall variability is defined over a 9-year time period. In this case we find that a one-standard deviation is associated with a 7% reduction in the average day wage and a 10% increase in the number of worker days. These effects are non-trivial; however, they only relate to a small fraction of households. Furthermore there is no consistency in sign or magnitude in the other specifications. Results are robust to using the

standard deviation of rainfall (Tables A22 and A23).

Table A9 explores the effects of rainfall variability on the likelihood that a household has hired any workers. Again, we find very limited evidence of any adjustments along this margin. The largest effect can once again be found when rainfall variability is defined over a 9-year period. Here we find that a one standard deviation increase in rainfall variability is associated with a 0.9% increase in the likelihood of hiring workers. However, the effect is not statistically significant after accounting for the small number of clusters. Results are robust to using the standard deviation of rainfall (Table A24).

Collectively, this evidence suggests that on the whole rainfall variability is unlikely to have a first-order effect on labor costs for households. The conjecture weakens as we increase the time-frame over which rainfall variability is measured; however, as discussed above there is less variation in rainfall variability measured over these time periods and so measuring rainfall variability over the 5-year period remains the preferred specification.

**Livestock** Tables A10, A12 and A11 examine the effects of rainfall variability on the number of livestock and whether the household owns any livestock over different time-definitions, using livestock  $\times$  household level data. We find no robust effects of rainfall variability on the number of livestock owned, sold, or slaughtered across all specifications. Results are robust to using the standard deviation of rainfall (Tables A25, A27 and A26).

Given that livestock forms the most important measure of assets for these households our findings suggest that rainfall variability has a limited effect on assets/wealth.

**Off-Farm Labor Supply** Table A13 explores the effects of rainfall variability on whether adults engage in non-farm employment as an additional source of income. Across all timing definitions we find limited evidence that rainfall variability is associated with engagement in the non-farm labor market. The exception to this is when rainfall variability is defined over a 7-year period. However, the magnitude of this effect is small. A one standard deviation increase in rainfall variability is associated with a 0.9% decrease in the likelihood of engaging in the non-farm sector. Results are robust to using the standard deviation of rainfall (Table A28).

Similar results are found in Table A14, which examines the effects of rainfall variability on whether adults engage in employment outside of the village (a proxy for migration). We find that there is no effect in the likelihood of engaging in out of village work, except when rainfall variability is defined over a 4-year period. Here we find that a one standard deviation increase in rainfall variability is associated with a 1.1% decrease in the likelihood of working outside of the village, although it only remains significant at the 10% level after accounting

for the small number of clusters. Taking the other point estimates as given the second largest effect is a 0.79% increase in the likelihood of working outside the village, demonstrating that the coefficient estimates are not robust across different time definitions. Results are robust to using the standard deviation of rainfall (Table A29).

Table A15 explores the effects of rainfall variability on the number of non-farm days worked during the last 4-months for the small subset of individuals that report to engage in such activities. We find no meaningful effects of rainfall variability on the number of days worked. Results are robust to using the standard deviation of rainfall (Table A30).

Collectively, these results suggest that rainfall variability is not having an effect on income through non-farm or off-farm activities, providing further support for the premise that rainfall variability is a reasonable proxy for income uncertainty.

**Rainfall Realizations** In addition, to exploring the effects of rainfall variability on contemporaneous income and wealth related outcomes, it is also important to look at how rainfall variability may affect the likelihood of historical income shocks as well as the potential future income shocks. We explore this potential by examining the direct effects of rainfall variability on rainfall realizations. This exercise is a direct test of the mean-preserving properties of rainfall, i.e., *a priori* there is no reason to expect that an increase in variability should affect the first-moment of the rainfall distribution. We explore the effects of rainfall variability (measured over different time-periods) on rainfall realizations contemporaneously as well as 4 years into the past and future. Furthermore, we estimate this relationship using 30 years of weather data. This means that our measure of rainfall variability in this context is a  $t$ -year moving average.

Table A16 presents the results of this analysis. Measured over the 5-year term, the preferred specification in our main analysis given the time between survey rounds. There is no relationship between rainfall variability and rainfall realizations contemporaneously, or over previous the 4-years. There appear to be weak relationships between rainfall variability and rainfall realizations 3-years into the future (significant at the 10% level). However, the magnitude of these effects are small. A one-standard deviation increase in rainfall variability is associated with a 22mm increase in rainfall. If we evaluate this using the agricultural production function results in Table A1 then such an effect could be associated with a 4% increase in yields.

Looking across different definitions of the time-period in which rainfall variability we observe a common pattern. Over smaller time-frames there appears to be little effect of rainfall variability on rainfall realizations. However, as the time-period increases from 7-years and above there appears to be more of a significant relationship between rainfall variability

and rainfall realizations. This may be because over these longer periods the controls and functional forms used to control for historical rainfall shocks over longer time-frames are too restrictive meaning that we don't fully account for these effects. However, the magnitude of the effects are still not very large. The largest contemporaneous effect is measured over a 9-year period. In this specification a one-standard deviation increase is associated with a 38mm increase in rainfall, corresponding to a 7% increase in yield. However, despite this effect we observe no direct effects of rainfall variability on the agricultural outcomes discussed above. Furthermore, the range of contemporaneous estimates, across time-frames, goes from an implied 3.6% reduction in yields (20mm reduction) to a 7% increase in yields (38mm increase). The average effect of a one standard deviation increase in rainfall variability on contemporaneous rainfall across specifications is 17mm, with an implied 3.1% increase in yields.

In terms of rainfall variability's effect on historical rainfall realizations the same patterns emerge; however the magnitudes are smaller. The most robust effects are found in t-4. Here the relationship is negative. The largest effect found when rainfall variability is measured over 2-years. A one standard deviation increase in contemporaneous rainfall variability is associated with a 46mm reduction in rainfall. However, the average effect measured across all time-frames results in an 18mm reduction in rainfall (3.2% reduction in yields).

In terms of rainfall variability's effect on future rainfall realizations we again observe a similar pattern, with statistical significance increasing as rainfall variability is measured over a longer term. The largest effect is found when estimating the relationship between rainfall variability and rainfall realizations 2-years into the future, using a specification in which rainfall variability is measured over 10-years. Here we find that a one-standard deviation increase in rainfall variability is associated with a 40mm increase in rainfall 2 years later, equivalent to a 7.3% increase in yields. However, the average effect across time-periods is smaller (26mm, equivalent to a 5% increase in yields).

It is interesting to note that the sign of the effects are not consistent across estimates, i.e., rainfall variability tends to be negatively correlated with historical rainfall realizations and positively correlated with future rainfall realizations. Taking an average of across estimates within a specification, e.g., rainfall variability measured over 10 years the specification with the largest effects, we find that the average effect of rainfall variability on rainfall realizations between t-4 and t+4 is a 23mm increase in rainfall per year, equivalent to a 4.2% increase in yields. Using our preferred specification (5-years the time between survey rounds) the average effect is a 10mm increase in rainfall, equivalent to a 1.8% increase in yields.

We have highlighted her the largest effects of rainfall variability on historical, contemporaneous, and future rainfall realizations. Over smaller time frames (up to 7 years) rainfall

variability, controlling for non-linear rainfall and temperature controls as well as interactions between these terms, does not appear to have a direct effect on rainfall realizations. However, over longer time-frames this functional form may be too restrictive, limiting our ability to control for historical rainfall shocks. Consequently, we should be cautious to interpret the effects of rainfall variability measured over longer-time periods as capturing the effects of income uncertainty.

Table A2: Disentangling Realized Income Events from Income Uncertainty: Defining Rainfall Variability Over Different Time Frames (Yields)

	(1) log YIELDS	(2) log YIELDS	(3) log YIELDS	(4) log YIELDS	(5) log YIELDS	(6) WITHIN GROUP STD. DEV
Rainfall Variability ( $\sigma/\mu$ ) (2 years)	-0.0143** (0.00645) [0.354]	-0.0240* (0.0117) [0.233]	-0.0335*** (0.0111) [0.177]	-0.00982 (0.0159) [0.663]	-0.00608 (0.0167) [0.865]	1.227
Rainfall Variability ( $\sigma/\mu$ ) (3 years)	-0.0206* (0.0102) [0.144]	-0.0122 (0.0121) [0.399]	-0.0172 (0.0106) [0.239]	0.00244 (0.00670) [0.757]	0.0118* (0.00572) [0.110]	1.678
Rainfall Variability ( $\sigma/\mu$ ) (4 years)	-0.0319** (0.0124) [0.049]	-0.00946 (0.0122) [0.514]	-0.00954 (0.0140) [0.633]	-0.00372 (0.0140) [0.852]	0.00604 (0.0112) [0.670]	1.471
Rainfall Variability ( $\sigma/\mu$ ) (5 years)	-0.0189 (0.0123) [0.253]	-0.00837 (0.0113) [0.649]	-0.00727 (0.0112) [0.696]	-0.00841 (0.0143) [0.930]	-0.00230 (0.00773) [0.764]	1.692
Rainfall Variability ( $\sigma/\mu$ ) (6 years)	-0.0275* (0.0147) [0.306]	-0.0124 (0.0139) [0.492]	-0.00911 (0.0134) [0.581]	-0.00891 (0.0208) [0.847]	-0.00590 (0.0113) [0.700]	1.266
Rainfall Variability ( $\sigma/\mu$ ) (7 years)	-0.0252 (0.0159) [0.309]	-0.0136 (0.0131) [0.379]	-0.0277 (0.0159) [0.183]	-0.00604 (0.0130) [0.779]	-0.0278** (0.0107) [0.140]	1.380
Rainfall Variability ( $\sigma/\mu$ ) (8 years)	-0.0178 (0.0233) [0.590]	-0.0280 (0.0162) [0.191]	-0.0302* (0.0163) [0.152]	-0.0116 (0.0176) [0.662]	-0.0347 (0.0202) [0.566]	1.141
Rainfall Variability ( $\sigma/\mu$ ) (9 years)	-0.0157 (0.0199) [0.627]	-0.0281 (0.0186) [0.314]	-0.0289 (0.0188) [0.313]	-0.0173 (0.0252) [0.887]	-0.0283 (0.0238) [0.732]	1.549
Rainfall Variability ( $\sigma/\mu$ ) (10 years)	-0.0216 (0.0171) [0.258]	-0.0156 (0.0204) [0.523]	-0.0139 (0.0216) [0.567]	0.0160 (0.0223) [0.613]	0.0115 (0.0172) [0.670]	1.093
FIXED EFFECTS			CROP $\times$ HOUSEHOLD, MONTH, AND YEAR			
WEATHER CONTROLS	No	YES	YES	YES	YES	YES
QUADRATIC WEATHER CONTROLS	No	No	No	YES	YES	YES
WEATHER INTERACTIONS	No	No	YES	No	YES	YES
OBSERVATIONS	3,812	3,812	3,812	3,812	3,812	3,812

NOTES: Significance levels are indicated as \* 0.10 \*\* 0.05 \*\*\* 0.01. The unit of analysis is at the household level. Rainfall variability is defined as the coefficient of variation for rainfall. Historical measures of atmospheric parameters correspond to the time period, over which rainfall variability is measured. Historical rainfall is measured in hundreds of mm. historical temperature is measured in  $^{\circ}\text{C}$ . Cluster robust standard errors are reported in parentheses. Wild Cluster Bootstrap-t p-values (null-imposed, 1,000 replications) are reported underneath in brackets, addressing concerns relating to the small number of clusters (Cameron, Gelbach, Miller, 2008).

Table A3: Disentangling Realized Income Events from Income Uncertainty: Defining Rainfall Variability Over Different Time Frames (Share Sold)

	(1) SHARE SOLD	(2) SHARE SOLD	(3) SHARE SOLD	(4) SHARE SOLD	(5) SHARE SOLD	(6) SHARE SOLD STD. DEV
Rainfall Variability ( $\sigma/\mu$ ) (2 years)	-0.00103 (0.000966) [0.537]	-0.00416* (0.00229) [0.065]	-0.00466 (0.00271) [0.096]	-0.00130 (0.00301) [0.798]	-0.00307 (0.00309) [0.718]	1.227
Rainfall Variability ( $\sigma/\mu$ ) (3 years)	-0.00171 (0.00132) [0.277]	-0.00184 (0.00235) [0.500]	-0.00217 (0.00251) [0.476]	0.00198 (0.00176) [0.413]	0.00260 (0.00205) [0.350]	1.678
Rainfall Variability ( $\sigma/\mu$ ) (4 years)	-0.00462** (0.00184) [0.038]	-0.00327 (0.00276) [0.394]	-0.00325 (0.00304) [0.443]	-0.00178 (0.00278) [0.683]	-0.000936 (0.00190) [0.712]	1.471
Rainfall Variability ( $\sigma/\mu$ ) (5 years)	-0.00175 (0.00170) [0.354]	-0.00284* (0.00151) [0.171]	-0.00262 (0.00149) [0.183]	-0.00289* (0.00162) [0.269]	-0.00194 (0.00137) [0.291]	1.692
Rainfall Variability ( $\sigma/\mu$ ) (6 years)	-0.00268 (0.00166) [0.267]	-0.00239 (0.00229) [0.418]	-0.00178 (0.00259) [0.580]	-0.00451 (0.00457) [0.488]	-0.00468 (0.00365) [0.391]	1.266
Rainfall Variability ( $\sigma/\mu$ ) (7 years)	-0.00153 (0.00228) [0.599]	-0.00159 (0.00251) [0.579]	-0.00476* (0.00253) [0.122]	-0.000736 (0.00289) [0.835]	-0.00660** (0.00258) [0.132]	1.380
Rainfall Variability ( $\sigma/\mu$ ) (8 years)	0.000237 (0.00338) [0.959]	-0.00276 (0.00291) [0.444]	-0.00318 (0.00286) [0.387]	-0.00136 (0.00369) [0.775]	-0.00668* (0.00363) [0.328]	1.141
Rainfall Variability ( $\sigma/\mu$ ) (9 years)	0.000241 (0.00265) [0.943]	-0.00196 (0.00304) [0.602]	-0.00207 (0.00299) [0.583]	0.000614 (0.00410) [0.924]	-0.000893 (0.00417) [0.903]	1.549
Rainfall Variability ( $\sigma/\mu$ ) (10 years)	-0.000823 (0.00302) [0.780]	0.000569 (0.00358) [0.920]	0.000256 (0.00378) [0.965]	0.00628 (0.00425) [0.418]	0.00482 (0.00421) [0.452]	1.093
FIXED EFFECTS				CROP × HOUSEHOLD, MONTH, AND YEAR		
WEATHER CONTROLS	NO	YES	YES	YES	YES	
QUADRATIC WEATHER CONTROLS	NO	NO	NO	YES	YES	
WEATHER INTERACTIONS	NO	NO	YES	NO	YES	
OBSERVATIONS	3,812	3,812	3,812	3,812	3,812	3,812

NOTES: Significance levels are indicated as \* 0.10 \*\* 0.05 \*\*\* 0.01. The unit of analysis is at the household level. Rainfall variability is defined as the coefficient of variation for rainfall. Historical measures of atmospheric parameters correspond to the time period, over which rainfall variability is measured. Historical rainfall is measured in hundreds of mm. historical temperature is measured in °C. Cluster robust standard errors are reported in parentheses. Wild Cluster Bootstrap-t p-values (null-imposed, 1,000 replications) are reported underneath in brackets, addressing concerns relating to the small number of clusters (Cameron, Gelbach, Miller, 2008).

Table A4: Disentangling Realized Income Events from Income Uncertainty: Defining Rainfall Variability Over Different Time Frames (Prices)

	(1) log PRICES	(2) log PRICES	(3) log PRICES	(4) log PRICES	(5) log PRICES	(6) WITHIN GROUP STD. DEV
Rainfall Variability ( $\sigma/\mu$ ) (2 years)	-0.0493*** (0.0135) [0.081]	-0.0475** (0.0166) [0.246]	-0.0472*** (0.00862) [0.145]	-0.0398*** (0.0110) [0.134]	-0.0335*** (0.00647) [0.028]	0.846
Rainfall Variability ( $\sigma/\mu$ ) (3 years)	-0.0496*** (0.0104) [0.096]	-0.0450*** (0.0116) [0.218]	-0.0411*** (0.00728) [0.061]	-0.0509*** (0.0122) [0.133]	-0.0153 (0.0140) [0.479]	0.715
Rainfall Variability ( $\sigma/\mu$ ) (4 years)	-0.0269 (0.0154) [0.340]	0.00181 (0.0105) [0.878]	-0.00208 (0.0126) [0.947]	0.0254 (0.0204) [0.453]	-0.00284 (0.0193) [0.900]	0.728
Rainfall Variability ( $\sigma/\mu$ ) (5 years)	0.0154 (0.0128) [0.370]	-0.00207 (0.00838) [0.837]	0.00357 (0.0117) [0.867]	0.00302 (0.00624) [0.594]	-0.0119 (0.0158) [0.528]	0.804
Rainfall Variability ( $\sigma/\mu$ ) (6 years)	-0.00423 (0.0217) [0.903]	0.0127 (0.0284) [0.780]	0.0300 (0.0227) [0.431]	0.00494 (0.0273) [0.893]	-0.0156 (0.0177) [0.500]	0.689
Rainfall Variability ( $\sigma/\mu$ ) (7 years)	-0.0646*** (0.0197) [0.032]	-0.0420** (0.0165) [0.101]	0.0222 (0.0429) [0.720]	-0.0855*** (0.0120) [0.024]	-0.0383 (0.0252) [0.340]	0.467
Rainfall Variability ( $\sigma/\mu$ ) (8 years)	0.00459 (0.0387) [0.961]	-0.0221 (0.0299) [0.599]	0.0357 (0.0324) [0.479]	0.0125 (0.0442) [0.830]	-0.0218 (0.0256) [0.467]	0.489
Rainfall Variability ( $\sigma/\mu$ ) (9 years)	0.0215 (0.0331) [0.763]	-0.00549 (0.0219) [0.853]	0.0170 (0.0169) [0.527]	0.0479** (0.0200) [0.152]	0.0207 (0.0179) [0.376]	0.638
Rainfall Variability ( $\sigma/\mu$ ) (10 years)	-0.0207 (0.0365) [0.794]	-0.00461 (0.0187) [0.853]	0.0219* (0.0120) [0.280]	0.00631 (0.0132) [0.702]	0.00268 (0.0138) [0.844]	0.693
FIXED EFFECTS			CROP $\times$ HOUSEHOLD, MONTH, AND YEAR			
WEATHER CONTROLS	No	YES	YES	YES	YES	YES
QUADRATIC WEATHER CONTROLS	No	No	No	YES	YES	YES
WEATHER INTERACTIONS	No	No	YES	NO	YES	YES
OBSERVATIONS	1,546	1,546	1,546	1,546	1,546	1,546

NOTES: Significance levels are indicated as \* 0.10 \*\* 0.05 \*\*\* 0.01. The unit of analysis is at the household level. Rainfall variability is defined as the coefficient of variation for rainfall. Historical measures of atmospheric parameters correspond to the time period, over which rainfall variability is measured. Historical rainfall is measured in hundreds of mm. historical temperature is measured in  $^{\circ}\text{C}$ . Cluster robust standard errors are reported in parentheses. Wild Cluster Bootstrap-t p-values (null-imposed, 1,000 replications) are reported underneath in brackets, addressing concerns relating to the small number of clusters (Cameron, Gelbach, Miller, 2008).

Table A5: Disentangling Realized Income Events from Income Uncertainty: Defining Rainfall Variability Over Different Time Frames (Number of Crops)

	(1) CROP COUNT	(2) CROP COUNT	(3) CROP COUNT	(4) CROP COUNT	(5) CROP COUNT	(6) WITHIN GROUP STD. DEV
Rainfall Variability ( $\sigma/\mu$ ) (2 years)	-0.0000777 (0.00320) [0.977]	0.00348 (0.00931) [0.724]	-0.000171 (0.0108) [0.988]	-0.00804 (0.0104) [0.587]	-0.00352 (0.00894) [0.810]	1.594
Rainfall Variability ( $\sigma/\mu$ ) (3 years)	0.000781 (0.00521) [0.885]	-0.000783 (0.0107) [0.945]	-0.00544 (0.00808) [0.586]	-0.0106 (0.00638) [0.149]	-0.0103 (0.00635) [0.206]	2.043
Rainfall Variability ( $\sigma/\mu$ ) (4 years)	-0.00519 (0.00625) [0.436]	0.000378 (0.0113) [0.985]	-0.0143 (0.00974) [0.240]	-0.0164* (0.00929) [0.202]	-0.0139** (0.00626) [0.030]	1.871
Rainfall Variability ( $\sigma/\mu$ ) (5 years)	-0.00580 (0.00421) [0.226]	0.00216 (0.00566) [0.747]	0.00134 (0.00546) [0.839]	-0.00782** (0.00348) [0.055]	-0.00917 (0.00544) [0.113]	2.154
Rainfall Variability ( $\sigma/\mu$ ) (6 years)	-0.000294 (0.00563) [0.953]	0.0141 (0.00905) [0.195]	0.0121 (0.0104) [0.350]	-0.0102 (0.0117) [0.532]	-0.0142 (0.0133) [0.587]	1.621
Rainfall Variability ( $\sigma/\mu$ ) (7 years)	-0.00989 (0.00663) [0.182]	-0.00509 (0.0114) [0.730]	0.00372 (0.00855) [0.701]	-0.00350 (0.0111) [0.856]	-0.00323 (0.00942) [0.807]	1.860
Rainfall Variability ( $\sigma/\mu$ ) (8 years)	-0.0121 (0.00745) [0.121]	-0.0112 (0.00897) [0.291]	-0.00971 (0.00658) [0.221]	-0.00551 (0.0112) [0.744]	0.00445 (0.0118) [0.762]	1.484
Rainfall Variability ( $\sigma/\mu$ ) (9 years)	-0.00930 (0.00671) [0.196]	-0.0110* (0.00611) [0.112]	-0.00978* (0.00537) [0.149]	0.00925 (0.0145) [0.647]	0.00856 (0.0160) [0.783]	1.820
Rainfall Variability ( $\sigma/\mu$ ) (10 years)	-0.0142 (0.00940) [0.211]	-0.0147 (0.0101) [0.249]	-0.00914 (0.0111) [0.560]	0.0136 (0.0101) [0.412]	0.0146 (0.00897) [0.330]	1.266
FIXED EFFECTS						
WEATHER CONTROLS	NO	YES	YES	YES	YES	YES
QUADRATIC WEATHER CONTROLS	NO	NO	NO	YES	YES	YES
WEATHER INTERACTIONS	NO	NO	YES	NO	YES	YES
OBSERVATIONS	2,072	2,072	2,072	2,072	2,072	2,072
HOUSEHOLD, MONTH, AND YEAR						
WEATHER CONTROLS	NO	YES	YES	YES	YES	YES
QUADRATIC WEATHER CONTROLS	NO	NO	NO	YES	YES	YES
WEATHER INTERACTIONS	NO	NO	YES	NO	YES	YES
OBSERVATIONS	2,072	2,072	2,072	2,072	2,072	2,072

NOTES: Significance levels are indicated as \* 0.10 \*\* 0.05 \*\*\* 0.01. The unit of analysis is at the household level. Rainfall variability is defined as the coefficient of variation for rainfall. Historical measures of atmospheric parameters correspond to the time period, over which rainfall variability is measured. Historical rainfall is measured in hundreds of mm. historical temperature is measured in °C. Cluster robust standard errors are reported in parentheses. Wild Cluster Bootstrap-t p-values (null-imposed, 1,000 replications) are reported underneath in brackets, addressing concerns relating to the small number of clusters (Cameron, Gelbach, Miller, 2008).

Table A6: Disentangling Realized Income Events from Income Uncertainty: Defining Rainfall Variability Over Different Time Frames (Main Crop Share)

	(1) MAIN CROP SHARE	(2) MAIN CROP SHARE	(3) MAIN CROP SHARE	(4) MAIN CROP SHARE	(5) MAIN CROP SHARE	(6) WITHIN GROUP STD. DEV
Rainfall Variability ( $\sigma/\mu$ ) (2 years)	-0.000564 (0.000724) [0.635]	-0.00114 (0.000995) [0.316]	-0.000112 (0.00177) [0.960]	0.000771 (0.00215) [0.784]	-0.00391** (0.00156) [0.085]	1.594
Rainfall Variability ( $\sigma/\mu$ ) (3 years)	-0.00137 (0.000820) [0.386]	-0.000805 (0.00135) [0.595]	-0.000318 (0.00151) [0.857]	0.00132 (0.00203) [0.602]	-0.000334 (0.00146) [0.861]	2.043
Rainfall Variability ( $\sigma/\mu$ ) (4 years)	-0.000681 (0.00127) [0.797]	-0.0000546 (0.00187) [0.973]	0.00188 (0.00254) [0.559]	0.000323 (0.00227) [0.251]	0.00234 (0.00243) [0.434]	1.871
Rainfall Variability ( $\sigma/\mu$ ) (5 years)	-0.000164 (0.00129) [0.938]	-0.00146 (0.00163) [0.494]	-0.00136 (0.00158) [0.511]	0.000181 (0.00129) [0.929]	0.00181 (0.00208) [0.491]	2.154
Rainfall Variability ( $\sigma/\mu$ ) (6 years)	-0.00183 (0.00145) [0.459]	-0.00447** (0.00206) [0.070]	-0.00457* (0.00226) [0.076]	-0.00286 (0.00350) [0.501]	-0.00182 (0.00341) [0.661]	1.621
Rainfall Variability ( $\sigma/\mu$ ) (7 years)	-0.000726 (0.00151) [0.754]	-0.00291 (0.00237) [0.324]	-0.00464 (0.00274) [0.243]	-0.00311 (0.00247) [0.282]	-0.00363 (0.00379) [0.448]	1.860
Rainfall Variability ( $\sigma/\mu$ ) (8 years)	0.000176 (0.00204) [0.941]	-0.00222 (0.00217) [0.464]	-0.00234 (0.00202) [0.446]	-0.00341 (0.00331) [0.431]	-0.00294 (0.00449) [0.739]	1.484
Rainfall Variability ( $\sigma/\mu$ ) (9 years)	0.000580 (0.00181) [0.804]	-0.000383 (0.00181) [0.841]	-0.000276 (0.00186) [0.886]	-0.00233 (0.00325) [0.536]	-0.000806 (0.00287) [0.762]	1.820
Rainfall Variability ( $\sigma/\mu$ ) (10 years)	0.000352 (0.00252) [0.926]	0.000631 (0.00292) [0.904]	0.00111 (0.00298) [0.805]	-0.001000 (0.00218) [0.759]	0.00299 (0.00268) [0.290]	1.266
FIXED EFFECTS						
WEATHER CONTROLS	No	Yes	Yes	Yes	Yes	Yes
QUADRATIC WEATHER CONTROLS	No	No	No	Yes	Yes	Yes
WEATHER INTERACTIONS	No	No	Yes	No	No	Yes
OBSERVATIONS	2,072	2,072	2,072	2,072	2,072	2,072

NOTES: Significance levels are indicated as \* 0.10 \*\* 0.05 \*\*\* 0.01. The unit of analysis is at the household level. Rainfall variability is defined as the coefficient of variation for rainfall. Historical measures of atmospheric parameters correspond to the time period, over which rainfall variability is measured. Historical rainfall is measured in hundreds of mm. historical temperature is measured in °C. Cluster robust standard errors are reported in parentheses. Wild Cluster Bootstrap-t p-values (null-imposed, 1,000 replications) are reported underneath in brackets, addressing concerns relating to the small number of clusters (Cameron, Gelbach, Miller, 2008).

Table A7: Disentangling Realized Income Events from Income Uncertainty: Defining Rainfall Variability Over Different Time Frames (Farm Wages)

	(1) log AVG. WAGE	(2) log AVG. WAGE	(3) log AVG. WAGE	(4) log AVG. WAGE	(5) log AVG. WAGE	(6) WITHIN GROUP STD. DEV
Rainfall Variability ( $\sigma/\mu$ ) (2 years)	0.00182 (0.0343) [0.973]	0.00194 (0.0328) [0.964]	-0.0119 (0.0228) [0.644]	0.0477* (0.0246) [0.147]	0.0497 (0.0539) [0.496]	0.839
Rainfall Variability ( $\sigma/\mu$ ) (3 years)	-0.0104 (0.0298) [0.721]	-0.0128 (0.0322) [0.739]	-0.0196 (0.0235) [0.547]	-0.0139 (0.0239) [0.598]	0.00430 (0.0500) [0.902]	0.865
Rainfall Variability ( $\sigma/\mu$ ) (4 years)	0.0195 (0.0367) [0.628]	0.0282 (0.0318) [0.602]	0.0396 (0.0359) [0.472]	0.0252 (0.0285) [0.581]	0.0766* (0.0418) [0.249]	0.848
Rainfall Variability ( $\sigma/\mu$ ) (5 years)	0.0109 (0.0290) [0.766]	0.0115 (0.0247) [0.770]	0.0234 (0.0294) [0.593]	0.0125 (0.0239) [0.738]	0.0270 (0.0287) [0.524]	1.398
Rainfall Variability ( $\sigma/\mu$ ) (6 years)	0.00162 (0.0352) [0.963]	-0.0234 (0.0417) [0.600]	0.00409 (0.0452) [0.956]	-0.00994 (0.0389) [0.768]	-0.00417 (0.0394) [0.922]	0.917
Rainfall Variability ( $\sigma/\mu$ ) (7 years)	-0.0667** (0.0303) [0.367]	-0.0657** (0.0304) [0.347]	-0.0247 (0.0556) [0.693]	-0.00924 (0.0453) [0.800]	0.01000 (0.0473) [0.857]	0.751
Rainfall Variability ( $\sigma/\mu$ ) (8 years)	-0.0452 (0.0436) [0.462]	-0.0766* (0.0366) [0.402]	-0.0235 (0.0424) [0.715]	-0.0273 (0.0327) [0.517]	-0.0161 (0.0415) [0.650]	0.763
Rainfall Variability ( $\sigma/\mu$ ) (9 years)	-0.0429 (0.0349) [0.434]	-0.0591** (0.0221) [0.122]	-0.0348** (0.0127) [0.136]	-0.0572** (0.0238) [0.068]	-0.0933*** (0.0283) [0.090]	0.803
Rainfall Variability ( $\sigma/\mu$ ) (10 years)	-0.0640** (0.0220) [0.312]	-0.0604** (0.0255) [0.188]	-0.0280* (0.0149) [0.135]	-0.0170 (0.0183) [0.470]	-0.0847* (0.0433) [0.164]	0.757
FIXED EFFECTS						
WEATHER CONTROLS	No	Yes	Yes	Yes	Yes	Yes
QUADRATIC WEATHER CONTROLS	No	No	No	Yes	Yes	Yes
WEATHER INTERACTIONS	No	No	Yes	No	Yes	Yes
OBSERVATIONS	683	683	683	683	683	683

NOTES: Significance levels are indicated as \* 0.10 \*\* 0.05 \*\*\* 0.01. The unit of analysis is at the household level. Rainfall variability is defined as the coefficient of variation for rainfall. Historical measures of atmospheric parameters correspond to the time period, over which rainfall variability is measured. Historical rainfall is measured in hundreds of mm. historical temperature is measured in °C. Cluster robust standard errors are reported in parentheses. Wild Cluster Bootstrap-t p-values (null-imposed, 1,000 replications) are reported underneath in brackets, addressing concerns relating to the small number of clusters (Cameron, Gelbach, Miller, 2008).

Table A8: Disentangling Realized Income Events from Income Uncertainty: Defining Rainfall Variability Over Different Time Frames (Hired Worker Days)

	(1) log WORKER DAYS (Hired)	(2) log WORKER DAYS (Hired)	(3) log WORKER DAYS (Hired)	(4) log WORKER DAYS (Hired)	(5) log WORKER DAYS (Hired)	(6) WITHIN GROUP STD. DEV
Rainfall Variability ( $\sigma/\mu$ ) (2 years)	-0.0365 (0.0385) [0.388]	-0.0220 (0.0265) [0.500]	-0.0152 (0.0290) [0.704]	-0.0699** (0.0308) [0.119]	-0.101** (0.0442) [0.238]	0.886
Rainfall Variability ( $\sigma/\mu$ ) (3 years)	-0.0344 (0.0355) [0.506]	-0.00747 (0.0299) [0.818]	-0.00345 (0.0293) [0.941]	-0.0126 (0.0307) [0.749]	-0.0394 (0.0467) [0.519]	0.906
Rainfall Variability ( $\sigma/\mu$ ) (4 years)	-0.0512 (0.0311) [0.223]	-0.0336 (0.0281) [0.390]	-0.0554 (0.0326) [0.269]	-0.0362 (0.0272) [0.355]	-0.0740* (0.0403) [0.255]	0.885
Rainfall Variability ( $\sigma/\mu$ ) (5 years)	0.0121 (0.0306)	-0.00830 (0.0286) [0.655]	-0.0175 (0.0279) [0.807]	-0.00839 (0.0276) [0.664]	-0.0314 (0.0268) [0.845]	1.445
Rainfall Variability ( $\sigma/\mu$ ) (6 years)	-0.0230 (0.0625)	0.00461 (0.0551) [0.788]	-0.0201 (0.0564) [0.948]	0.00356 (0.0437) [0.711]	0.00833 (0.0426) [0.946]	0.930
Rainfall Variability ( $\sigma/\mu$ ) (7 years)	0.0463 (0.0567)	0.0521 (0.0501) [0.598]	0.0174 (0.0787) [0.860]	-0.0241 (0.0479) [0.662]	-0.0150 (0.0443) [0.735]	0.772
Rainfall Variability ( $\sigma/\mu$ ) (8 years)	0.0784** (0.0357) [0.220]	0.0597 (0.0561) [0.527]	0.0246 (0.0678) [0.914]	0.0267 (0.0484) [0.724]	0.0198 (0.0459) [0.704]	0.782
Rainfall Variability ( $\sigma/\mu$ ) (9 years)	0.0656** (0.0274) [0.155]	0.0533** (0.0217) [0.270]	0.0423* (0.0239) [0.449]	0.0984*** (0.0308) [0.108]	0.122*** (0.0321) [0.071]	0.822
Rainfall Variability ( $\sigma/\mu$ ) (10 years)	0.0593* (0.0308) [0.541]	0.0676** (0.0281) [0.405]	0.0465 (0.0301) [0.430]	0.0341 (0.0326) [0.612]	0.111** (0.0480) [0.172]	0.772
FIXED EFFECTS						
WEATHER CONTROLS	No	Yes	Yes	Yes	Yes	Yes
QUADRATIC WEATHER CONTROLS	No	No	No	Yes	Yes	Yes
WEATHER INTERACTIONS	No	No	Yes	No	Yes	Yes
OBSERVATIONS	727	727	727	727	727	727
HOUSEHOLD, MONTH, AND YEAR						

NOTES: Significance levels are indicated as \* 0.10 \*\* 0.05 \*\*\* 0.01. The unit of analysis is at the household level. Rainfall variability is defined as the coefficient of variation for rainfall. Historical measures of atmospheric parameters correspond to the time period, over which rainfall variability is measured. Historical rainfall is measured in hundreds of mm. historical temperature is measured in °C. Cluster robust standard errors are reported in parentheses. Wild Cluster Bootstrap-t p-values (null-imposed, 1,000 replications) are reported underneath in brackets, addressing concerns relating to the small number of clusters (Cameron, Gelbach, Miller, 2008).

Table A9: Disentangling Realized Income Events from Income Uncertainty: Defining Rainfall Variability Over Different Time Frames (Hired Any Workers)

	(1) HIRED ANY WORKERS	(2) HIRED ANY WORKERS	(3) HIRED ANY WORKERS	(4) HIRED ANY WORKERS	(5) HIRED ANY WORKERS	(6) WITHIN GROUP STD. DEV
Rainfall Variability ( $\sigma/\mu$ ) (2 years)	-0.00130 (0.000805) [0.238]	0.00304 (0.00319) [0.478]	0.00679** (0.00294) [0.172]	0.00425 (0.00296) [0.260]	0.00541* (0.00269) [0.126]	1.594
Rainfall Variability ( $\sigma/\mu$ ) (3 years)	-0.00127 (0.00177) [0.585]	0.00455 (0.00421) [0.393]	0.00702** (0.00292) [0.109]	0.00518* (0.00243) [0.144]	0.00514* (0.00250) [0.213]	2.051
Rainfall Variability ( $\sigma/\mu$ ) (4 years)	0.000445 (0.00269) [0.885]	0.00209 (0.00424) [0.724]	0.00886** (0.00377) [0.052]	0.00573** (0.00218) [0.007]	0.00554* (0.00311) [0.103]	1.876
Rainfall Variability ( $\sigma/\mu$ ) (5 years)	0.000404 (0.00239) [0.882]	0.000744 (0.00320) [0.828]	0.000958 (0.00325) [0.789]	0.00446** (0.00160) [0.019]	0.00446** (0.00308) [0.222]	2.159
Rainfall Variability ( $\sigma/\mu$ ) (6 years)	-0.00212 (0.00155) [0.331]	-0.00469 (0.00304) [0.287]	-0.00413 (0.00362) [0.490]	0.00580 (0.00410) [0.285]	0.00486 (0.00423) [0.415]	1.617
Rainfall Variability ( $\sigma/\mu$ ) (7 years)	0.000290 (0.00344) [0.953]	0.00172 (0.00532) [0.786]	0.000609 (0.00466) [0.910]	-0.000138 (0.00327) [0.975]	0.00296 (0.00274) [0.320]	1.861
Rainfall Variability ( $\sigma/\mu$ ) (8 years)	-0.000108 (0.00392) [0.976]	0.00127 (0.00547) [0.835]	0.000822 (0.00469) [0.890]	-0.00261 (0.00490) [0.736]	0.00593 (0.00347) [0.132]	1.488
Rainfall Variability ( $\sigma/\mu$ ) (9 years)	-0.000787 (0.00388) [0.855]	0.000235 (0.00449) [0.965]	-0.000168 (0.00417) [0.978]	-0.000567 (0.00332) [0.881]	0.00527** (0.00198) [0.131]	1.826
Rainfall Variability ( $\sigma/\mu$ ) (10 years)	0.00118 (0.00651) [0.891]	0.000785 (0.00598) [0.930]	-0.00113 (0.00598) [0.888]	-0.00378 (0.00283) [0.179]	0.00270 (0.00405) [0.632]	1.269
FIXED EFFECTS						
WEATHER CONTROLS	No	Yes	Yes	Yes	Yes	Yes
QUADRATIC WEATHER CONTROLS	No	No	No	Yes	Yes	Yes
WEATHER INTERACTIONS	No	No	Yes	No	No	Yes
OBSERVATIONS	2,053	2,053	2,053	2,053	2,053	2,053

NOTES: Significance levels are indicated as \* 0.10 \*\* 0.05 \*\*\* 0.01. The unit of analysis is at the household level. Rainfall variability is defined as the coefficient of variation for rainfall. Historical measures of atmospheric parameters correspond to the time period, over which rainfall variability is measured. Historical rainfall is measured in hundreds of mm. historical temperature is measured in °C. Cluster robust standard errors are reported in parentheses. Wild Cluster Bootstrap-t p-values (null-imposed, 1,000 replications) are reported underneath in brackets, addressing concerns relating to the small number of clusters (Cameron, Gelbach, Miller, 2008).

Table A10: Disentangling Realized Income Events from Income Uncertainty: Defining Rainfall Variability Over Different Time Frames (Number of Livestock Owned)

	(1) NUMBER OF LIVESTOCK	(2) NUMBER OF LIVESTOCK	(3) NUMBER OF LIVESTOCK	(4) NUMBER OF LIVESTOCK	(5) NUMBER OF LIVESTOCK	(6) WITHIN GROUP STD. DEV
Rainfall Variability ( $\sigma/\mu$ ) (2 years)	0.000300 (0.00144) [0.873]	0.00264 (0.00575) [0.781]	0.000468 (0.00370) [0.923]	0.00173 (0.00529) [0.817]	-0.00115 (0.00578) [0.920]	1.875
Rainfall Variability ( $\sigma/\mu$ ) (3 years)	0.000975 (0.00201) [0.661]	0.00571 (0.00464) [0.404]	0.00499** (0.00222) [0.133]	0.00623** (0.00265) [0.071]	0.00653** (0.00269) [0.186]	2.569
Rainfall Variability ( $\sigma/\mu$ ) (4 years)	0.000900 (0.00533) [0.730]	0.00903* (0.00433) [0.208]	0.00685* (0.00342) [0.222]	0.0077** (0.00343) [0.159]	0.00667* (0.00347) [0.291]	2.459
Rainfall Variability ( $\sigma/\mu$ ) (5 years)	0.000932 (0.00212) [0.770]	0.00387* (0.00199) [0.201]	0.00348* (0.00195) [0.200]	0.00192 (0.00253) [0.534]	0.00467* (0.00258) [0.225]	2.755
Rainfall Variability ( $\sigma/\mu$ ) (6 years)	0.000462 (0.00263) [0.894]	0.00397 (0.00290) [0.316]	0.00304 (0.00231) [0.368]	0.000814 (0.00453) [0.894]	0.00181 (0.00341) [0.702]	2.220
Rainfall Variability ( $\sigma/\mu$ ) (7 years)	-0.00171 (0.00296) [0.730]	-0.00224 (0.00365) [0.619]	-0.00139 (0.00327) [0.772]	-0.00351 (0.00374) [0.477]	-0.00351 (0.00357) [0.513]	2.597
Rainfall Variability ( $\sigma/\mu$ ) (8 years)	-0.000918 (0.00354) [0.890]	-0.000806 (0.00368) [0.857]	-0.00255 (0.00336) [0.578]	-0.00100 (0.00374) [0.842]	-0.00560 (0.00580) [0.567]	1.796
Rainfall Variability ( $\sigma/\mu$ ) (9 years)	-0.00171 (0.00375) [0.790]	-0.00209 (0.00359) [0.750]	-0.00224 (0.00352) [0.831]	-0.00407 (0.00541) [0.850]	-0.00588 (0.00614) [0.825]	2.400
Rainfall Variability ( $\sigma/\mu$ ) (10 years)	-0.00294 (0.00472) [0.569]	-0.00225 (0.00492) [0.680]	-0.000525 (0.00536) [0.936]	-0.00897 (0.00871) [0.488]	-0.00696 (0.00610) [0.435]	1.653
FIXED EFFECTS				LIVESTOCK $\times$ HOUSEHOLD, MONTH, AND YEAR		
WEATHER CONTROLS	No	Yes	Yes	Yes	Yes	
QUADRATIC WEATHER CONTROLS	No	No	No	Yes	Yes	
WEATHER INTERACTIONS	No	No	Yes	No	Yes	
OBSERVATIONS	34,863	34,863	34,863	34,863	34,863	34,863

NOTES: Significance levels are indicated as \* 0.10 \*\* 0.05 \*\*\* 0.01. The unit of analysis is at the household level. Rainfall variability is defined as the coefficient of variation for rainfall. Historical measures of atmospheric parameters correspond to the time period, over which rainfall variability is measured. Historical rainfall is measured in hundreds of mm. historical temperature is measured in °C. Cluster robust standard errors are reported in parentheses. Wild Cluster Bootstrap-t p-values (null-imposed, 1,000 replications) are reported underneath in brackets, addressing concerns relating to the small number of clusters (Cameron, Gelbach, Miller, 2008).

Table A11: Disentangling Realized Income Events from Income Uncertainty: Defining Rainfall Variability Over Different Time Frames (Number of Livestock Slaughtered)

	(1)	(2)	(3)	(4)	(5)	(6)
	NUMBER OF LIVESTOCK SLAUGHTERED	NUMBER OF LIVESTOCK SLAUGHTERED	NUMBER OF LIVESTOCK SLAUGHTERED	NUMBER OF LIVESTOCK SLAUGHTERED	NUMBER OF LIVESTOCK SLAUGHTERED	WITHIN GROUP STD. DEV
Rainfall Variability ( $\sigma/\mu$ ) (2 years)	-0.000118 (0.000419) [0.826]	-0.000596 (0.00123) [0.686]	-0.00102 (0.000853) [0.386]	-0.000462 (0.00139) [0.826]	-0.000578 (0.00119) [0.888]	1.875
Rainfall Variability ( $\sigma/\mu$ ) (3 years)	-0.000287 (0.000634) [0.682]	0.000191 (0.000890) [0.860]	0.000366 (0.000681) [0.968]	0.000262 (0.000801) [0.805]	0.00116* (0.000594) [0.360]	2.569
Rainfall Variability ( $\sigma/\mu$ ) (4 years)	-0.000454 (0.000682) [0.617]	0.000785 (0.00104) [0.524]	0.000536 (0.00106) [0.714]	0.000505 (0.00113) [0.731]	0.000417 (0.00115) [0.810]	2.459
Rainfall Variability ( $\sigma/\mu$ ) (5 years)	-0.0000951 (0.000733) [0.937]	0.000331 (0.000523) [0.595]	0.000277 (0.000544) [0.687]	0.000235 (0.000694) [0.984]	-0.0000576 (0.000751) [0.952]	2.755
Rainfall Variability ( $\sigma/\mu$ ) (6 years)	-0.0000281 (0.000826) [0.758]	0.000386 (0.000663) [0.605]	0.000281 (0.000645) [0.735]	-0.000481 (0.00117) [0.760]	-0.000499 (0.00115) [0.787]	2.220
Rainfall Variability ( $\sigma/\mu$ ) (7 years)	-0.0000861 (0.000566) [0.443]	-0.00132 (0.000803) [0.284]	-0.00136 (0.000856) [0.338]	-0.00163* (0.000776) [0.262]	-0.000702 (0.000664) [0.423]	2.597
Rainfall Variability ( $\sigma/\mu$ ) (8 years)	-0.000684 (0.000951) [0.589]	-0.000965 (0.000613) [0.321]	-0.00103 (0.000714) [0.358]	-0.000697 (0.000785) [0.529]	0.00103 (0.00132) [0.591]	1.796
Rainfall Variability ( $\sigma/\mu$ ) (9 years)	-0.00112 (0.000943) [0.455]	-0.00115* (0.000635) [0.263]	-0.00116* (0.000635) [0.273]	-0.000234 (0.00135) [0.916]	-0.000361 (0.00161) [0.867]	2.400
Rainfall Variability ( $\sigma/\mu$ ) (10 years)	-0.00248* (0.00118) [0.228]	-0.00162 (0.00105) [0.201]	-0.00168 (0.00106) [0.171]	-0.00193 (0.00212) [0.535]	-0.00151 (0.00215) [0.695]	1.653
FIXED EFFECTS						
WEATHER CONTROLS	No	YES	YES	YES	YES	YES
QUADRATIC WEATHER CONTROLS	No	NO	NO	YES	YES	YES
WEATHER INTERACTIONS	No	NO	YES	NO	YES	YES
OBSERVATIONS	34,863	34,863	34,863	34,863	34,863	34,863

NOTES: Significance levels are indicated as \* 0.10 \*\* 0.05 \*\*\* 0.01. The unit of analysis is at the household level. Rainfall variability is defined as the coefficient of variation for rainfall. Historical measures of atmospheric parameters correspond to the time period, over which rainfall variability is measured. Historical rainfall is measured in hundreds of mm. historical temperature is measured in °C. Cluster robust standard errors are reported in parentheses. Wild Cluster Bootstrap-t p-values (null-imposed, 1,000 replications) are reported underneath in brackets, addressing concerns relating to the small number of clusters (Cameron, Gelbach, Miller, 2008).

Table A12: Disentangling Realized Income Events from Income Uncertainty: Defining Rainfall Variability Over Different Time Frames (Number of Livestock Sold)

	(1) NUMBER OF LIVESTOCK SOLD	(2) NUMBER OF LIVESTOCK SOLD	(3) NUMBER OF LIVESTOCK SOLD	(4) NUMBER OF LIVESTOCK SOLD	(5) NUMBER OF LIVESTOCK SOLD	(6) WITHIN GROUP STD. DEV
Rainfall Variability ( $\sigma/\mu$ ) (2 years)	0.00107** (0.000488) [0.144]	0.000727 (0.00133) [0.637]	0.000915 (0.00146) [0.603]	0.000229 (0.00182) [0.482]	0.00188 (0.00243) [0.701]	1.875
Rainfall Variability ( $\sigma/\mu$ ) (3 years)	0.00161 * (0.000874) [0.152]	0.000746 (0.00188) [0.837]	0.000865 (0.00168) [0.721]	0.00149 (0.00179) [0.549]	0.00198 (0.00170) [0.493]	2.567
Rainfall Variability ( $\sigma/\mu$ ) (4 years)	0.00209 * (0.00107) [0.190]	0.00121 (0.00175) [0.642]	0.00181 (0.00203) [0.587]	0.00173 (0.00179) [0.559]	0.00156 (0.00185) [0.646]	2.459
Rainfall Variability ( $\sigma/\mu$ ) (5 years)	0.00209 ** (0.000934) [0.153]	0.000421 (0.00127) [0.807]	0.000425 (0.00132) [0.822]	0.00148 (0.00122) [0.419]	0.00171 (0.00147) [0.549]	2.755
Rainfall Variability ( $\sigma/\mu$ ) (6 years)	0.00212 * (0.00108) [0.118]	0.000352 (0.00110) [0.795]	0.000430 (0.00111) [0.777]	0.00250 (0.00206) [0.405]	0.00257 (0.00216) [0.470]	2.220
Rainfall Variability ( $\sigma/\mu$ ) (7 years)	0.00279 ** (0.00130) [0.138]	0.00199 (0.00120) [0.165]	0.00195 (0.00123) [0.174]	0.00220 (0.00137) [0.238]	0.00295 * (0.00148) [0.249]	2.597
Rainfall Variability ( $\sigma/\mu$ ) (8 years)	0.00357 ** (0.00157) [0.073]	0.00323 ** (0.00144) [0.036]	0.00339 ** (0.00142) [0.075]	0.00271 * (0.00145) [0.216]	0.00524 ** (0.00229) [0.155]	1.796
Rainfall Variability ( $\sigma/\mu$ ) (9 years)	0.00294 * (0.00145) [0.106]	0.00275 (0.00162) [0.215]	0.00275 (0.00162) [0.210]	0.00401 * (0.00205) [0.413]	0.00501 ** (0.00206) [0.410]	2.400
Rainfall Variability ( $\sigma/\mu$ ) (10 years)	0.00294 (0.00202) [0.224]	0.00162 (0.00201) [0.553]	0.000377 (0.00205) [0.911]	0.00158 (0.00272) [0.726]	0.000748 (0.00248) [0.869]	1.653
FIXED EFFECTS						
WEATHER CONTROLS	No	Yes	Yes	Yes	Yes	Yes
QUADRATIC WEATHER CONTROLS	No	No	No	Yes	Yes	Yes
WEATHER INTERACTIONS	No	No	Yes	No	No	Yes
OBSERVATIONS	34,863	34,863	34,863	34,863	34,863	34,863

NOTES: Significance levels are indicated as \* 0.10 \*\* 0.05 \*\*\* 0.01. The unit of analysis is at the household level. Rainfall variability is defined as the coefficient of variation for rainfall. Historical measures of atmospheric parameters correspond to the time period, over which rainfall variability is measured. Historical rainfall is measured in hundreds of mm. historical temperature is measured in °C. Cluster robust standard errors are reported in parentheses. Wild Cluster Bootstrap-t p-values (null-imposed, 1,000 replications) are reported underneath in brackets, addressing concerns relating to the small number of clusters (Cameron, Gelbach, Miller, 2008).

Table A13: Disentangling Realized Income Events from Income Uncertainty: Defining Rainfall Variability Over Different Time Frames (Non-Farm Work)

	(1) ENGAGED IN OFF-FARM WORK	(2) ENGAGED IN OFF-FARM WORK	(3) ENGAGED IN OFF-FARM WORK	(4) ENGAGED IN OFF-FARM WORK	(5) ENGAGED IN OFF-FARM WORK	(6) WITHIN GROUP STD. DEV
Rainfall Variability ( $\sigma/\mu$ ) (2 years)	-0.00152 (0.00136) [0.870]	-0.00304 (0.00532) [0.746]	-0.00227 (0.00611) [0.870]	-0.00649 (0.00664) [0.710]	0.000679 (0.00572) [0.912]	1.152
Rainfall Variability ( $\sigma/\mu$ ) (3 years)	-0.00244 (0.00202) [0.917]	-0.000817 (0.00580) [0.907]	-0.000864 (0.00582) [0.904]	-0.00234 (0.00599) [0.800]	0.00651 (0.00468) [0.358]	1.444
Rainfall Variability ( $\sigma/\mu$ ) (4 years)	-0.00342 (0.00216) [0.884]	-0.00700 (0.00538) [0.471]	-0.00634 (0.00582) [0.509]	-0.00653 (0.00573) [0.517]	-0.00969 (0.00565) [0.457]	1.369
Rainfall Variability ( $\sigma/\mu$ ) (5 years)	-0.00351* (0.00197) [0.821]	-0.00571 (0.00489) [0.397]	-0.00629 (0.00448) [0.329]	-0.00490 (0.00534) [0.514]	-0.00957 (0.00598) [0.375]	1.417
Rainfall Variability ( $\sigma/\mu$ ) (6 years)	-0.00415 (0.00238) [0.811]	-0.00475 (0.00423) [0.488]	-0.00436 (0.00400) [0.506]	-0.00827 (0.00657) [0.409]	-0.0171* (0.00813) [0.254]	1.097
Rainfall Variability ( $\sigma/\mu$ ) (7 years)	-0.00497* (0.00242) [0.733]	-0.00700 (0.00425) [0.474]	-0.00975** (0.00336) [0.163]	-0.00668 (0.00419) [0.499]	-0.0105** (0.00409) [0.026]	0.876
Rainfall Variability ( $\sigma/\mu$ ) (8 years)	-0.00687* (0.00326) [0.655]	-0.00714 (0.00437) [0.663]	-0.00596 (0.00407) [0.566]	-0.00175 (0.00589) [0.809]	-0.00693 (0.00826) [0.433]	0.663
Rainfall Variability ( $\sigma/\mu$ ) (9 years)	-0.00762* (0.00394) [0.441]	-0.00805 (0.00522) [0.292]	-0.00755 (0.00529) [0.345]	-0.00173 (0.00619) [0.843]	-0.00458 (0.00740) [0.643]	1.281
Rainfall Variability ( $\sigma/\mu$ ) (10 years)	-0.0104** (0.00438) [0.421]	-0.0118 (0.00683) [0.494]	-0.0149** (0.00665) [0.428]	-0.00842 (0.00753) [0.596]	-0.00508 (0.00713) [0.607]	0.934
FIXED EFFECTS						
WEATHER CONTROLS	No	Yes	Yes	Yes	Yes	Yes
QUADRATIC WEATHER CONTROLS	No	No	No	Yes	Yes	Yes
WEATHER INTERACTIONS	No	No	Yes	No	Yes	Yes
OBSERVATIONS	1,039	1,039	1,039	1,039	1,039	1,039

NOTES: Significance levels are indicated as \* 0.10 \*\* 0.05 \*\*\* 0.01. The unit of analysis is at the household level. Rainfall variability is defined as the coefficient of variation for rainfall. Historical measures of atmospheric parameters correspond to the time period over which rainfall variability is measured. Historical rainfall is measured in hundreds of mm. historical temperature is measured in °C. Cluster robust standard errors are reported in parentheses. Wild Cluster Bootstrap-t p-values (null-imposed, 1,000 replications) are reported underneath in brackets, addressing concerns relating to the small number of clusters (Cameron, Gelbach, Miller, 2008).

Table A14: Disentangling Realized Income Events from Income Uncertainty: Defining Rainfall Variability Over Different Time Frames (Out-of-Village Work)

	(1) ENGAGED IN OUT OF VILLAGE WORK	(2) ENGAGED IN OUT OF VILLAGE WORK	(3) ENGAGED IN OUT OF VILLAGE WORK	(4) ENGAGED IN OUT OF VILLAGE WORK	(5) ENGAGED IN OUT OF VILLAGE WORK	(6) WITHIN GROUP STD. DEV
Rainfall Variability ( $\sigma/\mu$ ) (2 years)	0.00137 (0.00100) [0.146]	0.00687* (0.00340) [0.158]	0.00521 (0.00418) [0.447]	-0.00465 (0.00357) [0.292]	-0.000686 (0.00499) [0.893]	1.153
Rainfall Variability ( $\sigma/\mu$ ) (3 years)	0.00191 (0.00140) [0.129]	0.00151 (0.00422) [0.721]	0.000954 (0.00481) [0.861]	-0.00692*** (0.00226) [0.048]	-0.00502 (0.00294) [0.102]	1.444
Rainfall Variability ( $\sigma/\mu$ ) (4 years)	0.00241 (0.00163) [0.097]	-0.00647 (0.00406) [0.302]	-0.0103*** (0.00329) [0.078]	-0.00990*** (0.00159) [0.019]	-0.00881*** (0.00246) [0.090]	1.369
Rainfall Variability ( $\sigma/\mu$ ) (5 years)	0.00113 (0.00091) [0.181]	-0.00162 (0.00397) [0.754]	0.000181 (0.00423) [0.974]	-0.00442* (0.00234) [0.116]	-0.00312 (0.00358) [0.534]	1.418
Rainfall Variability ( $\sigma/\mu$ ) (6 years)	0.00305 (0.00223) [0.166]	0.00478* (0.00262) [0.170]	0.00405 (0.00252) [0.269]	-0.00466 (0.00364) [0.381]	-0.000402 (0.00432) [0.962]	1.097
Rainfall Variability ( $\sigma/\mu$ ) (7 years)	0.00120 (0.00140) [0.356]	-0.00306 (0.00370) [0.568]	-0.00183 (0.00432) [0.805]	-0.00368* (0.00201) [0.261]	0.00914 (0.00525) [0.461]	0.867
Rainfall Variability ( $\sigma/\mu$ ) (8 years)	0.0000209 (0.00192) [0.989]	-0.00431 (0.00278) [0.410]	-0.00455 (0.00285) [0.391]	-0.00225 (0.00373) [0.616]	0.00739 (0.0111) [0.796]	0.664
Rainfall Variability ( $\sigma/\mu$ ) (9 years)	-0.000120 (0.00248) [0.954]	0.00199 (0.00304) [0.563]	0.00223 (0.00299) [0.534]	0.00327 (0.00430) [0.523]	-0.000631 (0.00406) [0.870]	1.281
Rainfall Variability ( $\sigma/\mu$ ) (10 years)	-0.000264 (0.00321) [0.952]	0.00380 (0.00274) [0.223]	0.00458 (0.00300) [0.127]	-0.00233 (0.00397) [0.668]	-0.00622 (0.00570) [0.493]	0.935
FIXED EFFECTS						
WEATHER CONTROLS	No	Yes	Yes	Yes	Yes	Yes
QUADRATIC WEATHER CONTROLS	No	No	No	Yes	Yes	Yes
WEATHER INTERACTIONS	No	No	Yes	No	Yes	Yes
OBSERVATIONS	1,037	1,037	1,037	1,037	1,037	1,037

NOTES: Significance levels are indicated as \* 0.10 \*\* 0.05 \*\*\* 0.01. The unit of analysis is at the household level. Rainfall variability is defined as the coefficient of variation for rainfall. Historical measures of atmospheric parameters correspond to the time period, over which rainfall variability is measured. Historical rainfall is measured in hundreds of mm. historical temperature is measured in °C. Cluster robust standard errors are reported in parentheses. Wild Cluster Bootstrap-t p-values (null-imposed, 1,000 replications) are reported underneath in brackets, addressing concerns relating to the small number of clusters (Cameron, Gelbach, Miller, 2008).

Table A15: Disentangling Realized Income Events from Income Uncertainty: Defining Rainfall Variability Over Different Time Frames (Off-Farm Days Worked)

	(1) log DAYS WORKED (Off-Farm)	(2) log DAYS WORKED (Off-Farm)	(3) log DAYS WORKED (Off-Farm)	(4) log DAYS WORKED (Off-Farm)	(5) log DAYS WORKED (Off-Farm)	(6) WITHIN GROUP STD. DEV
Rainfall Variability ( $\sigma/\mu$ ) (2 years)	0.00700 (0.0113) [0.778]	0.0349 (0.0396) [0.520]	0.0503* (0.0274) [0.254]	0.145*** (0.0360) [0.024]	0.191*** (0.0372) [0.375]	0.341
Rainfall Variability ( $\sigma/\mu$ ) (3 years)	0.0162 (0.0171) [0.648]	0.0400 (0.0437) [0.451]	0.0563** (0.0250) [0.150]	-0.00704 (0.0783) [0.890]	0.0774 (0.0741) [0.712]	0.253
Rainfall Variability ( $\sigma/\mu$ ) (4 years)	0.0323 (0.0215) [0.392]	-0.0225 (0.0892) [0.871]	0.0671 (0.0922) [0.526]	0.00964 (0.0746) [0.886]	0.0629 (0.116) [0.558]	0.203
Rainfall Variability ( $\sigma/\mu$ ) (5 years)	0.0325* (0.0181) [0.461]	0.0205 (0.0153) [0.438]	0.0156 (0.0143) [0.387]	0.0676 (0.0414) [0.358]	0.0172 (0.0979) [0.785]	0.245
Rainfall Variability ( $\sigma/\mu$ ) (6 years)	0.0441* (0.0225) [0.783]	0.0576*** (0.0147) [0.608]	0.0476** (0.0195) [0.431]	0.0595*** (0.0111) [0.490]	0.0265 (0.0431) [0.977]	0.445
Rainfall Variability ( $\sigma/\mu$ ) (7 years)	0.0226 (0.0228) [0.414]	0.0188 (0.0203) [0.196]	0.0172 (0.0122) [0.746]	0.0428 (0.0480) [0.191]	-0.00112 (0.0356) [0.676]	0.418
Rainfall Variability ( $\sigma/\mu$ ) (8 years)	0.0411 (0.0283) [0.778]	0.0537*** (0.0145) [0.273]	0.0568** (0.0197) [0.761]	0.00132 (0.0533) [0.989]	-0.0258 (0.0960) [0.883]	0.212
Rainfall Variability ( $\sigma/\mu$ ) (9 years)	0.0435 (0.0284) [0.753]	0.0638* (0.0325) [0.286]	0.0720* (0.0359) [0.319]	0.0416 (0.0720) [0.745]	-0.0699 (0.0763) [0.594]	0.309
Rainfall Variability ( $\sigma/\mu$ ) (10 years)	0.0765*** (0.0237) [0.190]	0.0662 (0.0569) [0.494]	0.0529 (0.0866) [0.767]	0.107 (0.111) [0.707]	-0.0432 (0.0662) [0.731]	0.316
FIXED EFFECTS						
WEATHER CONTROLS	NO	YES	YES	YES	YES	YES
QUADRATIC WEATHER CONTROLS	NO	NO	NO	YES	YES	YES
WEATHER INTERACTIONS	NO	NO	YES	NO	YES	YES
OBSERVATIONS	536	536	536	536	536	536

NOTES: Significance levels are indicated as \* 0.10 \*\* 0.05 \*\*\* 0.01. The unit of analysis is at the household level. Rainfall variability is defined as the coefficient of variation for rainfall. Historical measures of atmospheric parameters correspond to the time period, over which rainfall variability is measured. Historical rainfall is measured in hundreds of mm. historical temperature is measured in °C. Cluster robust standard errors are reported in parentheses. Wild Cluster Bootstrap p-values (null-imposed, 1,000 replications) are reported underneath in brackets, addressing concerns relating to the small number of clusters (Cameron, Gelbach, Miller, 2008).

Table A16: Disentangling Realized Income Events from Income Uncertainty: The Effects of Rainfall Variability on Rainfall Realizations

OUTCOME VARIABLE	TREATMENT VARIABLE: Rainfall Variability ( $\sigma/\mu$ )								
	(1) (2 years)	(2) (3 years)	(3) (4 years)	(4) (5 years)	(5) (6 years)	(6) (7 years)	(7) (8 years)	(8) (9 years)	(9) (10 years)
ANNUAL RAINFALL (t+4)	-0.494 (0.858) [0.515]	1.157 (2.101) [0.593]	0.778 (1.712) [0.671]	2.805 (1.996) [0.187]	-0.785 (2.302) [0.733]	-0.987 (1.813) [0.547]	0.994 (1.600) [0.491]	2.064 (1.502) [0.180]	3.317** (1.294) [0.018]
ANNUAL RAINFALL (t+3)	0.844 (0.960) [0.390]	1.824* (1.022) [0.065]	2.726 (1.879) [0.179]	2.760* (1.411) [0.041]	4.505** (1.915) [0.042]	1.149 (2.252) [0.546]	1.388 (2.024) [0.474]	3.456 (2.051) [0.145]	4.790** (1.949) [0.054]
ANNUAL RAINFALL (t+2)	0.353 (1.155) [0.768]	1.215 (1.633) [0.502]	2.668 (1.611) [0.148]	4.192* (2.253) [0.123]	4.138** (1.879) [0.073]	6.188*** (1.886) [0.019]	3.766* (2.058) [0.119]	4.599** (2.082) [0.081]	6.821*** (2.243) [0.022]
ANNUAL RAINFALL (t+1)	-2.017* (0.992) [0.140]	-0.434 (1.431) [0.797]	0.388 (1.445) [0.789]	1.925 (1.687) [0.253]	3.377* (1.705) [0.074]	4.124*** (1.380) [0.011]	5.790*** (1.440) [0.004]	3.751* (1.749) [0.061]	4.552** (1.866) [0.038]
ANNUAL RAINFALL (t)	-1.746** (0.683) [0.083]	-1.054 (0.851) [0.268]	0.570 (1.171) [0.643]	1.762 (1.066) [0.130]	3.533** (1.289) [0.013]	4.673*** (1.489) [0.003]	5.644*** (0.979) [0.000]	6.249*** (1.188) [0.000]	4.766*** (1.512) [0.007]
ANNUAL RAINFALL (t-1)	1.746** (0.683) [0.083]	-0.972 (0.710) [0.195]	-0.814 (0.788) [0.318]	0.393 (1.084) [0.722]	1.583 (1.197) [0.248]	2.784** (1.272) [0.043]	3.607** (1.553) [0.007]	3.985*** (1.088) [0.005]	4.526*** (1.127) [0.002]
ANNUAL RAINFALL (t-2)	0.138 (1.415) [0.938]	2.109* (1.020) [0.122]	-0.283 (0.561) [0.621]	-0.688 (0.851) [0.507]	0.574 (1.257) [0.899]	1.482 (1.330) [0.420]	2.363 (1.538) [0.223]	3.170* (1.479) [0.064]	3.972** (1.810) [0.055]
ANNUAL RAINFALL (t-3)	-0.388 (0.934) [0.708]	-0.479 (1.368) [0.731]	0.418 (1.511) [0.804]	-0.979 (1.018) [0.371]	-1.192 (1.051) [0.288]	0.0914 (1.086) [0.926]	0.951 (1.265) [0.506]	1.812 (1.752) [0.336]	2.648* (1.362) [0.070]
ANNUAL RAINFALL (t-4)	-4.061*** (1.287) [0.041]	-2.846** (1.318) [0.193]	-2.141* (1.119) [0.113]	-1.088 (1.839) [0.587]	-2.595* (1.304) [0.093]	-3.347*** (1.023) [0.018]	-1.887*** (0.630) [0.003]	-0.898 (0.725) [0.229]	0.0577 (1.272) [0.964]
OBSERVATIONS	495	495	495	495	495	495	495	495	495
TREATMENT STD. DEV.	11.345	9.861	8.970	8.163	7.515	7.019	6.566	6.179	5.938
FIXED EFFECTS									
WEATHER CONTROLS	YES	YES	YES	YES	YES	YES	YES	YES	YES
QUADRATIC WEATHER CONTROLS	YES	YES	YES	YES	YES	YES	YES	YES	YES
WEATHER INTERACTIONS	YES	YES	YES	YES	YES	YES	YES	YES	YES

NOTES: Significance levels are indicated as \* 0.10 \*\* 0.05 \*\*\* 0.01. The unit of analysis is at the village level. Each coefficient relates to an individual regression. Rainfall variability is defined as the coefficient of variation for rainfall. Historical measures of atmospheric parameters correspond to the time period, over which rainfall variability is measured. Historical rainfall is measured in hundreds of mm. historical temperature is measured in °C. Cluster robust standard errors are reported in parentheses. Wild Cluster Bootstrap p-values (null-imposed, 1,000 replications) are reported underneath in brackets, addressing concerns relating to the small number of clusters (Cameron, Gelbach, Miller, 2008).

### **A.2.2 Using the Standard Deviation of Rainfall as an Alternative Measure of Rainfall Variability**

The following tables replicate the results, using the standard deviation of rainfall as our proxy for income uncertainty instead of the coefficient of variation.

Table A17: Disentangling Realized Income Events from Income Uncertainty: Defining Rainfall Variability Over Different Time Frames (Yields)

	(1) log YIELDS	(2) log YIELDS	(3) log YIELDS	(4) log YIELDS	(5) log YIELDS	(6) WITHIN GROUP STD. DEV
Rainfall Variability ( $\sigma$ , 100mm) (2 years)	-0.0867 (0.0538) [0.386]	-0.111 (0.0748) [0.288]	-0.160* (0.0808) [0.210]	0.0846 (0.131) [0.657]	0.0709 (0.127) [0.675]	0.185
Rainfall Variability ( $\sigma$ , 100mm) (3 years)	-0.127 (0.0791) [0.237]	-0.0385 (0.0731) [0.673]	-0.0678 (0.0619) [0.376]	0.0837 (0.0586) [0.232]	0.105* (0.0523) [0.142]	0.241
Rainfall Variability ( $\sigma$ , 100mm) (4 years)	-0.248** (0.0853) [0.033]	-0.0926 (0.0845) [0.368]	-0.0934 (0.0892) [0.426]	-0.0229 (0.128) [0.934]	0.0418 (0.0856) [0.711]	0.202
Rainfall Variability ( $\sigma$ , 100mm) (5 years)	-0.150 (0.0917) [0.238]	-0.0780 (0.0799) [0.515]	-0.0686 (0.0769) [0.582]	-0.0666 (0.107) [0.937]	-0.0311 (0.0644) [0.648]	0.220
Rainfall Variability ( $\sigma$ , 100mm) (6 years)	-0.257** (0.0981) [0.130]	-0.0985 (0.118) [0.555]	-0.0848 (0.106) [0.529]	-0.0761 (0.135) [0.836]	-0.0751 (0.0840) [0.556]	0.164
Rainfall Variability ( $\sigma$ , 100mm) (7 years)	-0.225* (0.109) [0.166]	-0.0624 (0.118) [0.683]	-0.190 (0.140) [0.296]	-0.0401 (0.101) [0.788]	-0.237** (0.0926) [0.141]	0.166
Rainfall Variability ( $\sigma$ , 100mm) (8 years)	-0.228 (0.148) [0.338]	-0.200 (0.136) [0.310]	-0.217 (0.129) [0.243]	-0.0921 (0.131) [0.621]	-0.279* (0.157) [0.499]	0.149
Rainfall Variability ( $\sigma$ , 100mm) (9 years)	-0.160 (0.134) [0.429]	-0.184 (0.147) [0.413]	-0.190 (0.149) [0.427]	-0.104 (0.191) [0.946]	-0.240 (0.185) [0.747]	0.197
Rainfall Variability ( $\sigma$ , 100mm) (10 years)	-0.157 (0.104) [0.163]	-0.0759 (0.121) [0.579]	-0.0626 (0.124) [0.641]	0.139 (0.129) [0.423]	0.0584 (0.136) [0.808]	0.164
FIXED EFFECTS						
WEATHER CONTROLS	NO	Y <sub>ES</sub>	Y <sub>ES</sub>	Y <sub>ES</sub>	Y <sub>ES</sub>	Y <sub>ES</sub>
QUADRATIC WEATHER CONTROLS	NO	NO	NO	YES	YES	YES
WEATHER INTERACTIONS	NO	NO	YES	NO	YES	YES
OBSERVATIONS	3,812	3,812	3,812	3,812	3,812	3,812

NOTES: Significance levels are indicated as \* 0.10 \*\* 0.05 \*\*\* 0.01. The unit of analysis is at the household level. Rainfall variability is defined as the standard deviation of rainfall. Historical measures of atmospheric parameters correspond to the time period, over which rainfall variability is measured. Historical rainfall is measured in hundreds of mm, historical temperature is measured in °C. Cluster robust standard errors are reported in parentheses. Wild Cluster Bootstrap-t p-values (null-imposed, 1,000 replications) are reported underneath in brackets, addressing concerns relating to the small number of clusters (Cameron, Gelbach, Miller, 2008).

Table A18: Disentangling Realized Income Events from Income Uncertainty: Defining Rainfall Variability Over Different Time Frames (Share Sold)

	(1) SHARE SOLD	(2) SHARE SOLD	(3) SHARE SOLD	(4) SHARE SOLD	(5) SHARE SOLD	(6) SHARE SOLD STD. DEV
Rainfall Variability ( $\sigma$ , 100mm) (2 years)	-0.00433 (0.00905) [0.637]	-0.0164 (0.0107) [0.128]	-0.0169 (0.0135) [0.240]	0.0226 (0.0268) [0.542]	0.0131 (0.0290) [0.742]	0.185
Rainfall Variability ( $\sigma$ , 100mm) (3 years)	-0.00802 (0.0127) [0.604]	-0.00264 (0.0131) [0.857]	-0.00425 (0.0144) [0.800]	0.0284 (0.0161) [0.300]	0.0302 (0.0182) [0.295]	0.241
Rainfall Variability ( $\sigma$ , 100mm) (4 years)	-0.0372** (0.0130) [0.023]	-0.0277 (0.0190) [0.381]	-0.0268 (0.0200) [0.339]	-0.0130 (0.0216) [0.702]	-0.00179 (0.0154) [0.930]	0.202
Rainfall Variability ( $\sigma$ , 100mm) (5 years)	-0.0142 (0.0131) [0.349]	-0.0199 (0.0122) [0.267]	-0.0180 (0.0117) [0.259]	-0.0177 (0.0124) [0.428]	-0.0108 (0.0121) [0.478]	0.220
Rainfall Variability ( $\sigma$ , 100mm) (6 years)	-0.0281** (0.0107) [0.091]	-0.0145 (0.0215) [0.592]	-0.0120 (0.0214) [0.654]	-0.0240 (0.0354) [0.611]	-0.0314 (0.0290) [0.448]	0.164
Rainfall Variability ( $\sigma$ , 100mm) (7 years)	-0.0186 (0.0131) [0.310]	-0.00298 (0.0244) [0.931]	-0.0312 (0.0241) [0.292]	-0.000311 (0.0249) [0.997]	-0.0494* (0.0237) [0.190]	0.166
Rainfall Variability ( $\sigma$ , 100mm) (8 years)	-0.0119 (0.0199) [0.717]	-0.0172 (0.0243) [0.591]	-0.0204 (0.0227) [0.495]	-0.00761 (0.0286) [0.824]	-0.0481 (0.0312) [0.363]	0.149
Rainfall Variability ( $\sigma$ , 100mm) (9 years)	-0.00706 (0.0164) [0.737]	-0.00867 (0.0229) [0.769]	-0.00932 (0.0226) [0.751]	0.0111 (0.0302) [0.798]	-0.00334 (0.0339) [0.940]	0.197
Rainfall Variability ( $\sigma$ , 100mm) (10 years)	-0.0146 (0.0242) [0.721]	0.00814 (0.0195) [0.777]	0.00692 (0.0206) [0.796]	0.0469** (0.0204) [0.202]	0.0358 (0.0288) [0.403]	0.164
FIXED EFFECTS						
WEATHER CONTROLS	No	Y <sub>ES</sub>	Y <sub>ES</sub>	Y <sub>ES</sub>	Y <sub>ES</sub>	Y <sub>ES</sub>
QUADRATIC WEATHER CONTROLS	No	No	No	Y <sub>ES</sub>	Y <sub>ES</sub>	Y <sub>ES</sub>
WEATHER INTERACTIONS	No	No	Y <sub>ES</sub>	No	Y <sub>ES</sub>	Y <sub>ES</sub>
OBSERVATIONS	3,812	3,812	3,812	3,812	3,812	3,812
CROP × HOUSEHOLD, MONTH, AND YEAR						
WEATHER CONTROLS	No	Y <sub>ES</sub>	Y <sub>ES</sub>	Y <sub>ES</sub>	Y <sub>ES</sub>	Y <sub>ES</sub>
QUADRATIC WEATHER CONTROLS	No	No	No	Y <sub>ES</sub>	Y <sub>ES</sub>	Y <sub>ES</sub>
WEATHER INTERACTIONS	No	No	Y <sub>ES</sub>	No	Y <sub>ES</sub>	Y <sub>ES</sub>

NOTES: Significance levels are indicated as \* 0.10 \*\* 0.05 \*\*\* 0.01. The unit of analysis is at the household level. Rainfall variability is defined as the standard deviation of rainfall. Historical measures of atmospheric parameters correspond to the time period, over which rainfall variability is measured. Historical rainfall is measured in hundreds of mm, historical temperature is measured in °C. Cluster robust standard errors are reported in parentheses. Wild Cluster Bootstrap-t p-values (null-imposed, 1,000 replications) are reported underneath in brackets, addressing concerns relating to the small number of clusters (Cameron, Gelbach, Miller, 2008).

Table A19: Disentangling Realized Income Events from Income Uncertainty: Defining Rainfall Variability Over Different Time Frames (Prices)

	(1) log PRICES	(2) log PRICES	(3) log PRICES	(4) log PRICES	(5) log PRICES	(6) WITHIN GROUP STD. DEV
Rainfall Variability ( $\sigma$ , 100mm) (2 years)	-0.278*** (0.0733) [0.049]	-0.294** (0.109) [0.266]	-0.289*** (0.0601) [0.164]	-0.222** (0.0927) [0.334]	-0.225*** (0.0433) [0.027]	0.123
Rainfall Variability ( $\sigma$ , 100mm) (3 years)	-0.310*** (0.0663) [0.066]	-0.305*** (0.0704) [0.222]	-0.276*** (0.0459) [0.075]	-0.330*** (0.0747) [0.182]	-0.0879 (0.0939) [0.498]	0.1110
Rainfall Variability ( $\sigma$ , 100mm) (4 years)	-0.180* (0.0936) [0.276]	0.0197 (0.0751) [0.794]	-0.00417 (0.0961) [0.987]	0.147 (0.131) [0.477]	-0.0881 (0.159) [0.745]	0.114
Rainfall Variability ( $\sigma$ , 100mm) (5 years)	0.0632 (0.0794) [0.537]	-0.0605 (0.0525) [0.350]	-0.0285 (0.0783) [0.874]	-0.00185 (0.0292) [0.923]	-0.169 (0.132) [0.480]	0.1117
Rainfall Variability ( $\sigma$ , 100mm) (6 years)	-0.279** (0.119) [0.198]	-0.0292 (0.190) [0.889]	0.159 (0.183) [0.568]	-0.0954 (0.174) [0.695]	-0.109 (0.114) [0.469]	0.105
Rainfall Variability ( $\sigma$ , 100mm) (7 years)	-0.473*** (0.0911) [0.048]	-0.287** (0.115) [0.068]	0.169 (0.290) [0.686]	-0.635*** (0.0796) [0.025]	-0.270 (0.167) [0.304]	0.069
Rainfall Variability ( $\sigma$ , 100mm) (8 years)	-0.367 (0.261) [0.409]	-0.226 (0.181) [0.325]	0.233 (0.240) [0.527]	-0.107 (0.297) [0.767]	-0.183 (0.176) [0.386]	0.067
Rainfall Variability ( $\sigma$ , 100mm) (9 years)	-0.0236 (0.220) [0.996]	-0.131 (0.133) [0.514]	0.0794 (0.117) [0.642]	0.262* (0.126) [0.244]	0.0334 (0.140) [0.769]	0.079
Rainfall Variability ( $\sigma$ , 100mm) (10 years)	-0.203 (0.125) [0.418]	-0.102 (0.105) [0.538]	0.0506 (0.0964) [0.749]	-0.122 (0.132) [0.831]	-0.0839 (0.0997) [0.564]	0.115
FIXED EFFECTS						
WEATHER CONTROLS	NO	YES	YES	YES	YES	
QUADRATIC WEATHER CONTROLS	NO	NO	NO	YES	YES	
WEATHER INTERACTIONS	NO	NO	YES	NO	YES	
OBSERVATIONS	1,546	1,546	1,546	1,546	1,546	1,546

NOTES: Significance levels are indicated as \* 0.10 \*\* 0.05 \*\*\* 0.01. The unit of analysis is at the household level. Rainfall variability is defined as the standard deviation of rainfall. Historical measures of atmospheric parameters correspond to the time period, over which rainfall variability is measured. Historical rainfall is measured in hundreds of mm, historical temperature is measured in °C. Cluster robust standard errors are reported in parentheses. Wild Cluster Bootstrap-t p-values (null-imposed, 1,000 replications) are reported underneath in brackets, addressing concerns relating to the small number of clusters (Cameron, Gelbach, Miller, 2008).

Table A20: Disentangling Realized Income Events from Income Uncertainty: Defining Rainfall Variability Over Different Time Frames (Number of Crops)

	(1) CROP COUNT	(2) CROP COUNT	(3) CROP COUNT	(4) CROP COUNT	(5) CROP COUNT	(6) WITHIN GROUP STD. DEV
Rainfall Variability ( $\sigma$ , 100mm) (2 years)	0.00925 (0.0287) [0.735]	0.00600 (0.0538) [0.377]	0.0422 (0.0628) [0.596]	0.0272 (0.0848) [0.817]	0.0807 (0.103) [0.590]	0.240
Rainfall Variability ( $\sigma$ , 100mm) (3 years)	0.0196 (0.0452) [0.673]	0.0292 (0.0750) [0.723]	0.000680 (0.0539) [0.994]	-0.0249 (0.0694) [0.746]	-0.0198 (0.0689) [0.823]	0.291
Rainfall Variability ( $\sigma$ , 100mm) (4 years)	-0.0409 (0.0483) [0.437]	-0.00653 (0.0833) [0.960]	-0.0816 (0.0697) [0.398]	-0.118* (0.0561) [0.090]	-0.0984** (0.0446) [0.011]	0.254
Rainfall Variability ( $\sigma$ , 100mm) (5 years)	-0.0343 (0.0375) [0.428]	0.0257 (0.0461) [0.628]	0.0202 (0.0466) [0.689]	-0.0539* (0.0287) [0.122]	-0.0718* (0.0461) [0.081]	0.275
Rainfall Variability ( $\sigma$ , 100mm) (6 years)	-0.0123 (0.0426) [0.732]	0.108 (0.0789) [0.244]	0.0992 (0.0832) [0.341]	-0.0718 (0.0865) [0.571]	-0.1112 (0.104) [0.539]	0.201
Rainfall Variability ( $\sigma$ , 100mm) (7 years)	-0.0769 (0.0509) [0.216]	-0.0343 (0.104) [0.781]	0.0601 (0.0880) [0.560]	-0.0284 (0.0928) [0.841]	-0.0308 (0.0772) [0.772]	0.217
Rainfall Variability ( $\sigma$ , 100mm) (8 years)	-0.104** (0.0448) [0.062]	-0.0840 (0.0734) [0.334]	-0.0714 (0.0605) [0.327]	-0.0569 (0.0859) [0.673]	0.000600 (0.0872) [0.997]	0.192
Rainfall Variability ( $\sigma$ , 100mm) (9 years)	-0.0833* (0.0471) [0.147]	-0.109** (0.0458) [0.072]	-0.0998** (0.0399) [0.088]	0.0347 (0.0994) [0.794]	0.0371 (0.128) [0.928]	0.230
Rainfall Variability ( $\sigma$ , 100mm) (10 years)	-0.104 (0.0755) [0.273]	-0.150** (0.0641) [0.196]	-0.121 (0.0755) [0.415]	0.0156 (0.0771) [0.912]	0.0169 (0.0798) [0.886]	0.192
FIXED EFFECTS				HOUSEHOLD, MONTH, AND YEAR		
WEATHER CONTROLS	No	Yes	Yes	Yes	Yes	YES
QUADRATIC WEATHER CONTROLS	No	No	No	Yes	Yes	YES
WEATHER INTERACTIONS	No	No	Yes	No	Yes	YES
OBSERVATIONS	2,072	2,072	2,072	2,072	2,072	2,072

NOTES: Significance levels are indicated as \* 0.10 \*\* 0.05 \*\*\* 0.01. The unit of analysis is at the household level. Rainfall variability is defined as the standard deviation of rainfall. Historical measures of atmospheric parameters correspond to the time period, over which rainfall variability is measured. Historical rainfall is measured in hundreds of mm. historical temperature is measured in °C. Cluster robust standard errors are reported in parentheses. Wild Cluster Bootstrap-t p-values (null-imposed, 1,000 replications) are reported underneath in brackets, addressing concerns relating to the small number of clusters (Cameron, Gelbach, Miller, 2008).

Table A21: Disentangling Realized Income Events from Income Uncertainty: Defining Rainfall Variability Over Different Time Frames (Main Crop Share)

	(1) MAIN CROP SHARE	(2) MAIN CROP SHARE	(3) MAIN CROP SHARE	(4) MAIN CROP SHARE	(5) MAIN CROP SHARE	(6) WITHIN GROUP STD. DEV
Rainfall Variability ( $\sigma$ , 100mm) (2 years)	-0.00423 (0.00542) [0.585]	-0.00767 (0.00955) [0.461]	-0.000474 (0.0162) [0.988]	0.00533 (0.0223) [0.878]	-0.00223 (0.0242) [0.531]	0.240
Rainfall Variability ( $\sigma$ , 100mm) (3 years)	-0.00984 (0.00690) [0.366]	-0.00448 (0.0126) [0.756]	-0.00122 (0.0138) [0.952]	0.0109 (0.0192) [0.723]	0.00910 (0.0189) [0.770]	0.291
Rainfall Variability ( $\sigma$ , 100mm) (4 years)	-0.00301 (0.0106) [0.834]	0.00568 (0.0163) [0.786]	0.0167 (0.0197) [0.491]	0.0309 (0.0199) [0.149]	0.0267 (0.0199) [0.260]	0.254
Rainfall Variability ( $\sigma$ , 100mm) (5 years)	-0.000174 (0.00925) [0.987]	-0.00744 (0.00916) [0.535]	-0.00673 (0.00906) [0.557]	0.00704 (0.00827) [0.513]	0.0116* (0.00614) [0.220]	0.275
Rainfall Variability ( $\sigma$ , 100mm) (6 years)	-0.0139 (0.0119) [0.396]	-0.0336* (0.0179) [0.071]	-0.0336* (0.0183) [0.073]	-0.0182 (0.0254) [0.564]	-0.0123 (0.0275) [0.806]	0.201
Rainfall Variability ( $\sigma$ , 100mm) (7 years)	-0.00672 (0.0113) [0.634]	-0.0221 (0.0202) [0.304]	-0.0409 (0.0270) [0.257]	-0.0225 (0.0195) [0.294]	-0.0265 (0.0315) [0.530]	0.217
Rainfall Variability ( $\sigma$ , 100mm) (8 years)	-0.0000932 (0.0155) [0.997]	-0.0179 (0.0189) [0.447]	-0.0189 (0.0180) [0.439]	-0.0233 (0.0255) [0.452]	-0.0202 (0.0283) [0.905]	0.192
Rainfall Variability ( $\sigma$ , 100mm) (9 years)	0.00556 (0.0127) [0.718]	0.000808 (0.0144) [0.944]	0.00172 (0.0148) [0.901]	-0.0117 (0.0224) [0.630]	-0.00607 (0.0215) [0.965]	0.230
Rainfall Variability ( $\sigma$ , 100mm) (10 years)	0.00564 (0.0128) [0.696]	0.0171 (0.0170) [0.459]	0.0205 (0.0167) [0.396]	0.0133 (0.0129) [0.407]	0.0270* (0.0127) [0.180]	0.192
FIXED EFFECTS						
WEATHER CONTROLS	No	Yes	Yes	Yes	Yes	Yes
QUADRATIC WEATHER CONTROLS	No	No	No	Yes	Yes	Yes
WEATHER INTERACTIONS	No	No	Yes	No	No	Yes
OBSERVATIONS	2,072	2,072	2,072	2,072	2,072	2,072

NOTES: Significance levels are indicated as \*  $0.10$  \*\*  $0.05$  \*\*\*  $0.01$ . The unit of analysis is at the household level. Rainfall variability is defined as the standard deviation of rainfall. Historical measures of atmospheric parameters correspond to the time period, over which rainfall variability is measured. Historical rainfall is measured in hundreds of mm. historical temperature is measured in  $^{\circ}\text{C}$ . Cluster robust standard errors are reported in parentheses. Wild Cluster Bootstrap-t p-values (null-imposed, 1,000 replications) are reported underneath in brackets, addressing concerns relating to the small number of clusters (Cameron, Gelbach, Miller, 2008).

Table A22: Disentangling Realized Income Events from Income Uncertainty: Defining Rainfall Variability Over Different Time Frames (Farm Wages)

	(1) log AVG. WAGE	(2) log AVG. WAGE	(3) log AVG. WAGE	(4) log AVG. WAGE	(5) log AVG. WAGE	(6) WITHIN GROUP STD. DEV
Rainfall Variability ( $\sigma$ , 100mm) (2 years)	-0.0170 (0.181) [0.917]	-0.0254 (0.202) [0.906]	-0.0756 (0.143) [0.633]	0.358* (0.179) [0.139]	0.342 (0.368) [0.497]	0.120
Rainfall Variability ( $\sigma$ , 100mm) (3 years)	-0.0995 (0.170) [0.581]	-0.139 (0.186) [0.616]	-0.147 (0.145) [0.508]	-0.113 (0.147) [0.565]	-0.0780 (0.262) [0.804]	0.139
Rainfall Variability ( $\sigma$ , 100mm) (4 years)	-0.003552 (0.212) [0.986]	0.150 (0.225) [0.705]	0.217 (0.275) [0.594]	0.109 (0.205) [0.705]	0.398 (0.281) [0.295]	0.120
Rainfall Variability ( $\sigma$ , 100mm) (5 years)	0.0326 (0.210) [0.892]	0.0306 (0.173) [0.899]	0.0890 (0.209) [0.767]	0.0369 (0.162) [0.878]	0.116 (0.202) [0.671]	0.199
Rainfall Variability ( $\sigma$ , 100mm) (6 years)	-0.186 (0.232) [0.442]	-0.258 (0.273) [0.431]	-0.0425 (0.308) [0.897]	-0.121 (0.261) [0.645]	-0.0747 (0.264) [0.787]	0.133
Rainfall Variability ( $\sigma$ , 100mm) (7 years)	-0.4444* (0.224) [0.289]	-0.448* (0.243) [0.341]	-0.112 (0.379) [0.748]	-0.128 (0.304) [0.740]	0.0419 (0.347) [0.906]	0.104
Rainfall Variability ( $\sigma$ , 100mm) (8 years)	-0.437 (0.302) [0.455]	-0.503* (0.273) [0.394]	-0.130 (0.307) [0.761]	-0.211 (0.224) [0.510]	-0.117 (0.325) [0.679]	0.103
Rainfall Variability ( $\sigma$ , 100mm) (9 years)	-0.317 (0.215) [0.453]	-0.387*** (0.123) [0.102]	-0.236** (0.0827) [0.167]	-0.264 (0.184) [0.337]	-0.720*** (0.208) [0.050]	0.105
Rainfall Variability ( $\sigma$ , 100mm) (10 years)	-0.360*** (0.118) [0.432]	-0.350* (0.168) [0.188]	-0.158 (0.103) [0.189]	-0.0988 (0.118) [0.505]	-0.454* (0.257) [0.178]	0.125
FIXED EFFECTS						
WEATHER CONTROLS	No	Yes	Yes	Yes	Yes	Yes
QUADRATIC WEATHER CONTROLS	No	No	No	Yes	Yes	Yes
WEATHER INTERACTIONS	No	No	Yes	No	Yes	Yes
OBSERVATIONS	683	683	683	683	683	683

Notes: Significance levels are indicated as \* 0.10 \*\* 0.05 \*\*\* 0.01. The unit of analysis is at the household level. Rainfall variability is defined as the standard deviation of rainfall. Historical measures of atmospheric parameters correspond to the time period over which rainfall variability is measured. Historical rainfall is measured in hundreds of mm. historical temperature is measured in °C. Cluster robust standard errors are reported in parentheses. Wild Cluster Bootstrap-t p-values (null-imposed, 1,000 replications) are reported underneath in brackets, addressing concerns relating to the small number of clusters (Cameron, Gelbach, Miller, 2008).

Table A23: Disentangling Realized Income Events from Income Uncertainty: Defining Rainfall Variability Over Different Time Frames (Hired Worker Days)

	(1) log WORKER DAYS (Hired)	(2) log WORKER DAYS (Hired)	(3) log WORKER DAYS (Hired)	(4) log WORKER DAYS (Hired)	(5) log WORKER DAYS (Hired)	(6) WITHIN GROUP STD. DEV
Rainfall Variability ( $\sigma$ , 100mm) (2 years)	-0.196 (0.223) [0.496]	-0.0882 (0.175) [0.691]	-0.0616 (0.182) [0.822]	-0.479* (0.226) [0.143]	-0.694** (0.304) [0.237]	0.127
Rainfall Variability ( $\sigma$ , 100mm) (3 years)	-0.186 (0.224) [0.584]	0.0132 (0.191) [0.960]	0.0113 (0.185) [0.957]	-0.0403 (0.193) [0.853]	-0.110 (0.273) [0.728]	0.144
Rainfall Variability ( $\sigma$ , 100mm) (4 years)	-0.249 (0.227) [0.631]	-0.149 (0.206) [0.609]	-0.294 (0.272) [0.414]	-0.157 (0.205) [0.530]	-0.347 (0.273) [0.372]	0.125
Rainfall Variability ( $\sigma$ , 100mm) (5 years)	0.081 (0.248) [0.669]	0.0164 (0.200) [0.954]	-0.0134 (0.203) [0.955]	0.00442 (0.190) [0.998]	-0.137 (0.198) [0.557]	0.205
Rainfall Variability ( $\sigma$ , 100mm) (6 years)	-0.240 (0.384) [0.702]	0.157 (0.376) [0.759]	-0.0366 (0.406) [0.909]	0.0808 (0.298) [0.814]	0.129 (0.289) [0.707]	0.135
Rainfall Variability ( $\sigma$ , 100mm) (7 years)	0.0287 (0.445) [0.963]	0.307 (0.390) [0.530]	-0.0346 (0.550) [0.960]	-0.0989 (0.347) [0.800]	-0.0624 (0.329) [0.860]	0.107
Rainfall Variability ( $\sigma$ , 100mm) (8 years)	0.386 (0.410) [0.545]	0.348 (0.434) [0.684]	0.0745 (0.497) [0.976]	0.188 (0.340) [0.762]	0.138 (0.355) [0.720]	0.105
Rainfall Variability ( $\sigma$ , 100mm) (9 years)	0.217 (0.341) [0.533]	0.290 (0.165) [0.661]	0.211 (0.190) [0.748]	0.422 (0.301) [0.480]	0.911*** (0.257) [0.046]	0.107
Rainfall Variability ( $\sigma$ , 100mm) (10 years)	0.128 (0.314) [0.800]	0.281 (0.279) [0.605]	0.141 (0.270) [0.760]	0.0524 (0.263) [0.900]	0.356 (0.338) [0.453]	0.127
FIXED EFFECTS						
WEATHER CONTROLS	No	Yes	Yes	Yes	Yes	Yes
QUADRATIC WEATHER CONTROLS	No	No	No	Yes	Yes	Yes
WEATHER INTERACTIONS	No	No	Yes	No	Yes	Yes
OBSERVATIONS						
	727	727	727	727	727	727

NOTES: Significance levels are indicated as \* 0.10 \*\* 0.05 \*\*\* 0.01. The unit of analysis is at the household level. Rainfall variability is defined as the standard deviation of rainfall. Historical measures of atmospheric parameters correspond to the time period, over which rainfall variability is measured. Historical rainfall is measured in hundreds of mm. historical temperature is measured in °C. Cluster robust standard errors are reported in parentheses. Wild Cluster Bootstrap-t p-values (null-imposed, 1,000 replications) are reported underneath in brackets, addressing concerns relating to the small number of clusters (Cameron, Gelbach, Miller, 2008).

Table A24: Disentangling Realized Income Events from Income Uncertainty: Defining Rainfall Variability Over Different Time Frames (Hired Any Workers)

	(1) Hired Any Workers	(2) Hired Any Workers	(3) Hired Any Workers	(4) Hired Any Workers	(5) Hired Any Workers	(6) Within Group Std. Dev
Rainfall Variability ( $\sigma$ , 100mm) (2 years)	-0.0108* (0.00587) [0.194]	0.0240 (0.0230) [0.402]	0.0492** (0.0208) [0.140]	0.0304 (0.0205) [0.220]	0.0388** (0.0175) [0.080]	0.240
Rainfall Variability ( $\sigma$ , 100mm) (3 years)	-0.00973 (0.0130) [0.540]	0.0356 (0.0289) [0.360]	0.0513** (0.0205) [0.123]	0.0399** (0.0184) [0.143]	0.0391* (0.0184) [0.193]	0.292
Rainfall Variability ( $\sigma$ , 100mm) (4 years)	0.0127 (0.0210) [0.608]	0.0374 (0.0280) [0.283]	0.0747*** (0.0229) [0.013]	0.0592*** (0.0190) [0.005]	0.0520** (0.0242) [0.069]	0.255
Rainfall Variability ( $\sigma$ , 100mm) (5 years)	0.00694 (0.0183) [0.738]	0.0114 (0.0224) [0.638]	0.0129 (0.0232) [0.617]	0.0400*** (0.0108) [0.006]	0.0445 (0.0253) [0.151]	0.275
Rainfall Variability ( $\sigma$ , 100mm) (6 years)	-0.00685 (0.0146) [0.692]	-0.0279 (0.0260) [0.402]	-0.0250 (0.0296) [0.576]	0.0604* (0.0289) [0.150]	0.0596* (0.0323) [0.246]	0.201
Rainfall Variability ( $\sigma$ , 100mm) (7 years)	0.00399 (0.0256) [0.862]	0.0105 (0.0444) [0.833]	-0.00226 (0.0392) [0.962]	0.00451 (0.0265) [0.891]	0.0386 (0.0264) [0.207]	0.2117
Rainfall Variability ( $\sigma$ , 100mm) (8 years)	-0.000923 (0.0280) [0.971]	0.00586 (0.0426) [0.893]	0.00220 (0.0377) [0.960]	-0.0149 (0.0383) [0.796]	0.0562* (0.0279) [0.091]	0.192
Rainfall Variability ( $\sigma$ , 100mm) (9 years)	-0.00763 (0.0276) [0.805]	0.000697 (0.0349) [0.989]	-0.00249 (0.0328) [0.935]	-0.0110 (0.0278) [0.732]	0.0454*** (0.0146) [0.109]	0.231
Rainfall Variability ( $\sigma$ , 100mm) (10 years)	0.0157 (0.0418) [0.809]	0.00679 (0.0379) [0.896]	-0.00363 (0.0373) [0.934]	-0.0302 (0.0197) [0.217]	0.00496 (0.0281) [0.885]	0.191
FIXED EFFECTS						
WEATHER CONTROLS	No	Yes	Yes	Yes	Yes	Yes
QUADRATIC WEATHER CONTROLS	No	No	No	Yes	Yes	Yes
WEATHER INTERACTIONS	No	No	Yes	No	Yes	Yes
OBSERVATIONS	2,053	2,053	2,053	2,053	2,053	2,053

NOTES: Significance levels are indicated as \* 0.10 \*\* 0.05 \*\*\* 0.01. The unit of analysis is at the household level. Rainfall variability is defined as the standard deviation of rainfall. Historical measures of atmospheric parameters correspond to the time period, over which rainfall variability is measured. Historical rainfall is measured in hundreds of mm. historical temperature is measured in °C. Cluster robust standard errors are reported in parentheses. Wild Cluster Bootstrap-t p-values (null-imposed, 1,000 replications) are reported underneath in brackets, addressing concerns relating to the small number of clusters (Cameron, Gelbach, Miller, 2008).

Table A25: Disentangling Realized Income Events from Income Uncertainty: Defining Rainfall Variability Over Different Time Frames (Number of Livestock Owned)

	(1) NUMBER OF LIVESTOCK	(2) NUMBER OF LIVESTOCK	(3) NUMBER OF LIVESTOCK	(4) NUMBER OF LIVESTOCK	(5) NUMBER OF LIVESTOCK	(6) WITHIN GROUP STD. DEV
Rainfall Variability ( $\sigma$ , 100mm) (2 years)	0.00478 (0.0103) [0.675]	0.0430 (0.0306) [0.414]	0.0351* (0.0193) [0.268]	0.0621* (0.0313) [0.298]	0.0429 (0.0297) [0.491]	.325
Rainfall Variability ( $\sigma$ , 100mm) (3 years)	0.00896 (0.0154) [0.606]	0.0469 (0.0301) [0.283]	0.0441*** (0.0140) [0.035]	0.0559*** (0.0163) [0.032]	0.0575*** (0.0163) [0.074]	.367
Rainfall Variability ( $\sigma$ , 100mm) (4 years)	0.00581 (0.0184) [0.773]	0.0685** (0.0319) [0.131]	0.0563* (0.0263) [0.153]	0.0659** (0.0242) [0.070]	0.0599** (0.0258) [0.186]	.323
Rainfall Variability ( $\sigma$ , 100mm) (5 years)	0.00419 (0.0187) [0.871]	0.0235 (0.0153) [0.226]	0.0201 (0.0158) [0.271]	0.00605 (0.0212) [0.783]	0.0285 (0.0227) [0.346]	.346
Rainfall Variability ( $\sigma$ , 100mm) (6 years)	-0.00526 (0.0213) [0.880]	0.0288 (0.0232) [0.319]	0.0236 (0.0194) [0.361]	-0.00452 (0.0412) [0.934]	0.0142 (0.0283) [0.689]	.256
Rainfall Variability ( $\sigma$ , 100mm) (7 years)	-0.0239 (0.0235) [0.578]	-0.0247 (0.0298) [0.508]	-0.0159 (0.0293) [0.766]	-0.0348 (0.0303) [0.417]	-0.0371 (0.0323) [0.490]	.311
Rainfall Variability ( $\sigma$ , 100mm) (8 years)	-0.0189 (0.0278) [0.753]	-0.0109 (0.0293) [0.793]	-0.0234 (0.0269) [0.567]	-0.0121 (0.0289) [0.773]	-0.0357 (0.0462) [0.577]	.243
Rainfall Variability ( $\sigma$ , 100mm) (9 years)	-0.0274 (0.0286) [0.534]	-0.0229 (0.0274) [0.634]	-0.0234 (0.0273) [0.703]	-0.0319 (0.0391) [0.907]	-0.0571 (0.0431) [0.780]	.316
Rainfall Variability ( $\sigma$ , 100mm) (10 years)	-0.0395 (0.0325) [0.303]	-0.0356 (0.0350) [0.415]	-0.0282 (0.0363) [0.561]	-0.0738 (0.0501) [0.358]	-0.0696* (0.0362) [0.319]	.275
FIXED EFFECTS						
WEATHER CONTROLS	No	Yes	Yes	Yes	Yes	Yes
QUADRATIC WEATHER CONTROLS	No	No	No	Yes	Yes	Yes
WEATHER INTERACTIONS	No	No	Yes	No	Yes	Yes
OBSERVATIONS	33,286	33,286	33,286	33,286	33,286	33,286
LIVESTOCK $\times$ HOUSEHOLD, MONTH, AND YEAR						
WEATHER CONTROLS	No	Yes	Yes	Yes	Yes	Yes
QUADRATIC WEATHER CONTROLS	No	No	No	Yes	Yes	Yes
WEATHER INTERACTIONS	No	No	Yes	No	Yes	Yes
OBSERVATIONS	33,286	33,286	33,286	33,286	33,286	33,286

NOTES: Significance levels are indicated as \* 0.10 \*\* 0.05 \*\*\* 0.01. The unit of analysis is at the household level. Rainfall variability is defined as the standard deviation of rainfall. Historical measures of atmospheric parameters correspond to the time period, over which rainfall variability is measured. Historical rainfall is measured in hundreds of mm. historical temperature is measured in °C. Cluster robust standard errors are reported in parentheses. Wild Cluster Bootstrap-t p-values (null-imposed, 1,000 replications) are reported underneath in brackets, addressing concerns relating to the small number of clusters (Cameron, Gelbach, Miller, 2008).

Table A26: Disentangling Realized Income Events from Income Uncertainty: Defining Rainfall Variability Over Different Time Frames (Number of Livestock Slaughtered)

	(1)	(2)	(3)	(4)	(5)	(6)
	NUMBER OF LIVESTOCK SLAUGHTERED	NUMBER OF LIVESTOCK SLAUGHTERED	NUMBER OF LIVESTOCK SLAUGHTERED	NUMBER OF LIVESTOCK SLAUGHTERED	NUMBER OF LIVESTOCK SLAUGHTERED	WITHIN GROUP STD. DEV
Rainfall Variability ( $\sigma$ , 100mm) (2 years)	-0.000718 (0.00345) [0.985]	0.00325 (0.00734) [0.746]	0.00183 (0.00619) [0.854]	0.00861 (0.00938) [0.585]	0.00416 (0.00633) [0.710]	.325
Rainfall Variability ( $\sigma$ , 100mm) (3 years)	-0.00137 (0.00525) [0.800]	0.00411 (0.00693) [0.687]	0.00352 (0.00532) [0.758]	0.00590 (0.00646) [0.660]	0.0107** (0.00406) [0.259]	.367
Rainfall Variability ( $\sigma$ , 100mm) (4 years)	-0.00301 (0.00592) [0.652]	0.00971 (0.00776) [0.272]	0.00858 (0.00788) [0.381]	0.00833 (0.00774) [0.428]	0.00793 (0.00808) [0.503]	.323
Rainfall Variability ( $\sigma$ , 100mm) (5 years)	-0.00119 (0.00589) [0.814]	0.00214 (0.00387) [0.670]	0.00168 (0.00419) [0.748]	-0.000731 (0.00564) [0.927]	-0.00161 (0.00612) [0.879]	.346
Rainfall Variability ( $\sigma$ , 100mm) (6 years)	-0.00441 (0.00549) [0.492]	0.00408 (0.00536) [0.524]	0.00351 (0.00530) [0.610]	-0.00193 (0.0100) [0.858]	-0.00218 (0.0108) [0.893]	.256
Rainfall Variability ( $\sigma$ , 100mm) (7 years)	-0.00967** (0.00332) [0.313]	-0.0114 (0.00742) [0.321]	-0.0121 (0.00812) [0.403]	-0.0138* (0.00685) [0.263]	-0.00700 (0.00656) [0.469]	.311
Rainfall Variability ( $\sigma$ , 100mm) (8 years)	-0.00899 (0.00559) [0.432]	-0.00846 (0.00534) [0.302]	-0.00892 (0.00600) [0.316]	-0.00653 (0.00624) [0.492]	0.00394 (0.0113) [0.822]	.243
Rainfall Variability ( $\sigma$ , 100mm) (9 years)	-0.0130* (0.00677) [0.197]	-0.0111* (0.00543) [0.188]	-0.0111* (0.00544) [0.201]	-0.00422 (0.00965) [0.803]	-0.00689 (0.0118) [0.721]	.316
Rainfall Variability ( $\sigma$ , 100mm) (10 years)	-0.0212** (0.00975) [0.104]	-0.0153* (0.00830) [0.205]	-0.0155* (0.00815) [0.236]	-0.0183 (0.0127) [0.414]	-0.0176 (0.0116) [0.476]	.275
FIXED EFFECTS						
WEATHER CONTROLS	No	YES	YES	YES	YES	YES
QUADRATIC WEATHER CONTROLS	No	No	No	YES	YES	YES
WEATHER INTERACTIONS	No	No	YES	No	YES	YES
OBSERVATIONS	34,863	34,863	34,863	34,863	34,863	34,863
LIVESTOCK $\times$ HOUSEHOLD, MONTH, AND YEAR						
WEATHER CONTROLS	No	YES	YES	YES	YES	YES
QUADRATIC WEATHER CONTROLS	No	No	No	YES	YES	YES
WEATHER INTERACTIONS	No	No	YES	No	YES	YES

Notes: Significance levels are indicated as \* 0.10 \*\* 0.05 \*\*\* 0.01. The unit of analysis is at the household level. Rainfall variability is defined as the standard deviation of rainfall. Historical measures of atmospheric parameters correspond to the time period, over which rainfall variability is measured. Historical rainfall is measured in hundreds of mm. historical temperature is measured in  $^{\circ}\text{C}$ . Cluster robust standard errors are reported in parentheses. Wild Cluster Bootstrap-t p-values (null-imposed, 1,000 replications) are reported underneath in brackets, addressing concerns relating to the small number of clusters (Cameron, Gelbach, Miller, 2008).

Table A27: Disentangling Realized Income Events from Income Uncertainty: Defining Rainfall Variability Over Different Time Frames (Number of Livestock Sold)

	(1)	(2)	(3)	(4)	(5)	(6)
	NUMBER OF LIVESTOCK SOLD	NUMBER OF LIVESTOCK SOLD	NUMBER OF LIVESTOCK SOLD	NUMBER OF LIVESTOCK SOLD	NUMBER OF LIVESTOCK SOLD	WITHIN GROUP STD. DEV
Rainfall Variability ( $\sigma$ , 100mm) (2 years)	0.00692* (0.00345) [0.132]	-0.00520 (0.00875) [0.657]	-0.00476 (0.00919) [0.697]	-0.00408 (0.0133) [0.837]	-0.0128 (0.0138) [0.624]	.325
Rainfall Variability ( $\sigma$ , 100mm) (3 years)	0.0114* (0.00620) [0.146]	0.00233 (0.0132) [0.909]	0.00278 (0.0120) [0.847]	0.00616 (0.0133) [0.731]	0.00829 (0.0127) [0.676]	.367
Rainfall Variability ( $\sigma$ , 100mm) (4 years)	0.0155* (0.00747) [0.155]	0.00924 (0.0124) [0.580]	0.0118 (0.0136) [0.526]	0.0107 (0.0139) [0.622]	0.00985 (0.0135) [0.665]	.323
Rainfall Variability ( $\sigma$ , 100mm) (5 years)	0.0168** (0.00653) [0.131]	0.00511 (0.00866) [0.603]	0.00517 (0.00906) [0.648]	0.0138 (0.00820) [0.224]	0.0168 (0.0106) [0.361]	.346
Rainfall Variability ( $\sigma$ , 100mm) (6 years)	0.0176* (0.00854) [0.148]	0.00624 (0.00866) [0.582]	0.00668 (0.00867) [0.588]	0.0306* (0.0151) [0.155]	0.0331** (0.0148) [0.176]	.256
Rainfall Variability ( $\sigma$ , 100mm) (7 years)	0.0223** (0.00968) [0.141]	0.0191* (0.00913) [0.111]	0.0192* (0.00953) [0.121]	0.0219* (0.0107) [0.141]	0.0306** (0.0118) [0.130]	.311
Rainfall Variability ( $\sigma$ , 100mm) (8 years)	0.0279** (0.0111) [0.090]	0.0272** (0.0103) [0.020]	0.0283** (0.0101) [0.062]	0.0234** (0.0102) [0.152]	0.0466** (0.0157) [0.097]	.243
Rainfall Variability ( $\sigma$ , 100mm) (9 years)	0.0221* (0.0113) [0.186]	0.0226* (0.0119) [0.171]	0.0226* (0.0119) [0.169]	0.0311* (0.0148) [0.445]	0.0403** (0.0138) [0.452]	.316
Rainfall Variability ( $\sigma$ , 100mm) (10 years)	0.0187 (0.0152) [0.379]	0.0107 (0.0147) [0.601]	0.00394 (0.0137) [0.834]	0.00532 (0.0190) [0.895]	0.00205 (0.0164) [0.939]	.275
FIXED EFFECTS						
WEATHER CONTROLS	No	YES	YES	YES	YES	YES
QUADRATIC WEATHER CONTROLS	No	No	No	YES	YES	YES
WEATHER INTERACTIONS	No	No	YES	No	YES	YES
OBSERVATIONS	34,863	34,863	34,863	34,863	34,863	34,863

NOTES: Significance levels are indicated as \* 0.10 \*\* 0.05 \*\*\* 0.01. The unit of analysis is at the household level. Rainfall variability is defined as the standard deviation of rainfall. Historical measures of atmospheric parameters correspond to the time period, over which rainfall variability is measured. Historical rainfall is measured in hundreds of mm. historical temperature is measured in °C. Cluster robust standard errors are reported in parentheses. Wild Cluster Bootstrap-t p-values (null-imposed, 1,000 replications) are reported underneath in brackets, addressing concerns relating to the small number of clusters (Cameron, Gelbach, Miller, 2008).

Table A28: Disentangling Realized Income Events from Income Uncertainty: Defining Rainfall Variability Over Different Time Frames (Non-Farm Work)

	(1) ENGAGED IN OFF-FARM WORK	(2) ENGAGED IN OFF-FARM WORK	(3) ENGAGED IN OFF-FARM WORK	(4) ENGAGED IN OFF-FARM WORK	(5) ENGAGED IN OFF-FARM WORK	(6) WITHIN GROUP STD. DEV
Rainfall Variability ( $\sigma$ , 100mm) (2 years)	-0.00922 (0.0109) [0.892]	0.00157 (0.0394) [0.975]	0.00950 (0.0455) [0.868]	-0.0237 (0.0369) [0.677]	0.000673 (0.0208) [0.981]	0.184
Rainfall Variability ( $\sigma$ , 100mm) (3 years)	-0.0158 (0.0177) [0.927]	0.0155 (0.0480) [0.822]	0.0154 (0.0481) [0.827]	0.00707 (0.0499) [0.929]	0.0587* (0.0297) [0.267]	0.202
Rainfall Variability ( $\sigma$ , 100mm) (4 years)	-0.0217 (0.0213) [0.903]	-0.0180 (0.0568) [0.840]	-0.0141 (0.0572) [0.866]	-0.0188 (0.0563) [0.823]	-0.0580 (0.0628) [0.622]	0.152
Rainfall Variability ( $\sigma$ , 100mm) (5 years)	-0.0282 (0.0193) [0.834]	-0.0268 (0.0501) [0.640]	-0.0346 (0.0462) [0.539]	-0.0151 (0.0533) [0.819]	-0.0515 (0.0621) [0.587]	0.153
Rainfall Variability ( $\sigma$ , 100mm) (6 years)	-0.0290 (0.0221) [0.849]	-0.0248 (0.0368) [0.621]	-0.0230 (0.0337) [0.625]	-0.0242 (0.0618) [0.748]	-0.110 (0.0862) [0.414]	0.112
Rainfall Variability ( $\sigma$ , 100mm) (7 years)	-0.0369 (0.0224) [0.762]	-0.0506 (0.0362) [0.482]	-0.0754** (0.0297) [0.215]	-0.0501 (0.0351) [0.492]	-0.0642 (0.0398) [0.159]	0.114
Rainfall Variability ( $\sigma$ , 100mm) (8 years)	-0.0499* (0.0255) [0.628]	-0.0536 (0.0357) [0.618]	-0.0436 (0.0328) [0.540]	-0.0104 (0.0424) [0.837]	-0.0229 (0.0547) [0.702]	0.102
Rainfall Variability ( $\sigma$ , 100mm) (9 years)	-0.0594* (0.0334) [0.435]	-0.0607 (0.0442) [0.310]	-0.0554 (0.0447) [0.368]	-0.0125 (0.0422) [0.797]	-0.0283 (0.0512) [0.667]	0.177
Rainfall Variability ( $\sigma$ , 100mm) (10 years)	-0.0731 (0.0494) [0.490]	-0.0922 (0.0667) [0.531]	-0.106 (0.0661) [0.534]	-0.0549 (0.0572) [0.611]	-0.0214 (0.0460) [0.717]	0.136
FIXED EFFECTS						
WEATHER CONTROLS	NO	YES	YES	YES	YES	YES
QUADRATIC WEATHER CONTROLS	NO	NO	NO	YES	YES	YES
WEATHER INTERACTIONS	NO	NO	YES	NO	YES	YES
OBSERVATIONS	1,039	1,039	1,039	1,039	1,039	1,039
HOUSEHOLD, MONTH, AND YEAR						

NOTES: Significance levels are indicated as \* 0.10 \*\* 0.05 \*\*\* 0.01. The unit of analysis is at the household level. Rainfall variability is defined as the standard deviation of rainfall. Historical measures of atmospheric parameters correspond to the time period, over which rainfall variability is measured. Historical rainfall is measured in hundreds of mm. historical temperature is measured in °C. Cluster robust standard errors are reported in parentheses. Wild Cluster Bootstrap-t p-values (null-imposed, 1,000 replications) are reported underneath in brackets, addressing concerns relating to the small number of clusters (Cameron, Gelbach, Miller, 2008).

Table A29: Disentangling Realized Income Events from Income Uncertainty: Defining Rainfall Variability Over Different Time Frames (Out-of-Village Work)

	(1) ENGAGED IN OUT OF	(2) ENGAGED IN OUT OF	(3) ENGAGED IN OUT OF	(4) ENGAGED IN OUT OF	(5) ENGAGED IN OUT OF	(6) WITHIN GROUP STD. DEV
	VILLAGE WORK	VILLAGE WORK	VILLAGE WORK	VILLAGE WORK	VILLAGE WORK	VILLAGE WORK
Rainfall Variability ( $\sigma$ , 100mm) (2 years)	0.0100 (0.00761) [0.161]	0.0414 (0.0258) [0.217]	0.0299 (0.0322) [0.472]	-0.0406 (0.0232) [0.287]	-0.0146 (0.0257) [0.607]	0.184
Rainfall Variability ( $\sigma$ , 100mm) (3 years)	0.0146 (0.0109) [0.129]	0.0111 (0.0323) [0.743]	0.00879 (0.0347) [0.833]	-0.0504** (0.0193) [0.069]	-0.0364* (0.0195) [0.054]	0.202
Rainfall Variability ( $\sigma$ , 100mm) (4 years)	0.0219 (0.0141) [0.083]	-0.0571 (0.0330) [0.228]	-0.0678** (0.0265) [0.114]	-0.0748*** (0.0154) [0.018]	-0.0629* (0.0317) [0.249]	0.153
Rainfall Variability ( $\sigma$ , 100mm) (5 years)	0.00999 (0.00893) [0.207]	-0.0205 (0.0361) [0.670]	0.00409 (0.0397) [0.937]	-0.0370 (0.0253) [0.223]	-0.0252 (0.0410) [0.693]	0.153
Rainfall Variability ( $\sigma$ , 100mm) (6 years)	0.0293 (0.0186) [0.103]	0.0460** (0.0205) [0.110]	0.0429** (0.0194) [0.175]	-0.0298 (0.0333) [0.472]	0.00847 (0.0446) [0.906]	0.112
Rainfall Variability ( $\sigma$ , 100mm) (7 years)	0.0154 (0.0128) [0.201]	-0.0281 (0.0329) [0.550]	-0.0172 (0.0391) [0.814]	-0.0314* (0.0173) [0.237]	0.0505 (0.0454) [0.568]	0.114
Rainfall Variability ( $\sigma$ , 100mm) (8 years)	0.00785 (0.0144) [0.569]	-0.0371 (0.0237) [0.378]	-0.0393 (0.0245) [0.346]	-0.0233 (0.0264) [0.464]	0.0194 (0.0663) [0.860]	0.102
Rainfall Variability ( $\sigma$ , 100mm) (9 years)	0.00374 (0.0212) [0.835]	0.00677 (0.0243) [0.776]	0.00931 (0.0241) [0.734]	0.0109 (0.0275) [0.742]	-0.0105 (0.0264) [0.735]	0.177
Rainfall Variability ( $\sigma$ , 100mm) (10 years)	0.000606 (0.0303) [0.840]	0.0189 (0.0308) [0.583]	0.0208 (0.0300) [0.500]	-0.0225 (0.0323) [0.604]	-0.0378 (0.0405) [0.542]	0.136
FIXED EFFECTS						
WEATHER CONTROLS	No	Yes	Yes	Yes	Yes	Yes
QUADRATIC WEATHER CONTROLS	No	No	No	Yes	Yes	Yes
WEATHER INTERACTIONS	No	No	Yes	No	Yes	Yes
OBSERVATIONS	1,037	1,037	1,037	1,037	1,037	1,037

NOTES: Significance levels are indicated as \* 0.10 \*\* 0.05 \*\*\* 0.01. The unit of analysis is at the household level. Rainfall variability is defined as the standard deviation of rainfall. Historical measures of atmospheric parameters correspond to the time period, over which rainfall variability is measured. Historical rainfall is measured in hundreds of mm. historical temperature is measured in °C. Cluster robust standard errors are reported in parentheses. Wild Cluster Bootstrap-t p-values (null-imposed, 1,000 replications) are reported underneath in brackets, addressing concerns relating to the small number of clusters (Cameron, Gelbach, Miller, 2008).

Table A30: Disentangling Realized Income Events from Income Uncertainty: Defining Rainfall Variability Over Different Time Frames (Off-Farm Days Worked)

	(1) log DAYS WORKED (Off-Farm)	(2) log DAYS WORKED (Off-Farm)	(3) log DAYS WORKED (Off-Farm)	(4) log DAYS WORKED (Off-Farm)	(5) log DAYS WORKED (Off-Farm)	(6) WITHIN GROUP STD. DEV
Rainfall Variability ( $\sigma$ , 100mm) (2 years)	0.0334 (0.0750) [0.795]	0.133 (0.211) [0.641]	0.173 (0.147) [0.502]	1.103** (0.423) [0.139]	1.726*** (0.306) [0.140]	0.042
Rainfall Variability ( $\sigma$ , 100mm) (3 years)	0.108 (0.126) [0.607]	0.202 (0.262) [0.534]	0.270 (0.184) [0.279]	-0.283 (0.430) [0.532]	0.790 (0.576) [0.719]	0.026
Rainfall Variability ( $\sigma$ , 100mm) (4 years)	0.266 (0.171) [0.299]	-0.428 (0.911) [0.815]	-0.0986 (0.868) [0.830]	-0.418 (0.812) [0.576]	-0.0556 (0.962) [0.959]	0.025
Rainfall Variability ( $\sigma$ , 100mm) (5 years)	0.310* (0.151) [0.365]	0.174 (0.134) [0.451]	0.0899 (0.138) [0.634]	0.462 (0.331) [0.435]	0.0657 (0.645) [0.982]	0.036
Rainfall Variability ( $\sigma$ , 100mm) (6 years)	0.245 (0.190) [0.531]	0.149 (0.169) [0.606]	0.107 (0.113) [0.555]	0.305 (0.389) [0.522]	-0.195 (0.301) [0.714]	0.049
Rainfall Variability ( $\sigma$ , 100mm) (7 years)	0.475** (0.189) [0.240]	0.469*** (0.133) [0.212]	0.375* (0.197) [0.807]	0.504*** (0.108) [0.217]	0.172 (0.430) [0.719]	0.046
Rainfall Variability ( $\sigma$ , 100mm) (8 years)	0.444** (0.191) [0.515]	0.426*** (0.121) [0.381]	0.458** (0.178) [0.783]	-0.0285 (0.437) [0.962]	-0.237 (0.840) [0.858]	0.025
Rainfall Variability ( $\sigma$ , 100mm) (9 years)	0.517** (0.188) [0.390]	0.600* (0.304) [0.222]	0.699** (0.323) [0.281]	0.256 (0.699) [0.806]	-0.486 (0.740) [0.683]	0.037
Rainfall Variability ( $\sigma$ , 100mm) (10 years)	0.686** (0.282) [0.100]	0.644 (0.608) [0.531]	0.519 (0.841) [0.728]	0.789 (0.967) [0.664]	-0.334 (0.454) [0.726]	0.046
FIXED EFFECTS						
WEATHER CONTROLS	No	Yes	Yes	Yes	Yes	Yes
QUADRATIC WEATHER CONTROLS	No	No	No	Yes	Yes	Yes
WEATHER INTERACTIONS	No	No	Yes	No	Yes	Yes
OBSERVATIONS	536	536	536	536	536	536

NOTES: Significance levels are indicated as \* 0.10 \*\* 0.05 \*\*\* 0.01. The unit of analysis is at the household level. Rainfall variability is defined as the standard deviation of rainfall. Historical measures of atmospheric parameters correspond to the time period over which rainfall variability is measured. Historical rainfall is measured in hundreds of mm. historical temperature is measured in °C. Cluster robust standard errors are reported in parentheses. Wild Cluster Bootstrap-t p-values (null-imposed, 1,000 replications) are reported underneath in brackets, addressing concerns relating to the small number of clusters (Cameron, Gelbach, Miller, 2008).

Table A31: Disentangling Realized Income Events from Income Uncertainty: The Effects of Rainfall Variability on Rainfall Realizations

OUTCOME VARIABLE	TREATMENT VARIABLE: Rainfall Variability ( $\sigma$ , 100mm)								
	(1) (2 years)	(2) (3 years)	(3) (4 years)	(4) (5 years)	(5) (6 years)	(6) (7 years)	(7) (8 years)	(8) (9 years)	(9) (10 years)
ANNUAL RAINFALL (t+4)	-1.278 (6.028) [0.823]	15.63 (14.12) [0.279]	16.42 (12.32) [0.198]	31.09** (14.61) [0.040]	4.195 (13.27) [0.741]	3.120 (15.92) [0.787]	22.22 (19.28) [0.187]	33.54 (17.30) [0.111]	46.05** [0.020]
ANNUAL RAINFALL (t+3)	3.840 (7.506) [0.628]	18.24* (8.715) [0.074]	27.47* (13.45) [0.077]	28.49** (11.25) [0.028]	39.72** (13.38) [0.019]	13.54 (16.46) [0.406]	14.36 (17.15) [0.426]	34.08 (21.21) [0.150]	47.08* [0.097]
ANNUAL RAINFALL (t+2)	-4.940 (7.539) [0.513]	-3.513 (11.44) [0.765]	14.15 (12.17) [0.264]	28.43 (16.17) [0.126]	28.74* (14.20) [0.079]	42.40** (14.93) [0.027]	22.57 (16.78) [0.210]	28.31 (18.67) [0.170]	50.26** [0.061]
ANNUAL RAINFALL (t+1)	-14.919* (8.330) [0.122]	-10.01 (11.39) [0.448]	-3.470 (11.58) [0.793]	13.79 (13.57) [0.328]	26.71* (14.23) [0.102]	32.00** (12.48) [0.037]	43.35*** (12.82) [0.010]	26.56* (14.87) [0.094]	33.51* [0.070]
ANNUAL RAINFALL (t)	-9.295 (7.265) [0.263]	-4.727 (10.10) [0.680]	7.529 (11.27) [0.551]	18.66* (10.33) [0.140]	36.03*** (11.30) [0.012]	47.73*** (11.45) [0.001]	53.86*** (9.271) [0.000]	59.52*** (11.35) [0.000]	48.65*** [0.000]
ANNUAL RAINFALL (t-1)	9.295 (7.265) [0.263]	-4.192 (4.891) [0.382]	-3.096 (6.669) [0.645]	6.994 (8.738) [0.444]	19.60* (9.842) [0.073]	33.50** (11.57) [0.011]	45.16*** (13.01) [0.002]	48.68*** (11.44) [0.003]	54.52*** [0.001]
ANNUAL RAINFALL (t-2)	-5.638 (11.89) [0.668]	8.758 (11.04) [0.473]	-2.613 (4.604) [0.608]	-5.061 (4.906) [0.342]	3.413 (6.779) [0.713]	13.18 (7.717) [0.151]	24.50** (11.21) [0.072]	35.60*** (13.01) [0.002]	41.44*** [0.021]
ANNUAL RAINFALL (t-3)	-6.825 (5.801) [0.271]	-12.75 (11.93) [0.321]	-3.819 (13.91) [0.821]	-8.784 (8.426) [0.336]	-9.351 (7.131) [0.205]	-1.834 (6.788) [0.802]	8.968 (8.301) [0.325]	20.30 (13.37) [0.158]	32.56** [0.030]
ANNUAL RAINFALL (t-4)	-32.32*** (9.659) [0.030]	-26.25** (10.43) [0.083]	-27.66** (10.55) [0.020]	-17.54 (16.40) [0.375]	-24.16** (10.69) [0.082]	-26.74*** (6.921) [0.001]	-17.79*** (5.021) [0.206]	-6.578 (4.949) [0.466]	6.958 (9.470) [0.684]
OBSERVATIONS	495	495	495	495	495	495	495	495	495
TREATMENT STD. DEV.	1.508	1.222	1.088	0.981	0.902	0.840	0.780	0.726	0.684
FIXED EFFECTS									
WEATHER CONTROLS	YES	YES	YES	YES	YES	YES	YES	YES	YES
QUADRATIC WEATHER CONTROLS	YES	YES	YES	YES	YES	YES	YES	YES	YES
WEATHER INTERACTIONS	YES	YES	YES	YES	YES	YES	YES	YES	YES

NOTES: Significance levels are indicated as \* 0.10 \*\* 0.05 \*\*\* 0.01. The unit of analysis is at the village level. Each coefficient relates to an individual regression. Rainfall variability is defined as the standard deviation of rainfall. Historical measures of atmospheric parameters correspond to the time period, over which rainfall variability is measured. Historical rainfall is measured in hundreds of mm. historical temperature is measured in °C. Cluster robust standard errors are reported in parentheses. Wild Cluster Bootstrap-t p-values (null-imposed, 1,000 replications) are reported underneath in brackets, addressing concerns relating to the small number of clusters (Cameron, Gelbach, Miller, 2008).

## A.3 Main Results

### A.3.1 Alternative Timing Definitions

As explored for the supporting results, we also examine the sensitivity of the main results to defining rainfall variability over different time frames, ranging from two to 10 years. These results are presented in Tables [A32](#).

**Consumption** First, we re-explore the effects of rainfall variability on consumption (Table [A32](#)). We find similar results when rainfall variability is defined over 2-6 years. However, when rainfall variability is defined over longer periods the effects quickly lose statistical significance. This may be due to the reduction in independent variation across rounds associated with expanding the time horizon.

**Life Satisfaction** Second, we re-explore the effects of rainfall variability of life satisfaction (Table [A33](#)). We find similar results when rainfall variability is defined over all years (2-10) years; however, results become statistically insignificant when rainfall variability is defined over very short periods (2-3 years) or long periods (9-10 years) after accounting for the small number of clusters.

Table A32: Rainfall Variability and Consumption

	LOG REAL CONSUMPTION PER CAPITA						STD. DEV.
	(1)	(2)	(3)	(4)	(5)	(6)	
Rainfall Variability ( $\sigma/\mu$ ) (2 years)	-0.01000*** (0.00205) [0.020]	-0.0360*** (0.00488) [0.004]	-0.0369*** (0.00743) [0.008]	-0.0478*** (0.00753) [0.010]	-0.0270*** (0.00489) [0.080]		1.887
Rainfall Variability ( $\sigma/\mu$ ) (3 years)	-0.0173*** (0.00269) [0.034]	-0.0303*** (0.00816) [0.040]	-0.0306*** (0.00861) [0.030]	-0.0318*** (0.00921) [0.030]	-0.0206*** (0.00588) [0.038]		2.598
Rainfall Variability ( $\sigma/\mu$ ) (4 years)	-0.0259*** (0.00361) [0.050]	-0.0364*** (0.00657) [0.014]	-0.0373*** (0.00827) [0.006]	-0.0411*** (0.00761) [0.008]	-0.0340*** (0.00463) [0.014]		2.494
Rainfall Variability ( $\sigma/\mu$ ) (5 years)	-0.0189*** (0.00307) [0.032]	-0.0139*** (0.00457) [0.026]	-0.0120** (0.00529) [0.072]	-0.0183*** (0.00588) [0.060]	-0.0326*** (0.00485) [0.016]		2.808
Rainfall Variability ( $\sigma/\mu$ ) (6 years)	-0.0181*** (0.00406) [0.100]	-0.00564 (0.00906) [0.612]	0.0000331 (0.00659) [0.998]	-0.00906 (0.0114) [0.592]	-0.0158* (0.00776) [0.312]		2.257
Rainfall Variability ( $\sigma/\mu$ ) (7 years)	-0.0166*** (0.00606) [0.328]	0.000946 (0.00843) [0.946]	-0.00448 (0.00604) [0.606]	0.00210 (0.00829) [0.878]	-0.00573 (0.00721) [0.656]		2.694
Rainfall Variability ( $\sigma/\mu$ ) (8 years)	-0.0198** (0.00795) [0.326]	-0.0103 (0.00806) [0.618]	-0.00579 (0.00595) [0.526]	-0.00781 (0.00787) [0.948]	0.00193 (0.00971) [0.904]		1.866
Rainfall Variability ( $\sigma/\mu$ ) (9 years)	-0.0168* (0.00895) [0.402]	-0.0178** (0.00744) [0.362]	-0.0179*** (0.00525) [0.226]	0.00445 (0.0101) [0.758]	-0.00359 (0.00905) [0.772]		2.449
Rainfall Variability ( $\sigma/\mu$ ) (10 years)	-0.0245* (0.01119) [0.434]	-0.0166 (0.0133) [0.526]	-0.0253 (0.0165) [0.442]	0.0194 (0.0116) [0.188]	0.0138 (0.0156) [0.622]		1.651
FIXED EFFECTS	HOUSEHOLD, MONTH, AND YEAR						
WEATHER CONTROLS	No	YES	YES	YES	YES	YES	
QUADRATIC WEATHER CONTROLS	No	No	No	YES	YES	YES	
WEATHER INTERACTIONS	No	No	YES	NO	NO	YES	
OBSERVATIONS	2,686	2,686	2,686	2,686	2,686	2,686	

NOTES: Significance levels are indicated as \* 0.10 \*\* 0.05 \*\*\* 0.01. The unit of analysis is the household. Rainfall variability is defined as the coefficient of variation for rainfall. Historical measures of atmospheric parameters correspond to the time period, over which rainfall variability is measured. Historical rainfall is measured in hundreds of mm. historical temperature is measured in  $^{\circ}\text{C}$ . Cluster robust standard errors are reported in parentheses. Wild Cluster Bootstrap-t p-values (null-imposed, 1,000 replications) are reported underneath in brackets, addressing concerns relating to the small number of clusters (Cameron, Gelbach, Miller, 2008).

Table A33: Rainfall Variability and Life Satisfaction

	(1) LIFE SATISFACTION	(2) LIFE SATISFACTION	(3) LIFE SATISFACTION	(4) LIFE SATISFACTION	(5) LIFE SATISFACTION	(6) WITHIN GROUP STD. DEV
Rainfall Variability ( $\sigma/\mu$ ) (2 years)	-0.0104*** (0.00284) [0.164]	-0.0278** (0.00975) [0.066]	-0.0313** (0.0107) [0.108]	-0.0413*** (0.0100) [0.052]	-0.0370*** (0.0113) [0.258]	1.683
Rainfall Variability ( $\sigma/\mu$ ) (3 years)	-0.0182*** (0.00399) [0.074]	-0.0240** (0.0105) [0.102]	-0.0262** (0.00995) [0.130]	-0.0290** (0.0102) [0.086]	-0.0252** (0.00961) [0.198]	2.270
Rainfall Variability ( $\sigma/\mu$ ) (4 years)	-0.0259*** (0.00353) [0.052]	-0.0262*** (0.00848) [0.034]	-0.0289** (0.0107) [0.038]	-0.0360*** (0.0107) [0.042]	-0.0310*** (0.00909) [0.022]	2.096
Rainfall Variability ( $\sigma/\mu$ ) (5 years)	-0.0192*** (0.00455) [0.114]	-0.0145** (0.00672) [0.102]	-0.0132* (0.00687) [0.144]	-0.0213** (0.00786) [0.068]	-0.0323*** (0.00569) [0.002]	2.393
Rainfall Variability ( $\sigma/\mu$ ) (6 years)	-0.0227*** (0.00467) [0.108]	-0.0126* (0.00638) [0.178]	-0.0108 (0.00654) [0.224]	-0.0351*** (0.00937) [0.028]	-0.0408*** (0.00858) [0.024]	1.920
Rainfall Variability ( $\sigma/\mu$ ) (7 years)	-0.0270*** (0.00466) [0.056]	-0.0210*** (0.00574) [0.060]	-0.0242*** (0.00530) [0.040]	-0.0218*** (0.00660) [0.096]	-0.0308*** (0.00643) [0.040]	2.384
Rainfall Variability ( $\sigma/\mu$ ) (8 years)	-0.0313*** (0.00661) [0.102]	-0.0278*** (0.00330) [0.008]	-0.0266*** (0.00402) [0.010]	-0.0263*** (0.00324) [0.004]	-0.0317*** (0.00912) [0.056]	1.669
Rainfall Variability ( $\sigma/\mu$ ) (9 years)	-0.0302*** (0.00679) [0.128]	-0.0319*** (0.00398) [0.042]	-0.0319*** (0.00388) [0.038]	-0.0249** (0.00987) [0.244]	-0.0296** (0.0103) [0.252]	2.122
Rainfall Variability ( $\sigma/\mu$ ) (10 years)	-0.0463*** (0.00699) [0.018]	-0.0379*** (0.00979) [0.096]	-0.0371** (0.0128) [0.130]	-0.0104 (0.0127) [0.694]	-0.0132 (0.0124) [0.508]	1.429
FIXED EFFECTS						
WEATHER CONTROLS	No	YES	YES	YES	YES	YES
QUADRATIC WEATHER CONTROLS	No	No	No	YES	YES	YES
WEATHER INTERACTIONS	No	No	YES	No	YES	YES
OBSERVATIONS	4,033	4,033	4,033	4,033	4,033	4,033
HOUSEHOLD, MONTH, AND YEAR						
WEATHER CONTROLS	No	YES	YES	YES	YES	YES
WEATHER INTERACTIONS	No	No	YES	No	YES	YES

NOTES: Significance levels are indicated as \* 0.10 \*\* 0.05 \*\*\* 0.01. The unit of analysis is the individual. Rainfall variability is defined as the coefficient of variation for rainfall. Historical measures of atmospheric parameters correspond to the time period, over which rainfall variability is measured. Historical rainfall is measured in hundreds of mm. historical temperature is measured in °C. Cluster robust standard errors are reported in parentheses. Wild Cluster Bootstrap-t p-values (null-imposed, 1,000 replications) are reported underneath in brackets, addressing concerns relating to the small number of clusters (Cameron, Gelbach, Miller, 2008).

### **A.3.2 An Alternative Measure of Rainfall Variability – Standard Deviation of Rainfall**

In addition, to exploring the effects of the coefficient of variation for rainfall, we also explore an alternative measure, the standard deviation of rainfall to ensure that the effects. Tables [A34](#), [A35](#). The inferences made about the main results are robust across different timing definitions (Tables [A34](#), [A35](#).

Table A34: Rainfall Variability and Consumption

	LOG REAL CONSUMPTION PER CAPITA					STD. DEV.
	(1)	(2)	(3)	(4)	(5)	(6)
Rainfall Variability ( $\sigma$ , 100mm) (2 years)	-0.0695*** (0.0162) [0.032]	-0.185*** (0.0502) [0.058]	-0.177** (0.0649) [0.074]	-0.220** (0.0775) [0.118]	-0.123** (0.0417) [0.176]	0.330
Rainfall Variability ( $\sigma$ , 100mm) (3 years)	-0.122*** (0.0262) [0.034]	-0.186*** (0.0651) [0.068]	-0.184** (0.0676) [0.070]	-0.182** (0.0787) [0.124]	-0.119** (0.0443) [0.090]	0.372
Rainfall Variability ( $\sigma$ , 100mm) (4 years)	-0.199*** (0.0219) [0.016]	-0.280*** (0.0537) [0.006]	-0.271*** (0.0612) [0.004]	-0.300*** (0.0523) [0.014]	-0.259*** (0.0306) [0.014]	0.328
Rainfall Variability ( $\sigma$ , 100mm) (5 years)	-0.141*** (0.0305) [0.040]	-0.0907*** (0.0298) [0.012]	-0.0765* (0.0375) [0.064]	-0.113* (0.0571) [0.158]	-0.242*** (0.0404) [0.012]	0.352
Rainfall Variability ( $\sigma$ , 100mm) (6 years)	-0.139*** (0.0348) [0.096]	-0.0233 (0.0750) [0.788]	0.0117 (0.0546) [0.894]	-0.0194 (0.106) [0.886]	-0.124 (0.0818) [0.378]	0.258
Rainfall Variability ( $\sigma$ , 100mm) (7 years)	-0.129** (0.0481) [0.320]	0.0321 (0.0894) [0.726]	-0.0222 (0.0545) [0.764]	0.0318 (0.0693) [0.762]	-0.0356 (0.0612) [0.704]	0.322
Rainfall Variability ( $\sigma$ , 100mm) (8 years)	-0.160*** (0.0493) [0.278]	-0.0686 (0.0558) [0.642]	-0.0350 (0.0489) [0.616]	-0.00475 (0.0604) [0.950]	0.0236 (0.0708) [0.818]	0.251
Rainfall Variability ( $\sigma$ , 100mm) (9 years)	-0.131* (0.0679) [0.390]	-0.122* (0.0665) [0.410]	-0.124** (0.0511) [0.324]	0.0231 (0.0693) [0.766]	-0.0266 (0.0641) [0.776]	0.323
Rainfall Variability ( $\sigma$ , 100mm) (10 years)	-0.162 (0.101) [0.310]	-0.0841 (0.105) [0.598]	-0.121 (0.123) [0.534]	0.115 (0.0724) [0.300]	0.0921 (0.0903) [0.576]	0.275
FIXED EFFECTS						
WEATHER CONTROLS	No	Yes	Yes	Yes	Yes	Yes
QUADRATIC WEATHER CONTROLS	No	No	No	Yes	Yes	Yes
WEATHER INTERACTIONS	No	No	Yes	No	Yes	Yes
OBSERVATIONS	2,686	2,686	2,686	2,686	2,686	2,686

NOTES: Significance levels are indicated as \* 0.10 \*\* 0.05 \*\*\* 0.01. The unit of analysis is the household. Rainfall variability is defined as the standard deviation of rainfall. Historical measures of atmospheric parameters correspond to the time period, over which rainfall variability is measured. Historical rainfall is measured in hundreds of mm. historical temperature is measured in °C. Cluster robust standard errors are reported in parentheses. Wild Cluster Bootstrap-t p-values (null-imposed, 1,000 replications) are reported underneath in brackets, addressing concerns relating to the small number of clusters (Cameron, Gelbach, Miller, 2008).

Table A35: Rainfall Variability and Life Satisfaction

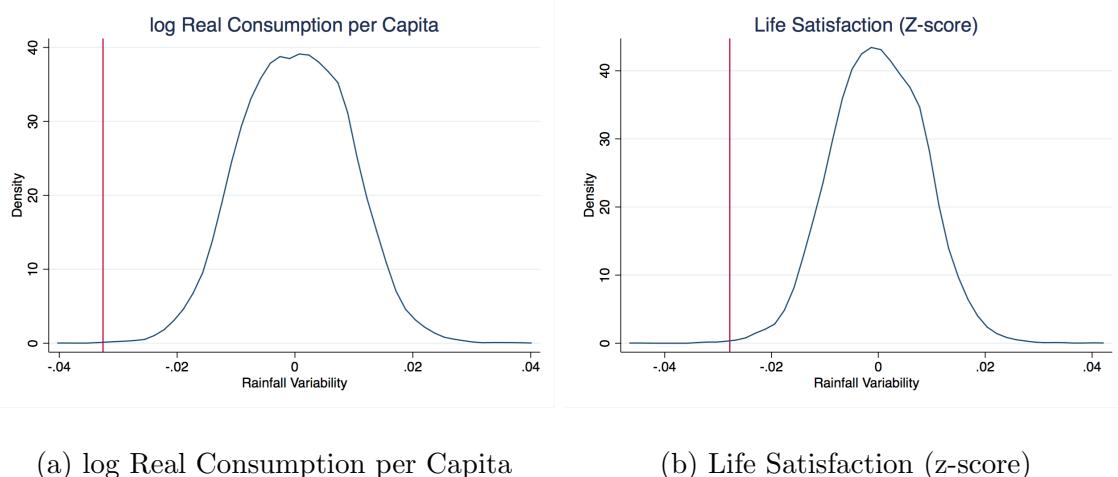
	(1) LIFE SATISFACTION	(2) LIFE SATISFACTION	(3) LIFE SATISFACTION	(4) LIFE SATISFACTION	(5) LIFE SATISFACTION	(6) WITHIN GROUP STD. DEV
Rainfall Variability ( $\sigma$ , 100mm) (2 years)	-0.0661** (0.0266) [0.232]	-0.0851 (0.0591) [0.248]	-0.0862 (0.0723) [0.352]	-0.0855 (0.0933) [0.536]	-0.0534 (0.0975) [0.788]	0.285
Rainfall Variability ( $\sigma$ , 100mm) (3 years)	-0.123*** (0.0389) [0.114]	-0.116 (0.0743) [0.240]	-0.126 (0.0746) [0.298]	-0.127 (0.0870) [0.272]	-0.103 (0.0866) [0.424]	0.322
Rainfall Variability ( $\sigma$ , 100mm) (4 years)	-0.191*** (0.0317) [0.030]	-0.162** (0.0648) [0.052]	-0.161** (0.0734) [0.076]	-0.216** (0.0833) [0.086]	-0.191** (0.0721) [0.068]	0.277
Rainfall Variability ( $\sigma$ , 100mm) (5 years)	-0.142*** (0.0410) [0.132]	-0.0892 (0.0508) [0.160]	-0.0784 (0.0526) [0.226]	-0.135* (0.0677) [0.154]	-0.233*** (0.0605) [0.014]	0.300
Rainfall Variability ( $\sigma$ , 100mm) (6 years)	-0.196*** (0.0307) [0.042]	-0.102* (0.0530) [0.152]	-0.0895 (0.0537) [0.200]	-0.285*** (0.0930) [0.048]	-0.386*** (0.0660) [0.014]	0.221
Rainfall Variability ( $\sigma$ , 100mm) (7 years)	-0.235*** (0.0301) [0.024]	-0.176*** (0.0507) [0.060]	-0.216*** (0.0363) [0.016]	-0.189*** (0.0596) [0.104]	-0.269*** (0.0495) [0.020]	0.284
Rainfall Variability ( $\sigma$ , 100mm) (8 years)	-0.271*** (0.0311) [0.024]	-0.223*** (0.0248) [0.008]	-0.214*** (0.0298) [0.008]	-0.205*** (0.0251) [0.012]	-0.250*** (0.0596) [0.020]	0.223
Rainfall Variability ( $\sigma$ , 100mm) (9 years)	-0.261*** (0.0427) [0.058]	-0.253*** (0.0273) [0.024]	-0.254*** (0.0263) [0.026]	-0.192** (0.0661) [0.250]	-0.225*** (0.0718) [0.320]	0.277
Rainfall Variability ( $\sigma$ , 100mm) (10 years)	-0.343*** (0.0750) [0.030]	-0.269*** (0.0722) [0.076]	-0.255*** (0.0841) [0.098]	-0.0963 (0.0708) [0.308]	-0.0970 (0.0704) [0.312]	0.245
FIXED EFFECTS						
WEATHER CONTROLS	No	Yes	Yes	Yes	Yes	Yes
QUADRATIC WEATHER CONTROLS	No	No	No	Yes	Yes	Yes
WEATHER INTERACTIONS	No	No	Yes	No	Yes	Yes
OBSERVATIONS	4,033	4,033	4,033	4,033	4,033	4,033
HOUSEHOLD, MONTH, AND YEAR						
WEATHER CONTROLS	No	Yes	Yes	Yes	Yes	Yes
QUADRATIC WEATHER CONTROLS	No	No	No	Yes	Yes	Yes
WEATHER INTERACTIONS	No	No	Yes	No	Yes	Yes

NOTES: Significance levels are indicated as \* 0.10 \*\* 0.05 \*\*\* 0.01. The unit of analysis is the individual. Rainfall variability is defined as the standard deviation of rainfall. Historical measures of atmospheric parameters correspond to the time period, over which rainfall variability is measured. Historical rainfall is measured in hundreds of mm. historical temperature is measured in °C. Cluster robust standard errors are reported in parentheses. Wild Cluster Bootstrap-t p-values (null-imposed, 1,000 replications) are reported underneath in brackets, addressing concerns relating to the small number of clusters (Cameron, Gelbach, Miller, 2008).

## A.4 Randomization Inference

As a final exercise to address the small number of clusters, as well as any concerns that the results are driven by sampling variability, we conduct a randomization inference exercise. Given the short panel it is possible that changes in rainfall variability could be due to sampling variability rather than a change in the underlying “state” of income uncertainty. However, as shown in the main article we find no effects of rainfall variability on a broad range of income related outcomes. In addition, we estimate that rainfall realizations are an important determinant of agricultural yields, highlighting that there is meaningful variation in the underlying weather data (Table A1). Consequently, if the estimates were simply capturing sampling variability, or residual weather shocks, we should expect to observe similar effects across all outcomes. Holding the sample fixed we re-assign rainfall variability across village-years 10,000 times and use these placebo realizations of rainfall variability to estimate the original model. We then plot the distribution of each estimated coefficient and compute the share of placebo  $\beta$ ’s that are higher in absolute value than the original estimate of  $\beta$ , providing an exact p-value. Figure A1 presents the results of this exercise for our main outcome variables. The distribution of placebo estimates is centered around zero, supporting the premise that the estimates are not driven by sampling variability or spurious trends. Exact p-values for our main results are less than 0.01.

Figure A1: Randomization Inference Distributions



NOTES: Each plot represents the distribution of point estimates for rainfall variability by re-estimating equation (1) and (2) on randomized placebo datasets. Each distribution is constructed by repeating the randomization and estimation procedure 10,000 times. Coefficients from the estimate using the real data are presented as vertical lines with p-values. Only the estimates on real consumption and life satisfaction have  $p < 0.01$ .

## A.5 Alternative Measures of Subjective Well-Being

To provide further support for our argument we show that rainfall variability has a similar effect on alternative, evaluative measure of life satisfaction. Different measures of subjective well-being provide different perspectives on the process by which respondents reflect on, or experience, their lives. These measures lie closer to the end of the continuum representing more evaluative judgements of life, similar to the measure of life satisfaction.

The measures examined are responses to the statement *“In most ways my life is close to ideal”* and *“So far I have gotten the important things I want in life”*, *“If I could live my life over, I would change almost nothing”*, in which responses are based on a 7-point scale ranging from *“strongly disagree”* to *“strongly agree”*. In addition, we explore response to the Cantril Ladder, *“Where on the ladder is your standing?”*, in which responses are on a 10-point scale with 10 being the best possible and 0 being the worst possible. In addition, we consider a standardized index of all evaluative measures of subjective well-being, including life satisfaction.

The estimated effects are comparable to the life satisfaction results presented in the main text. We estimate that a one standard deviation increase in rainfall variability (2.39 units) is associated with a 0.089 standard deviation reduction in the index, with similar magnitudes across each of the individual responses.

We also explore the effects of rainfall variability on happiness. Happiness captures present affect rather than the more evaluative measures of subjective well-being. While both measures of subjective well-being are highly correlated ( $\rho = 0.425$ ), we might expect that rainfall variability should have a smaller effect on happiness (contemporaneous well-being) than life satisfaction (evaluative well-being) if it is capturing the effects of income uncertainty. Table A37 shows that rainfall variability has smaller effects on contemporaneous happiness.

Table A36: RAINFALL VARIABILITY AND ALTERNATIVE MEASURES OF SUBJECTIVE WELL-BEING - COEFFICIENT OF VARIATION

	(1) Cantril Ladder (Standardized)	(2) “Life is Close to Ideal” (Standardized)	(3) “Got the Important things in Life” (Standardized)	(4) “I’d Change Nothing” (Standardized)	(5) Index (Standardized)
RAINFALL VARIABILITY ( $\sigma/\mu$ )	-0.0132* (0.00685)	-0.0136** (0.00489)	-0.0364*** (0.00440)	-0.0309*** (0.00745)	-0.0375*** (0.00428)
FIXED EFFECTS					
			INDIVIDUAL, YEAR, MONTH		
WEATHER CONTROLS	No	YES	YES	YES	YES
QUADRATIC WEATHER CONTROLS	No	No	No	YES	YES
WEATHER INTERACTIONS	No	No	YES	No	YES
Observations	4029	4027	4031	4029	4033

NOTES: Significance levels are indicated as \* 0.10 \*\* 0.05 \*\*\* 0.01. The unit of analysis is at the individual level. Our proxy for uncertainty is the coefficient of variation for rainfall, measured over the previous 5 years, the time period between each survey round. Historical measures of atmospheric parameters correspond to this period. Contemporaneous and historical rainfall is measured in hundreds of mm. Contemporaneous and historical temperature is measured in °C. Cluster robust standard errors are reported in parentheses. Results are robust to clustering following the bootstrap procedure to account for concerns relating to the small number of clusters (Cameron, Gelbach, Miller, 2008)

Table A37: RAINFALL VARIABILITY AND HAPPINESS

	HAPPINESS (Standardized)				
	(1)	(2)	(3)	(4)	(5)
Rainfall Variability ( $\sigma/\mu$ )	-0.00695* (0.00348) [0.194]	-0.00324 (0.00592) [0.724]	-0.00454 (0.00597) [0.652]	-0.0145* (0.00708) [0.080]	-0.0158** (0.00682) [0.062]
FIXED EFFECTS					
			INDIVIDUAL, YEAR, MONTH		
WEATHER CONTROLS	No	YES	YES	YES	YES
QUADRATIC WEATHER CONTROLS	No	No	No	YES	YES
WEATHER INTERACTIONS	No	No	YES	No	YES
TREATMENT STD. DEV.	5.217	3.093	3.057	2.742	2.390
Observations	4,033	4,033	4,033	4,033	4,033

NOTES: Significance levels are indicated as \* 0.10 \*\* 0.05 \*\*\* 0.01. The unit of analysis is the individual. Rainfall variability is defined as the coefficient of variation for rainfall, measured over the previous 5 years, the time period between each survey round. Historical measures of atmospheric parameters correspond to this period. Historical rainfall is measured in hundreds of mm. Historical temperature is measured in °C. Cluster robust standard errors are reported in parentheses. Wild Cluster Bootstrap-t p-values (null-imposed, 1,000 replications) are reported underneath in brackets, addressing concerns relating to the small number of clusters (Cameron, Gelbach, Miller, 2008).

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