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Consumption Smoothing and the Welfare Cost of Uncertainty

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Abstract
How does income uncertainty affect 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. Mediation analysis suggests that the estimated reduction in consumption does not fully explain the total effect on individual well-being. Increased rainfall variability also has a large direct effect on individual well-being. These findings suggest that the gains from further consumption smoothing are likely greater than estimates based solely on observed consumption fluctuations.

Keywords: consumption smoothing, income uncertainty, rainfall variability, subjective well-being
JEL codes: I31; O13; Q12; Q56

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Risk and uncertainty is an inherent feature of life, especially for those living in rural parts of developing countries. Uninsured risk can lead to significant reductions in consumption, which may result in poverty traps (Paxson 1992; Townsend 1994; Udry 1994; Morduch 1995; Jayachandran 2006; Suri 2011; Dercon and Christiaensen 2011; Carter and Lybbert 2012; Porter 2012; Barrett and Carter 2013; Dercon and Porter 2014). However, less is known about the broader effects of risk and uncertainty on subjective well-being. If uninsured risk causes stress, anxiety, and negative affective states it may further reinforce poverty (Shah et al. 2012; Mani et al. 2013; Mullainathan and Shafir 2013; Haushofer and Fehr 2014; Haushofer and Shapiro 2016; Genicot and Ray 2017). Consumption responses are frequently presumed to measure the welfare cost of uninsured risk. Expected utility theory, however, tells us that risk-averse individuals dislike variance, and so greater uncertainty should result in lower experienced utility. Chetty and Looney (2006) show that the welfare gain from further insurance is the product of the coefficient on relative risk aversion and the consumption drop. If uninsured risk has direct effects on well-being the welfare gains from further consumption smoothing may be much greater than observed consumption fluctuations.

This paper provides suggestive evidence that income uncertainty has substantial 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 exploit village-level variation over time in a five-year moving-average of the coefficient of variation of rainfall, controlling for non-linear rainfall and temperature effects 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 measures of subjective well-being. However, the degree to which rainfall variability has a direct effect on well-being, other than through consumption, remains unclear.

To estimate the direct effects of uncertainty on well-being we identify the average controlled direct effect, following Acharya et al. (2016). Our estimates suggest that consumption, through precautionary savings, explains a small share of the total effect on individual well-being. Our findings suggest that the returns to further consumption smoothing are likely much greater than estimates based solely on observed consumption fluctuations (Paxson 1992; Townsend 1994; Morduch 1995). Taken at face value, our estimates suggest that, when the direct effect of rainfall variability on well-being is incorporated, willingness to pay for complete insurance could be almost 5 times higher than implied by the estimated drop in consumption.[1]

The main empirical challenge is separately identifying the effects of income uncertainty from realized income shocks. Without data on subjective beliefs, we are unable to show directly that increased rainfall variability results in a changes in beliefs about income uncertainty. If beliefs don't change there should be no change in outcomes, unless driven by residual variation in 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. The other is that rainfall variability captures realized income shocks. We present evidence that rainfall variability is a reasonable proxy for income uncertainty in this context. Rainfall variability is uncorrelated with historical, contemporaneous, and future rainfall realizations, i.e., it 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, rainfall variability has no effect on a broad range of income, wealth, and agricultural production outcomes. Collectively, these results support the premise that rainfall variability is not having an effect through agricultural markets or income.

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. In light of this we argue that the observed changes imply a change in beliefs. We also note that an income uncertainty interpretation is not required for the second part of our analysis – the decomposition. Our conclusion, that the gains from further consumption smoothing are larger than estimates based solely on realized consumption fluctuations holds regardless of how rainfall variability is interpreted. Finally, 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.

Our findings make several contributions. First, we contribute to the literature on the economic consequences of uninsured risk in developing countries. A large literature has focused on *ex post* responses to weather shocks. We contribute to a smaller, burgeoning, literature on the *ex ante* effects of uninsured risk (Binswanger 1980; Binswanger and Rosenzweig 1993; Barrett 1996; Jensen 2000; Jalan and Ravallion 2001; Fitzsimons 2007; Lybbert et al. 2007; Just and Lybbert 2009; Yesuf and Bluffstone 2009; Alem et al. 2010; Kazianga 2012; Bellemare et al. 2013; Kala 2017; Bellemare et al. 2020; Foster and Gehrke 2020; Colmer 2021; Lee 2021). The existing literature has focused on how price and income risk affects various outcomes such as consumption, investments, and even conflict. Our focus is to measure and identify the overall effect of uninsured risk on individual well-being, providing a more holistic understanding of its consequences. Our results highlight that income uncertainty has a meaningful direct effect on individual well-being, beyond its effect through consumption. This suggests that the welfare gains from further consumption smoothing are likely much greater than estimates based solely on observed consumption fluctuations. Our findings are consistent with a small literature that has identified "peace of mind" effects from rainfall and health insurance (Finkelstein et al., 2012; Tafere et al., 2019; Haushofer et al., 2020). These studies find that holding insurance before the resolution of uncertainty generates *ex ante* well-being effects. Our contribution to the understanding of "peace of mind" effects is the decomposition of *ex ante* consumption responses and direct effects on well-being.

Second, we contribute to the literature on the economics of well-being. Our work highlights 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. In this regard, 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. 2016; De Neve et al. 2018), 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 2020), and to evaluate government policy (Gruber and Mullainathan 2005; Diener et al. 2009; Dolan et al. 2011).

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

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. All surveys were completed within three months and at roughly the same time each round. 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).

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).[2] 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.[3]

The ERA-Interim reanalysis data archive provides 6-hourly measurements for a very rich set of atmospheric parameters, from 1st 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).[4] Reanalysis data are 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 are increasingly being used by economists, since it fills in the data gap apparent in developing countries, where the collection of consistent weather data are lower down the priority list in governmental budgets (see Dell et al. (2014) for a review of its recent applications in the literature).

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_{hvt}, in household h, of village v, in year t, and measures of subjective well-being, $\mathcal{W}_{it}$ for individual i, in year t. Subjective well-being questions are 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 Eurobaromoter 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.

Empirical Strategy

To explore the empirical relevance of income uncertainty on individual well-being we exploit plausibly exogenous variation in rainfall variability between survey rounds. We first examine the relationship between rainfall variability and consumption. Whether rainfall variability has an effect on contemporaneous consumption is an empirical question: consumption expenditures may increase if farmers perceive an increase in uncertainty and 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, perceiving an increase in income uncertainty, engage in precautionary saving (to the degree that saving is possible); or increased rainfall variability may have no effect on present consumption if farmers are unable to smooth consumption over time, or if changes in rainfall variability do not induce changes in beliefs about uncertainty.

We estimate the following specification,

$$(1) \qquad \log C_{ht} = \beta_1 \textsc{Rainfall Variability}_{vt,\ldots,t-4} + \gamma f(\bar{w}_{vt,\ldots,t-4}) + \alpha_h + \alpha_m + \alpha_t + \epsilon_{hvt}$$

The key explanatory variable of interest is a five-year moving average of the coefficient of variation for rainfall measured at the village (v) level, $\textsc{Rainfall Variability}_{vt,\ldots,t-4}$ – a proxy for income uncertainty after controlling for a five-year moving average of weather realizations, $f(\bar{w}_{vt,\ldots,t-4})$. The choice of a five-year moving average is made based on the time between survey rounds. The weather variables included vary across specifications and are robust to using different measures of rainfall and temperature. In the most parsimonious specification we do not include any weather controls. In the least parsimonious specification we include linear and quadratic controls for rainfall and temperature over the previous 5 years and interactions between these terms,

$$f(\bar{w}_{vt,\ldots,t-4}) = \gamma_1 \overline{rain}_{vt,\ldots,t-4} + \gamma_2 \overline{rain}^2_{vt,\ldots,t-4} + \gamma_3 \overline{temp}_{vt,\ldots,t-4} + \gamma_4 \overline{temp}^2_{vt,\ldots,t-4} + \gamma_5 \overline{rain} \times \overline{temp}_{vt,\ldots,t-4} + \gamma_6 \overline{rain}^2 \times \overline{temp}^2_{vt,\ldots,t-4} \tag{2}$$

In addition, we control for household (α_h), year (α_t), and month of survey (α_m) fixed effects.

We also estimate the relationship between rainfall variability and subjective well-being,

$$\mathcal{W}_{it} = \beta_2 \text{Rainfall Variability}_{vt,\ldots,t-4} + \gamma f(\bar{w}_{vt,\ldots,t-4}) + \alpha_i + \alpha_m + \alpha_t + \epsilon_{ivt} \tag{3}$$

where $\mathcal{W}_{ivt}$ is a measure of subjective well-being at the individual (i) level, which has been standardized to aid comparisons across alternative measures of subjective well-being recorded on different scales. Here, individual fixed effects, α_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, α_t, to control for aggregate shocks, economic development, and macroeconomic policies. We also include survey month fixed effects, α_m, to control for seasonal variation in the timing of the survey.

The last term in equations 1 and 3 is the stochastic error term, ϵ_{ivt}. Standard errors are clustered at the village level. We also use 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). Standard errors are substantially smaller when we use this adjustment.

Identification Assumptions

One of the attractive properties of rainfall realizations is that they are exogenous to local and individual circumstances. However, even if our estimates of rainfall variability are identified, it is unclear how they should be interpreted.

There are two possible interpretations for our estimated rainfall variability coefficients: 1) rainfall variability is capturing the effect of income uncertainty; 2) there is no change in income uncertainty and rainfall variability is simply picking up the residual effect of past or contemporaneous rainfall shocks.

To capture the effect of uncertainty, it is important that increases in rainfall variability are mean-preserving; rainfall variability should be uncorrelated with past, contemporaneous, or expected future, rainfall. Evidence in support of this premise is presented in Colmer (2021), which explores the effects of rainfall variability on child labor and educational attainment. The results are also replicated in the Appendix materials (Tables A3-A32). Colmer (2021) finds that there is no meaningful statistical or sizable effect of rainfall variability on historical, contemporaneous, or future rainfall realizations. The absence of a direct effect on rainfall realizations significantly attenuates the mechanism through which direct income effects might arise. Colmer (2021) also finds that there is no effect of rainfall variability on a broad set of income-related outcomes, such as agricultural yields, wages, prices, and inputs, nor any effect of rainfall variability on whether households own, sell, or slaughter livestock, which is the most important marketable asset in rural Ethiopia, accounting for more than 90% of the total value of assets (Dercon 2004). Collectively, these findings provide compelling evidence that rainfall variability is capturing a measure of income uncertainty rather than realized rainfall shocks. Of course, it is possible that other unobservables could be affected. However, to the degree that these unobservables are affected they do not appear to explain meaningful variation in yields, or other income sources. While we can never rule out any residual correlation between rainfall variability and realized events, these findings suggest that first-order concerns should be alleviated.

It is also necessary that there is variation in the underlying rainfall distribution and that beliefs about the underlying rainfall distribution change. Unfortunately, we do not have data on subjective beliefs and so cannot directly identify this step of the data generating process. However, Colmer (2021) documents a significant reduction in five-year rainfall variability between rounds, rather than a stable distribution over time. Prior to the 2004 round average rainfall variability across villages was at a markedly higher level. After 2004, average rainfall variability across villages 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 at least scope for individuals to change their beliefs in response to changes in rainfall variability across rounds. 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. As discussed above, we see little evidence to suggest that rainfall variability is having an effect through income-related outcomes.

Main Results

In this section we estimate the relationship between rainfall variability, our proxy for income uncertainty, and our main outcomes of interest: real consumption per capita and life satisfaction. First we estimate the relationship between rainfall variability and real consumption per capita – an objective measure of household well-being. Economic theory tells us that a mean-preserving increase in income uncertainty will result in a reduction in contemporaneous consumption in the presence of borrowing constraints and/or prudence. The results in Table 2 show that greater rainfall variability is associated with significant reductions in real per capita consumption. In the least parsimonious specification (column 5), we estimate that a one standard deviation increase in rainfall variability (2.808 points) is associated with a 9.15% reduction in real per capita consumption. Taken at face value, these findings suggest that households would be willing to pay almost 10% of consumption to reduce rainfall variability by one standard deviation.[5]

We are also interested in understanding whether income uncertainty has broader effects on individual well-being. Expected utility theory tells us that risk-averse individuals dislike variance, and so greater uncertainty should result in lower experienced utility. Chetty and Looney (2006) show that the welfare gain from further insurance is the product of the coefficient on relative risk aversion and the consumption drop. Greater rainfall variability may therefore have meaningful direct effects on well-being beyond consumption.

We begin by estimating the relationship between rainfall variability and life satisfaction, an evaluative, forward-looking, measure of subjective well-being. Panel A of Table 3 presents the results of this analysis. In the least parsimonious 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.

Our findings are 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 (Tables A33-A36), and to a randomization inference approach, highlighting that the results are unlikely to be driven by sampling variability (Figure A1). We also show that the results are robust to alternative functional form assumptions relating to weather shocks and different fixed effect choices (Tables A37, A38, and A39). Following, Jayachandran (2006) we define a low rainfall shock as occurring if rainfall is within the bottom 20^{th} percentile of the long-run rainfall distribution for each village. High rainfall shocks are defined to occur if rainfall is above the 80^{th} percentile of the long-run rainfall distribution. Comparable measures are defined for our temperature control variables. We also explore the robustness of our findings to alternative measures of subjective well-being (Tables A40 and A41). Within the subjective well-being literature, it is generally considered that questions based on the life satisfaction scale are more evaluative measures, whereas questions related to happiness are a better measure of present affect (Benjamin et al. 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. When exploring other evaluative measures of subjective well-being the coefficient estimate for rainfall variability is similar in magnitude. Our estimate of the association between rainfall variability and contemporaneous happiness is smaller in magnitude.

Finally, in Table A42 we show that the association between rainfall variability and subjective well-being is attenuated for households that are engaged in informal risk-sharing networks, known as *Eqqub*. *Eqqub* are the dominant form of informal insurance in Ethiopia and are a balanced reciprocity risk sharing mechanism. While rotary savings are often used to allow savings to purchase an indivisible durable good, they are also used for insurance – members may pay another member to receive the pot at a time of need (Anderson and Baland 2002; Calomiris and Rajaraman 1998; Klonner 2001). Given the aggregate nature of rainfall variability it may not be obvious as to how eqqub can help. Members of *Eqqub*, however, can join from distant villages, although we have no way of determining whether this is the case. A more important issue relates to the interpretation of this exercise. *Eqqub's* are self-organized groups and so *Eqqub* membership is an endogenous choice. To minimize this concern we focus on households that have always been *Eqqub* members to avoid selection based on changes in rainfall variability. Consequently, our measure of *Eqqub* membership is orthogonal to changes in rainfall variability. That being said, households that enter into *Eqqub* are a selective group and so the moderating effect of *Eqqub* on rainfall variability may also capture the unobservable characteristics of households that led them to select into membership. The interaction term should not be interpreted as a causal moderator. We show that *Eqqub* membership completely attenuates the negative association between rainfall variability and life satisfaction, but has no effect on the association between rainfall variability and consumption. While being of interest in its own right, these findings also provide further support for the premise that rainfall variability can be interpreted as income uncertainty, rather than an income shock. In the event of a shock, we might expect access to insurance to attenuate the association between rainfall variability and consumption as well.

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

To explore the direct effects of rainfall variability on life satisfaction we decompose the total effect into the consumption effect and the residual direct effect. The magnitude of the direct effect has implications for the welfare gains from further consumption smoothing. A graphical representation of the possible channels is shown in Figure 1. Having controlled for historical weather shocks, and other fixed effects, (X), rainfall variability,(R), can affect life satisfaction, (U), through consumption ($R \rightarrow C \rightarrow U$) and through direct well-being effects ($R \rightarrow U$). 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 1 as being captured by the following set of equations, where ϵ_1 and ϵ_2, represent the error terms,

$$U = \alpha_1 + \beta_1 R + \gamma_1 C + \delta_1 X + \epsilon_1 \tag{4}$$

$$C = \alpha_2 + \beta_2 R + \delta_2 X + \epsilon_2 \tag{5}$$

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

$$U = (\alpha_1 + \gamma_1 \alpha_2) + R(\beta_1 + \gamma_1 \beta_2) + X(\delta_1 + \gamma_1 \delta_2) + (\epsilon_1 + \gamma_1 \epsilon_2) \tag{6}$$

The total effect is then calculated as,

$$\text{Total Effect} = \frac{\partial U}{\partial R} = \beta_1 + \gamma_1 \beta_2 \tag{7}$$

which can be decomposed into the direct effect, β_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, because consumption is a post-treatment outcome it is a bad control (Angrist and Pischke 2009). Simply conditioning on 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. 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,

$$\mathcal{W}_{it} = \beta_7 \text{Rainfall Variability}_{vt,\ldots,t-4} + \gamma f(\bar{w}_{vt,\ldots,t-4}) + \delta \log C_{ht} + \alpha_i + \alpha_m + \alpha_t + \epsilon_{ivt} \tag{8}$$

The model implies a parametric formulation of the demediation function,

$$\phi(\log C_{ht}; \delta) = \delta \log C_{ht} \tag{9}$$

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

$$\widetilde{\mathcal{W}}_{it} = \mathcal{W}_{it} - \hat{\phi}(\log C_{ht}; \hat{\delta}) \tag{10}$$

We then estimate the average CDE by regressing this demediated outcome on rainfall variability and our other controls,

$$\widetilde{\mathcal{W}}_{it} = \beta_8 \text{Rainfall Variability}_{vt,\ldots,t-4} + \gamma f(\bar{w}_{vt,\ldots,t-4}) + \alpha_i + \alpha_m + \alpha_t + \epsilon_{ivt} \tag{11}$$

In Panel B of Table 3 we present the results of this analysis. The sequential-g estimator provides an estimate of the average CDE which accounts for 79-86% of the reduced form effect of rainfall variability on life satisfaction. This suggests that rainfall variability has direct effects on life satisfaction that are not explained through consumption and that the welfare gains from further consumption smoothing are likely much greater than estimates based solely on observed consumption fluctuations. Our estimates suggest that marginal willingness to pay to reduce rainfall variability by one standard deviation is, on average, 9.15% of real per capita consumption. The direct effect is four times larger than the consumption effect. Pricing the direct effect in consumption terms through linear extrapolation, our results suggest that marginal willingness to pay to reduce rainfall variability by one standard deviation could be 46% of real per capita consumption.

We note caveats. First, identification of the average CDE requires that the sequential unconfoundedness assumption holds. While this assumption likely holds for the first step, it is unlikely to hold for the second step. Our estimate of the average CDE 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 average CDE when the sequential unconfoundedness assumption is violated. The results of this sensitivity test are presented in Figure 2. 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 average CDE under the amount of unmeasured confounding variation. It is most plausible that real consumption and life satisfaction are positively correlated. The average CDE 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 the association between consumption and life satisfaction, and in turn attenuate its contribution as an indirect effect. We note that even if the relationship between 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 almost 30% of the total effect, suggesting that marginal willingness to pay to avoid uncertainty would be around 15% of real per capita consumption.

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 increased rainfall variability, our proxy for income uncertainty, has a direct effect on individual well-being, beyond its effects through consumption. Consequently, the returns to further consumption smoothing are likely to be substantially greater than estimates based solely on observed consumption fluctuations.

We note caveats. First, it is possible that part of these estimates 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, but 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 valid but the welfare implications are less clear. Finally, these findings may not hold in other contexts. That being said, recent work has highlighted the potential benefits of access to insurance on mental health and well-being through "peace of mind" effects (Finkelstein et al. 2012; Tafere et al. 2019; 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 beliefs and 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.

Notes

[1]We note that 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. 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., implied willingness to pay for further consumption smoothing would be 1.5 times higher than based solely on the reduction in consumption.

[2]See Dee et al. (2011) for a detailed discussion of the ERA-Interim data.

[3]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. 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 are 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 are 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. 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.

[4]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 x cos(40) = 21.4 km x 21.4 km.

[5]True willingness to pay depends on the product of the coefficient of relative risk aversion and the consumption drop (Chetty and Looney 2006).

References

Acharya, A., M. Blackwell, and M. Sen (2016). Explaining causal findings without bias: Detecting and assessing direct effects. *American Political Science Review 110*(3), 512–529.

Aghion, P., U. Akcigit, A. Deaton, and A. Roulet (2016). Creative destruction and subjective wellbeing. *American Economic Review 106*(12), 3869–3897.

Alem, Y., M. Bezabih, M. Kassie, and P. Zikhali (2010). Does Fertilizer Use Respond to Rainfall Variability: Evidence from Ethiopia. *Agricultural Economics 41*(2), 165–175.

Alem, Y. and M. Söderbom (2012). Household-level consumption in urban Ethiopia: The effects of a large food price shock. *World Development 18*(3), 291–308.

Anderson, S. and J.-M. Baland (2002). The economics of roscas and intrahousehold resource allocation. *Quarterly Journal of Economics 117*(3), 963–995.

Angrist, J. and J. Pischke (2009). *Mostly Harmless Econometrics: an empiricist's companion*. Princeton University Press, Princeton, N.J., USA.

Argyle, M. (1999). Causes and correlates of happiness. In D. Kahneman, E. Diener, and N. Schwarz (Eds.), *Well-Being: The Foundations of Hedonic Psychology: scientific perspectives on employment and suffering*. New York: Russel Sage Foundation.

Auffhammer, M., S. Hsiang, W. Schlenker, and A. Sobel (2013). Using weather data and climate model output in economic analyses of climate change. *Review of Environmental Economics and Policy 7*(2), 181–198.

Barrett, C. (1996). On price risk and the inverse farm size-productivity relationship. *Journal of Development Economics 51*(1), 193–215.

Barrett, C. and M. Carter (2013). The economics of poverty traps and persistent poverty: Empirical and policy implications. *Journal of Development Studies 49*(7), 976–990.

Baylis, P. (2020). Temperature and temperament: Evidence from twitter. *Journal of Public Economics 184*(104161).

Bellemare, M., C. Barrett, and D. Just (2013). The Welfare Impacts of Commodity Price Volatility: Evidence from Rural Ethiopia. *American Journal of Agricultural Economics 95*(4), 877–899.

Bellemare, M., Y. Lee, and D. Just (2020). Producer attitudes toward output price risk: Experimental evidence from the lab and from the field. *American Journal of Agricultural Economics 102*(3), 806–825.

Benjamin, D., O. Heffetz, M. Kimball, and A. Rees-Jones (2012). What do you think would make you happier? what do you think you would choose? *American Economic Review 102*(5), 2083–2110.

Benjamin, D., M. Ori Heffetz, M. Kimball, and N. Szembrot (2013). Aggregating local preferences to guide marginal policy adjustments. *American Economic Review: Paper and Proceedings*.

Binswanger, H. (1980). Attitudes toward risk: Experimental measurement in rural india. *American Journal of Agricultural Economics 62*(3), 395–407.

Binswanger, H. and M. Rosenzweig (1993). Wealth, weather risk, and the composition and profitability of agricultural investments. *The Economic Journal 103*(416), 56–78.

Calomiris, C. and I. Rajaraman (1998). The role of roscas: Lumpy indivisibles or event insurance. *Journal of Development Economics 56*(1), 207–216.

Cameron, C., J. Gelbach, and D. Miller (2008). Bootstrap-based improvements for inference with clustered errors. *Review of Economics and Statistics 90*(3), 414–427.

Carroll, N., P. Frijters, and M. Shields (2009). Quantifying the costs of drought: new evidence from life satisfaction data. *Journal of Population Economics 22*, 445–461.

Carter, M. and T. Lybbert (2012). Consumption versus asset smoothing: testing the implications of poverty trap theory in burkina faso. *Journal of Development Economics 99*(2), 255–264.

Central Statistics Agency, The Federal Democratic Republic of Ethiopia (2009). Country and regional level consumer price indices. *Data*.

Chetty, R. and W. Looney (2006). Consumption smoothing and the welfare consequences of social insurance in developing economies. *Journal of Public Economics 90*(12), 2351–2356.

Colmer, J. (2021). Rainfall variability, child labor, and human capital accumulation in rural ethiopia. *American Journal of Agricultural Economics 103*(3), 858–877.

Conley, T. (1999). GMM estimation with cross sectional dependence. *Journal of Econometrics 92*(1), 1–45.

De Neve, J., G. Ward, F. De Keulenaer, B. Van Landeghem, G. Kavetsos, and N. M.I. (2018). The asymmetric experience of positive and negative economic growth: global evidence using subjective well-being data. *Review of Economics and Statistics 100*(2), 362–375.

Dee, D. P., S. M. Uppala, A. J. Simmons, P. Berrisford, P. Poli, S. Kobayashi, U. Andrae, M. A. Balmaseda, G. Balsamo, P. Bauer, P. Bechtold, A. C. Beljaars, L. M. van de Berg, J. Bidlot, N. Bormann, C. Delsol, R. Dragani, M. Fuentes, A. J. Geer, L. Haimberger, S. B. Healy, H. Hersbach, E. V. Holm, L. Isaksen, P. Kallberg, M. Kohler, M. Matricardi, A. P. McNally, B. Monge-Sanz, J. Morcrette, B. Park, C. Peubey, P. de Rosnay, C. Tavolato, J. Thepaut, and F. Vitart (2011). The era-interim reanalysis: configuration and performance of the data assimilation system. *Quarterly Journal of the Royal Meteorological Society 137*, 553–597.

Dell, M., B. Jones, and B. Olken (2014). What do we learn from the weather? the new climate-economy literature. *Journal of Economic Literature 52*(3), 740–798.

Dercon, S. (2004). Growth and shocks: Evidence from rural ethiopia. *Journal of Development Economics 74*(2), 309–329.

Dercon, S. and L. Christiaensen (2011). Consumption risk, technology adoption and poverty traps: Evidence from ethiopia. *Journal of Development Economics 96*(2), 159–173.

Dercon, S. and J. Hoddinott (2011). The ethiopian rural household survey 1989 - 2009: Introduction. *IFPRI*.

Dercon, S. and C. Porter (2014). Live aid revisited: Long-term impacts of the 1984 ethiopian famine on children. *Journal of the European Economic Association 12*(4), 927–948.

Diener, E. and R. Lucas (1999). Personality and subjective well-being. In D. Kahneman, E. Diener, and N. Schwarz (Eds.), *Well-Being: The Foundations of Hedonic Psychology: scientific perspectives on employment and suffering.*

Diener, E., R. Lucas, U. Schimmack, and J. Helliwell (2009). *Well-Being for Public Policy.* New York: Oxford University Press.

Dolan, P. and D. Kahneman (2008). Interpretations of utility and their implications for the valuation of health. *Economic Journal 118*(525), 215–234.

Dolan, P., R. Layard, and R. Metcalfe (2011). Measuring subjective well-being for public policy: recommendations on measures. *CEP Special Paper No. 23*.

Durevall, D., J. Loening, and Y. Ayalew Birru (2013). Inflation dynamics and food prices in ethiopia. *Journal of Development Economics 104*, 89–106.

Feddersen, J., R. Metcalfe, and M. Wooden (2015). Subjective wellbeing: why weather matters. *Journal of Royal Statistical Society 179*(1), 203–228.

Ferrer-i Carbonell, A. and P. Frijters (2004). How important is methodology for the estimates of the determinants of happiness? *Economic Journal 114*(497), 641–659.

Finkelstein, A., S. Taubman, B. Wright, M. Bernstein, J. Gruber, J. Newhouse, H. Allen, and K. Baicker (2012). The oregon health insurance experiment: Evidence from the first year. *The Quarterly Journal of Economics 127*(3), 1057–1106.

Fitzsimons, E. (2007). The Effects of Risk on Education in Indonesia. *Economic Development and Cultural Change 56*(1), 1–25.

Foster, A. and E. Gehrke (2020). Start What You Finish! Ex Ante Risk and Schooling Investments in the Presence of Dynamic Complementarities. *Mimeo*.

Frey, B., S. Luechinger, and A. Stutzer (2010). The life satisfaction approach to environmental valuation. *Annual Review of Resource Economics 2*(1), 139–160.

Frey, B. and A. Stutzer (2002). *Happiness and Economics.* Princeton University Press, Princeton, N.J., USA.

Genicot, G. and D. Ray (2017). Aspirations and inequality. *Econometrica 85*(2), 489–519.

Gruber, J. and S. Mullainathan (2005). Do cigarette taxes make smokers happier? *The B.E. Journal of Economic Analysis and Policy 5*(1), 1–45.

Haushofer, J., M. Chemin, C. Jang, and J. Abraham (2020). Economic and psychological effects of health insurance and cash transfers: Evidence from a randomized experiment in kenya. *Journal of Development Economics 144*(102416).

Haushofer, J. and E. Fehr (2014). On the psychology of poverty. *Science 344*(6186), 862–867.

Haushofer, J. and J. Shapiro (2016). The short-term impact of unconditional cash transfers to the poor: Experimental evidence from kenya. *Quarterly Journal of Economics 131*(4), 1973–2042.

Hsiang, S. (2010). Temperatures and cyclones strongly associated with economic production in the caribbean and central america. *Proceedings of the National Academy of Sciences 107*(35), 15,367–15,372.

Jalan, J. and M. Ravallion (2001). Behavioral Responses to Risk in Rural China. *Journal of Development Economics 66*(1), 23–49.

Jayachandran, S. (2006). Selling labor low: Wage responses to productivity shocks in developing countries. *Journal of Political Economy 114*(3), 538–575.

Jensen, R. (2000). Agricultural Volatility and Investments in Children. *American Economic Review: Paper and Proceedings 90*(2), 399–404.

Just, D. and T. Lybbert (2009). Risk averters that love risk? marginal risk aversion in comparison to a reference gamble. *American Journal of Agricultural Economics 91*(3), 612–626.

Kahneman, D. and A. Krueger (2006). Developments in the measurement of subjective well-being. *Journal of Economic Perspectives 20*(1), 3–24.

Kahneman, D., P. Wakker, and R. Sarin (1997). Back to bentham? exploration of experienced utility. *The Quarterly Journal of Economics 112*(2), 375–406.

Kala, N. (2017). Learning, Adaptation, and Climate Uncertainty: Evidence from Indian Agriculture. *Mimeo*.

Kazianga, H. (2012). Income Risk and Household Schooling Decisions in Burkina Faso. *World Development 40*(8), 1647–1662.

Klonner, S. (2001). How roscas perform as insurance. *Mimeo*.

Layard, R. (2005). *Happiness: lessons from a new science*. London: Allen Lane.

Lee, Y. (2021). Does aversion to price risk drive migration? evidence from rural ethiopia. *American Journal of Agricultural Economics*.

Levinson, A. (2012). Valuing public goods using happiness data: the case of air quality. *Journal of Public Economics 96*(9), 869–880.

Lorenz, C. and H. Kuntsmann (2012). The hydrological cycle in three state-of-the-art re-analyses: intercomparison and performance analysis. *Journal of Hyrdrometeorology 13*(5), 1397–1420.

Lybbert, T., C. Barrett, J. McPeak, and W. Luseno (2007). Bayesian herders: Updating of rainfall beliefs in response to external forecasts. *World Development 35*(3), 480–497.

Mani, A., S. Mullainathan, E. Shafir, and J. Zhao (2013). Poverty impedes cognitive function. *Science 341*(6149), 976–980.

Morduch, J. (1995). Income smoothing and consumption smoothing. *Journal of Economic Perspectives 9*(3), 103–114.

Mullainathan, S. and E. Shafir (2013). *Scarcity: Why having too little means so much.* Macmillan.

Newey, W. and K. West (1987). A simple, positive semi-definite, heteroskedasticity and autocorrelation consistent covariance matrix. *Econometrica 55*(3), 703–708.

Paxson, C. (1992). Using weather variability to estimate the response of savings to transitory income in thailand. *American Economic Review 82*(1), 15–33.

Porter, C. (2012). Shocks, consumption and income diversification in rural ethiopia. *Journal of Development Studies 48*(9), 1209–1222.

Rehdanz, K. and D. Maddison (2011). The impact of climate on life satisfaction. *Ecological Economics 70*(12), 2437–2445.

Shah, A., S. Mullainathan, and E. Shafir (2012). Some consequences of having too little. *Science 338*(6107), 682–685.

Suri, T. (2011). Estimating the extent of local risk sharing between households. *Mimeo*.

Tafere, K., C. Barrett, and E. Lentz (2019). Insuring well-being? buyer's remorse and peace of mind effects from insurance. *American Journal of Agricultural Economics 101*(3), 627–650.

Townsend, R. (1994). Risk and insurance in village india. *Econometrica 62*(3), 539–591.

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

Welsch, H. (2002). Preferences over prosperity and pollution: environmental valuation based on happiness surveys. *Kyklos 55*(4), 473–494.

Welsch, H. (2006). Environment and happiness: evaluation of air pollution using life satisfaction data. *Ecological Economics 58*(4), 801–813.

Yesuf, M. and R. Bluffstone (2009). Poverty, Risk Aversion, and Path Dependence in Low-Income Countries: Experimental Evidence from Ethiopia. *American Journal of Agricultural Economics 91*(4), 1022–1037.

Table 1: Descriptive Statistics

	Mean	Std. Dev. (within)	Std. Dev. (between)	Obs.
Real Consumption Per Capita (Birr)	75.733	69.544	28.682	2,686
Life Satisfaction (score/max)	0.572	0.135	0.223	4,033
Rainfall Variability (σ/μ)	18.590	7.200	10.908	30
Total Rainfall (mm)	1,452	243	471	30
Average Temperature (°C)	19.187	0.329	1.873	30

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

Table 2: Rainfall Variability and Consumption

	Log Real Consumption Per Capita				
	(1)	(2)	(3)	(4)	(5)
Rainfall Variability (σ/μ)	-0.0189***	-0.0139***	-0.0120**	-0.0183***	-0.0326***
	(0.00307)	(0.00457)	(0.00529)	(0.00588)	(0.00485)
	[0.034]	[0.019]	[0.078]	[0.066]	[0.006]
Fixed Effects	Household, Year, Month				
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)	75.733	75.733	75.733	75.733	75.733
Treatment Std. Dev.	5.930	3.449	3.419	3.087	2.808
Observations	2,686	2,686	2,686	2,686	2,686

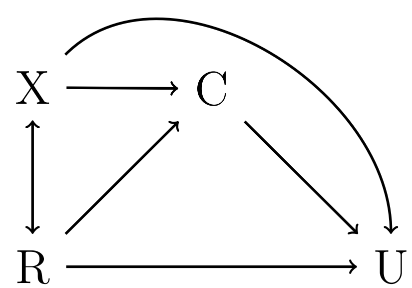
Notes: Significance levels are indicated as * 0.10 ** 0.05 *** 0.01. The unit of analysis is at the household level. Our proxy for uncertainty is the coefficient of variation for rainfall, measured over the previous 5 years, the time period between each survey round. Historical measures of atmospheric 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 3: RAINFALL VARIABILITY AND LIFE SATISFACTION

	Life Satisfaction (Standardized)				
	(1)	(2)	(3)	(4)	(5)
Panel A:					
Rainfall Variability (σ/μ)	-0.0192***	-0.0145**	-0.0132*	-0.0213**	-0.0323***
(Total Effect)	(0.00455)	(0.00672)	(0.00687)	(0.00786)	(0.00569)
	[0.116]	[0.108]	[0.129]	[0.048]	[0.001]
Panel B:					
Rainfall Variability (σ/μ)	-0.0152***	-0.0116	-0.0108	-0.0180**	-0.0278***
(Direct Effect)	(0.00424)	(0.00663)	(0.00666)	(0.00718)	(0.00557)
	[0.163]	[0.163]	[0.202]	[0.057]	[0.002]
Direct Effect Share (%)	79	80	81	84	86
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	2.393
Observations	4,033	4,033	4,033	4,033	4,033

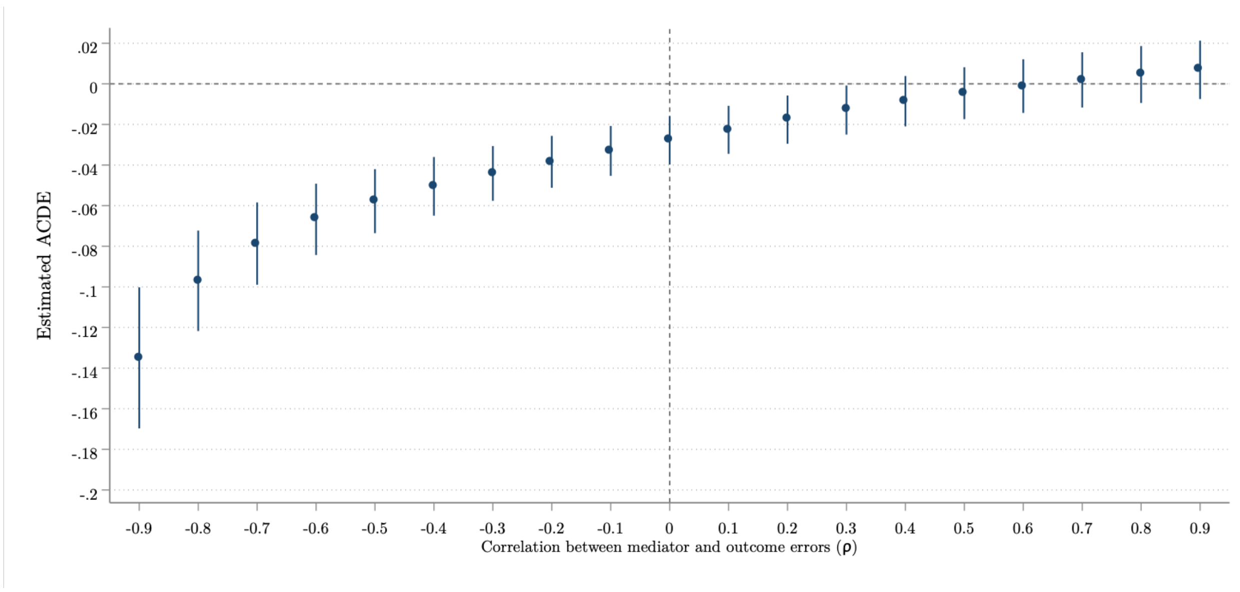
Notes: Significance levels are indicated as * 0.10 ** 0.05 *** 0.01. The unit of analysis is the individual. Rainfall variability is defined as the coefficient of variation for rainfall, measured over the previous 5 years, the time period between each survey round. Historical measures of atmospheric parameters correspond to this period. Historical rainfall is measured in hundreds of mm. Historical temperature is measured in °C. 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: Directed Acyclic Graphs Documenting Direct, Total and Indirect Effects



Notes: Figure 1 provides a graphical representation of the data generating process for a world in which rainfall variability (R) has an indirect effect on utility (U) through consumption (C), and also a direct effect. We assume that the direct effect and the consumption effect are identified after controlling for historical weather shocks, individual-level time-invariant unobserved heterogeneity, and aggregate time-varying shocks (encapsulated in X).

Figure 2: 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. The average CDE 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.

AJAE Appendix for "Blame it on the Rain: Rainfall Variability, Consumption Smoothing, and Subjective Well-Being in Rural Ethiopia

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July 2021

Note: The material contained herein is supplementary to the article named in the title and published in the *American Journal of Agricultural Economics*

Contents

A Additional Results and Robustness Tests

A.1 Descriptive Statistics by ERHS Round

Table A1: Descriptive Statistics

	2004		2009	
	Mean	Std. Dev.	Mean	Std. Dev.
Panel A: *Consumption*				
Real Consumption Per Capita (Birr)	91.917	93.196	59.305	44.498
Panel B: *Subjective Well-Being*				
Life Satisfaction (score/max)	0.554	0.243	0.590	0.258
Happy (score/max)	0.590	0.215	0.650	0.209
Panel C: *Weather Data* (Village level):				
Rainfall Variability (σ/μ)	19.778	8.597	17.403	16.385
Total Rainfall (mm)	1,673	513	1,231	445
Average Temperature (°C)	18.935	1.960	19.440	1.806
Panel D: *Agricultural Production* (Crop level):				
Yield (kg/Ha)	935.645	1,200.320	1,253.234	6,655.844
Share Sold	0.288	0.386	0.181	0.305
Price (Birr/kg)	3.551	9.263	11.204	46.248
Panel E: *Crop Choice* (Household level):				
Crops Planted	2.212	1.126	2.573	1.389
Main Crop Share	0.461	0.250	0.455	0.248
Panel F: *Farm Inputs* (Household-level):				
Average Day Wage (Birr)	17.576	22.213	59.371	84.392
Hired Worker Days	51.239	276.094	62.874	383.970
Hired Any Workers (0/1)	0.318	0.466	0.406	0.491
Panel G: *Livestock* (Livestock-type level):				
Number Owned	0.805	2.128	0.921	2.416
Number Sold	0.124	0.687	0.164	0.809
Number Slaughtered	0.057	0.421	0.103	0.560
Panel H: *Other Income Activities* (Individual-level):				
Off-Farm Work (0/1)	0.089	0.285	0.160	0.367
Out of Village Work (0/1)	0.129	0.335	0.131	0.338
Days Worked (Previous 4 months)	12.687	23.213	29.610	37.080

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

A.2 Supporting Evidence

This section reports replicated results from Colmer (2021a), providing support for the premise that rainfall variability is a reasonable proxy for income uncertainty in this context.

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.[1] Exploring the association between rainfall variability and yields, however, 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, 2021b). 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 association between rainfall variability on yields, we explore the relationship between rainfall variability and 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 association between rainfall variability and prices, which are available for households that sell their produce.

Using this data, we estimate the crop-specific relationship between rainfall variability and yields, share sold, and price,

$$\begin{aligned} \log(\mathrm{Y}_{chvt}) &= \beta_4 \textsc{Rainfall Variability}_{vt,\ldots,t-4} + \gamma f(\bar{w}_{vt,\ldots,t-4}) \\ &+ \alpha_{ch} + \alpha_m + \alpha_t + \epsilon_{chvt} \end{aligned} \quad (1)$$

$\textsc{Rainfall Variability}_{vt,\ldots,t-4}$ is our proxy for income uncertainty – the coefficient of variation for rainfall measured over the previous 5 years – and $f(\bar{w}_{vt,\ldots,t-4})$ is a function of historical weather variables measured over the previous 5 years. The weather variables included vary across specifications. In the most parsimonious specification we do not include any weather controls. In the least parsimonious specification we include linear and quadratic controls for rainfall and temperature over the previous 5 years and interactions between rainfall and temperature. α_{ch} captures crop–household fixed effects, α_t captures year fixed effects, and α_m captures month-of-survey fixed effects.[2]

In Table A2 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. 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 the contribution of non-linearities through a quadratic term. The R^2 is largest for this specification. Columns 4 and 5 define rainfall shocks following Jayachandran (2006). Low rainfall shocks are defined if rainfall is within the bottom 20^{th} percentile of the historical rainfall distribution for each village. High rainfall shocks are defined to occur if rainfall is above the 80^{th} percentile of the historical rainfall distribution. Column 4 defines one variable equal to -1 if a low rainfall shock occurs, 1 if a positive rainfall shock occurs, and 0 otherwise. The results, consistent with the other columns are that more rainfall is better. Column 5 defines low rainfall and high rainfall shocks as separate variables. Finally column 6, constructs bins for each quintile of the rainfall distribution. Again, more rainfall appears to be better, although coefficients are less precisely estimated.

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. We also 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 rural 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,

$$\begin{aligned} \log(\mathrm{Y}_{hvt}) &= \beta_5 \textsc{Rainfall Variability}_{vt,\ldots,t-4} + \gamma f(\bar{w}_{vt,\ldots,t-4}) \\ &+ \alpha_h + \alpha_m + \alpha_t + \epsilon_{hvt} \end{aligned} \tag{2}$$

except for livestock outcomes, which are evaluated at the livestock–household level.[3].

$$\begin{aligned} \mathrm{Y}_{lhvt} &= \beta_6 \textsc{Rainfall Variability}_{vt,\ldots,t-4} + \gamma f(\bar{w}_{vt,\ldots,t-4}) \\ &+ \alpha_{lh} + \alpha_m + \alpha_t + \epsilon_{lhvt} \end{aligned} \tag{3}$$

Table A2: Disentangling Realized Income Events from Income Uncertainty: The Agricultural Production Function

	(1) log Yields	(2) log Yields	(3) log Yields	(4) log Yields	(5) log Yields	(6) log Yields
log Rainfall	2.157***					
	(0.638)					
	[0.0210]					
Rainfall (100 mm)		0.182***	0.254**			
		(0.0549)	(0.0856)			
		[0.128]	[0.126]			
Rainfall^2			-0.00327			
			(0.00209)			
			[0.304]			
Rainfall Shock (-1/0/1)				0.307*		
				(0.162)		
				[0.220]		
Low Rainfall					-0.234	
					(0.231)	
					[0.355]	
High Rainfall					0.382*	
					(0.199)	
					[0.180]	
Quintile 1						-0.301
						(0.192)
						[0.360]
Quintile 2						0.115
						(0.150)
						[0.641]
Quintile 3						–
Quintile 4						0.330
						(0.200)
						[0.299
Quintile 5						0.670*
						(0.321)
						[0.216]
exp(Dep. Var. Mean)	1,109.769	1,109.769	1,109.769	1,109.769	1,109.769	1,109.769
Observations	3,812	3,812	3,812	3,812	3,812	3,812
Adjusted R^2	0.087	0.080	0.102	0.033	0.035	0.044
Fixed Effects	Crop × Household, Month, and Year					
Temperature Controls	Yes	Yes	Yes	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).

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. There is no other reason to restrict rainfall variability to the 5 year period and if applied to other contexts the choice of a five-year time period would certainly be considered ad hoc.

We present results for all timing definitions between 2 and 10 years. As discussed above there are reasons that shorter or longer-time periods are less preferable; yet, 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 × household level data we explore the effects of rainfall variability on agricultural yields, the share of each crop that is sold 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 five-year time period, providing support for the decision rule.

In Table A3 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 A18).

Table A4 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 A19)

Table A5 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 two-year time period. 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 subsample. 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 A20)

Tables A6 and A7 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 A21 and A22).

Hired Labor and Wages Tables A8 and A9, 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 nine-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 but 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 A23 and A24).

Table A10 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 nine-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. 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 A25).

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. As discussed above there is less variation in rainfall variability measured over these time periods and so measuring rainfall variability over the five-year period remains the preferred specification.

Livestock Tables A11, A13 and A12 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 A26, A28 and A27).

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 A14 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 seven-year period. 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 A29).

Similar results are found in Table A15, 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 A30).

Table A16 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 A31).

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 whether rainfall variability 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.

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,

$$\begin{aligned} \text{Rainfall}_{vt} &= \beta_3 \text{Rainfall Variability}_{vt,\dots,t-4} + \gamma f(\bar{w}_{vt,\dots,t-4}) \\ &+ \alpha_v + \alpha_t + \epsilon_{vt} \end{aligned} \tag{4}$$

Table A17 presents the results of this analysis. Measured over the five-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 three-years into the future (significant at the 10% level). 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 A2 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. As the time-period increases from seven 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. The magnitude of the effects are still not very large. The largest contemporaneous effect is measured over a nine-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. 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 two-years. A one standard deviation increase in contemporaneous rainfall variability is associated with a 46mm reduction in rainfall. 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 two-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. 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 (five-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 here 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 effects as well as interactions between these terms, does not appear to have a direct effect on rainfall realizations. 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 A3: 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 (σ/μ) (2 years)	-0.0143**	-0.0240*	-0.0335***	-0.00982	-0.00608	1.227
	(0.00645)	(0.0117)	(0.0111)	(0.0159)	(0.0167)	
	[0.354]	[0.233]	[0.177]	[0.663]	[0.865]	
Rainfall Variability (σ/μ) (3 years)	-0.0206*	-0.0122	-0.0172	0.00244	0.0118*	1.678
	(0.0102)	(0.0121)	(0.0106)	(0.00670)	(0.00572)	
	[0.144]	[0.399]	[0.239]	[0.757]	[0.110]	
Rainfall Variability (σ/μ) (4 years)	-0.0319**	-0.00946	-0.00954	-0.00372	0.00604	1.471
	(0.0124)	(0.0122)	(0.0140)	(0.0140)	(0.0112)	
	[0.049]	[0.514]	[0.633]	[0.852]	[0.670]	
Rainfall Variability (σ/μ) (5 years)	-0.0189	-0.00837	-0.00727	-0.00841	-0.00230	1.692
	(0.0123)	(0.0113)	(0.0112)	(0.0143)	(0.00773)	
	[0.253]	[0.649]	[0.696]	[0.930]	[0.764]	
Rainfall Variability (σ/μ) (6 years)	-0.0275*	-0.0124	-0.00911	-0.00891	-0.00590	1.266
	(0.0147)	(0.0139)	(0.0134)	(0.0208)	(0.0113)	
	[0.306]	[0.492]	[0.581]	[0.847]	[0.700]	
Rainfall Variability (σ/μ) (7 years)	-0.0252	-0.0136	-0.0277	-0.00604	-0.0278**	1.380
	(0.0159)	(0.0131)	(0.0159)	(0.0130)	(0.0107)	
	[0.309	[0.379]	[0.183]	[0.779]	[0.140]	
Rainfall Variability (σ/μ) (8 years)	-0.0178	-0.0280	-0.0302*	-0.0116	-0.0347	1.141
	(0.0233)	(0.0162)	(0.0163)	(0.0176)	(0.0202)	
	[0.590]	[0.191]	[0.152]	[0.662]	[0.566]	
Rainfall Variability (σ/μ) (9 years)	-0.0157	-0.0281	-0.0289	-0.0173	-0.0283	1.549
	(0.0199)	(0.0186)	(0.0188)	(0.0252)	(0.0238)	
	[0.627]	[0.314]	[0.313]	[0.887]	[0.732]	
Rainfall Variability (σ/μ) (10 years)	-0.0216	-0.0156	-0.0139	0.0160	0.0115	1.093
	(0.0171)	(0.0204)	(0.0216)	(0.0223)	(0.0172)	
	[0.258]	[0.523]	[0.567]	[0.613]	[0.670]	
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	

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 (Share Sold)

	(1) Share Sold	(2) Share Sold	(3) Share Sold	(4) Share Sold	(5) Share Sold	(6) Share Sold Std. Dev
Rainfall Variability (σ/μ) (2 years)	-0.00103	-0.00416*	-0.00466	-0.00130	-0.00307	1.227
	(0.000966)	(0.00229)	(0.00271)	(0.00301)	(0.00309)	
	[0.537]	[0.065]	[0.096]	[0.798]	[0.718]	
Rainfall Variability (σ/μ) (3 years)	-0.00171	-0.00184	-0.00217	0.00198	0.00260	1.678
	(0.00132)	(0.00235)	(0.00251)	(0.00176)	(0.00205)	
	[0.277]	[0.500]	[0.476]	[0.413]	[0.350]	
Rainfall Variability (σ/μ) (4 years)	-0.00462**	-0.00327	-0.00325	-0.00178	-0.000936	1.471
	(0.00184)	(0.00276)	(0.00304)	(0.00278)	(0.00190)	
	[0.038]	[0.394]	[0.443]	[0.683]	[0.712]	
Rainfall Variability (σ/μ) (5 years)	-0.00175	-0.00284*	-0.00262	-0.00289*	-0.00194	1.692
	(0.00170)	(0.00151)	(0.00149)	(0.00162)	(0.00137)	
	[0.354]	[0.171]	[0.183]	[0.269]	[0.291]	
Rainfall Variability (σ/μ) (6 years)	-0.00268	-0.00239	-0.00178	-0.00451	-0.00468	1.266
	(0.00166)	(0.00229)	(0.00259)	(0.00457)	(0.00365)	
	[0.267]	[0.418]	[0.580]	[0.488]	[0.391]	
Rainfall Variability (σ/μ) (7 years)	-0.00153	-0.00159	-0.00476*	-0.000736	-0.00660**	1.380
	(0.00228)	(0.00251)	(0.00253)	(0.00289)	(0.00258)	
	[0.599]	[0.579]	[0.122]	[0.835]	[0.132]	
Rainfall Variability (σ/μ) (8 years)	0.000237	-0.00276	-0.00318	-0.00136	-0.00668*	1.141
	(0.00338)	(0.00291)	(0.00286)	(0.00369)	(0.00363)	
	[0.959]	[0.444]	[0.387]	[0.775]	[0.328]	
Rainfall Variability (σ/μ) (9 years)	0.000241	-0.00196	-0.00207	0.000614	-0.000893	1.549
	(0.00265)	(0.00304)	(0.00299)	(0.00410)	(0.00417)	
	[0.943]	[0.602]	[0.583]	[0.924]	[0.903]	
Rainfall Variability (σ/μ) (10 years)	-0.000823	0.000569	0.000256	0.00628	0.00482	1.093
	(0.00302)	(0.00358)	(0.00378)	(0.00425)	(0.00421)	
	[0.780]	[0.920]	[0.965]	[0.418]	[0.452]	
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	

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 A5: 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 (σ/μ) (2 years)	-0.0493***	-0.0475**	-0.0472***	-0.0398***	-0.0335***	0.846
	(0.0135)	(0.0166)	(0.00862)	(0.0110)	(0.00647)	
	[0.081]	[0.246]	[0.145]	[0.134]	[0.028]	
Rainfall Variability (σ/μ) (3 years)	-0.0496***	-0.0450***	-0.0411***	-0.0509***	-0.0153	0.715
	(0.0104)	(0.0116)	(0.00728)	(0.0122)	(0.0140)	
	[0.096]	[0.218]	[0.061]	[0.133]	[0.479]	
Rainfall Variability (σ/μ) (4 years)	-0.0269	0.00181	-0.00208	0.0254	-0.00284	0.728
	(0.0154)	(0.0105)	(0.0126)	(0.0204)	(0.0193)	
	[0.340]	[0.878]	[0.947]	[0.453]	[0.900]	
Rainfall Variability (σ/μ) (5 years)	0.0154	-0.00207	0.00357	0.00302	-0.0119	0.804
	(0.0128)	(0.00838)	(0.0117)	(0.00624)	(0.0158)	
	[0.370]	[0.837]	[0.867]	[0.594]	[0.528]	
Rainfall Variability (σ/μ) (6 years)	-0.00423	0.0127	0.0300	0.00494	-0.0156	0.689
	(0.0217)	(0.0284)	(0.0227)	(0.0273)	(0.0177)	
	[0.903]	[0.780]	[0.431]	[0.893]	[0.500]	
Rainfall Variability (σ/μ) (7 years)	-0.0646***	-0.0420**	0.0222	-0.0855***	-0.0383	0.467
	(0.0197)	(0.0165)	(0.0429)	(0.0120)	(0.0252)	
	[0.032]	[0.101]	[0.720]	[0.024]	[0.340]	
Rainfall Variability (σ/μ) (8 years)	0.00459	-0.0221	0.0357	0.0125	-0.0218	0.489
	(0.0387)	(0.0299)	(0.0324)	(0.0442)	(0.0256)	
	[0.961]	[0.599]	[0.479]	[0.830]	[0.467]	
Rainfall Variability (σ/μ) (9 years)	0.0215	-0.00549	0.0170	0.0479**	0.0207	0.638
	(0.0331)	(0.0219)	(0.0169)	(0.0200)	(0.0179)	
	[0.763]	[0.853]	[0.527]	[0.152]	[0.376]	
Rainfall Variability (σ/μ) (10 years)	-0.0207	-0.00461	0.0219*	0.00631	0.00268	0.693
	(0.0365)	(0.0187)	(0.0120)	(0.0132)	(0.0138)	
	[0.794]	[0.853]	[0.280]	[0.702]	[0.844]	
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	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 °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 (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 (σ/μ) (2 years)	-0.0000777	0.00348	-0.000171	-0.00804	-0.00352	1.594
	(0.00320)	(0.00931)	(0.0108)	(0.0104)	(0.00894)	
	[0.977]	[0.724]	[0.988]	[0.587]	[0.810]	
Rainfall Variability (σ/μ) (3 years)	0.000781	-0.000783	-0.00544	-0.0106	-0.0103	2.043
	(0.00521)	(0.0107)	(0.00808)	(0.00638)	(0.00635)	
	[0.885]	[0.945]	[0.586]	[0.149]	[0.206]	
Rainfall Variability (σ/μ) (4 years)	-0.00519	0.000378	-0.0143	-0.0164*	-0.0139**	1.871
	(0.00625)	(0.0113)	(0.00974)	(0.00929)	(0.00626)	
	[0.436]	[0.985]	[0.240]	[0.202]	[0.030]	
Rainfall Variability (σ/μ) (5 years)	-0.00580	0.00216	0.00134	-0.00782**	-0.00917	2.154
	(0.00421)	(0.00566)	(0.00546)	(0.00348)	(0.00544)	
	[0.226]	[0.747]	[0.830]	[0.055]	[0.113]	
Rainfall Variability (σ/μ) (6 years)	-0.000294	0.0141	0.0121	-0.0102	-0.0142	1.621
	(0.00563)	(0.00905)	(0.0104)	(0.0117)	(0.0133)	
	[0.953]	[0.195]	[0.350]	[0.532]	[0.587]	
Rainfall Variability (σ/μ) (7 years)	-0.00989	-0.00509	0.00372	-0.00350	-0.00323	1.860
	(0.00663)	(0.0114)	(0.00855)	(0.0111)	(0.00942)	
	[0.182]	[0.730]	[0.701]	[0.856]	[0.807]	
Rainfall Variability (σ/μ) (8 years)	-0.0121	-0.0112	-0.00971	-0.00551	0.00445	1.484
	(0.00745)	(0.00897)	(0.00658)	(0.0112)	(0.0118)	
	[0.121]	[0.291]	[0.221]	[0.744]	[0.762]	
Rainfall Variability (σ/μ) (9 years)	-0.00930	-0.0110*	-0.00978*	0.00925	0.00856	1.820
	(0.00671)	(0.00611)	(0.00537)	(0.0145)	(0.0160)	
	[0.196]	[0.112]	[0.149]	[0.647]	[0.783]	
Rainfall Variability (σ/μ) (10 years)	-0.0142	-0.0147	-0.00914	0.0136	0.0146	1.266
	(0.00940)	(0.0101)	(0.0111)	(0.0101)	(0.00897)	
	[0.211]	[0.249]	[0.560]	[0.412]	[0.330]	
Fixed Effects	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	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 (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 (σ/μ) (2 years)	-0.000564	-0.00114	-0.000112	0.000771	-0.00391**	1.594
	(0.000724)	(0.000995)	(0.00177)	(0.00215)	(0.00156)	
	[0.635]	[0.316]	[0.960]	[0.784]	[0.085]	
Rainfall Variability (σ/μ) (3 years)	-0.00137	-0.000805	-0.000318	0.00132	-0.000334	2.043
	(0.000820)	(0.00135)	(0.00151)	(0.00203)	(0.00146)	
	[0.386]	[0.595]	[0.857]	[0.602]	[0.861]	
Rainfall Variability (σ/μ) (4 years)	-0.000681	-0.0000546	0.00188	0.00323	0.00234	1.871
	(0.00127)	(0.00187)	(0.00254)	(0.00227)	(0.00243)	
	[0.797]	[0.973]	[0.559]	[0.251]	[0.434]	
Rainfall Variability (σ/μ) (5 years)	-0.000164	-0.00146	-0.00136	0.000181	0.00181	2.154
	(0.00129)	(0.00163)	(0.00158)	(0.00129)	(0.00208)	
	[0.938]	[0.494]	[0.511]	[0.929]	[0.491]	
Rainfall Variability (σ/μ) (6 years)	-0.00183	-0.00447**	-0.00457*	-0.00286	-0.00182	1.621
	(0.00145)	(0.00206)	(0.00226)	(0.00350)	(0.00341)	
	[0.459]	[0.070]	[0.076]	[0.501]	[0.661]	
Rainfall Variability (σ/μ) (7 years)	-0.000726	-0.00291	-0.00464	-0.00311	-0.00363	1.860
	(0.00151)	(0.00237)	(0.00274)	(0.00247)	(0.00379)	
	[0.754]	[0.324]	[0.243]	[0.282]	[0.448]	
Rainfall Variability (σ/μ) (8 years)	0.000176	-0.00222	-0.00234	-0.00341	-0.00294	1.484
	(0.00204)	(0.00217)	(0.00202)	(0.00331)	(0.00449)	
	[0.941]	[0.464]	[0.446]	[0.431]	[0.799]	
Rainfall Variability (σ/μ) (9 years)	0.000580	-0.000383	-0.000276	-0.00233	-0.000806	1.820
	(0.00181)	(0.00181)	(0.00186)	(0.00325)	(0.00287)	
	[0.804]	[0.841]	[0.886]	[0.536]	[0.762]	
Rainfall Variability (σ/μ) (10 years)	0.000352	0.000631	0.00111	-0.001000	0.00299	1.266
	(0.00252)	(0.00292)	(0.00298)	(0.00218)	(0.00268)	
	[0.926]	[0.904]	[0.805]	[0.759]	[0.290]	
Fixed Effects	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	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 A8: 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 (σ/μ) (2 years)	0.00182	0.00194	-0.0119	0.0477*	0.0497	0.839
	(0.0343)	(0.0328)	(0.0228)	(0.0246)	(0.0539)	
	[0.973]	[0.964]	[0.644]	[0.147]	[0.496]	
Rainfall Variability (σ/μ) (3 years)	-0.0104	-0.0128	-0.0196	-0.0139	0.00430	0.865
	(0.0298)	(0.0322)	(0.0235)	(0.0239)	(0.0500)	
	[0.721]	[0.739]	[0.547]	[0.598]	[0.902]	
Rainfall Variability (σ/μ) (4 years)	0.0195	0.0282	0.0396	0.0252	0.0766*	0.848
	(0.0367)	(0.0318)	(0.0359)	(0.0285)	(0.0418)	
	[0.628]	[0.602]	[0.472	[0.581]	[0.249]	
Rainfall Variability (σ/μ) (5 years)	0.0109	0.0115	0.0234	0.0125	0.0270	1.398
	(0.0290)	(0.0247)	(0.0294)	(0.0239)	(0.0287)	
	[0.766]	[0.770]	[0.593]	[0.738]	[0.524]	
Rainfall Variability (σ/μ) (6 years)	0.00162	-0.0234	0.00409	-0.00994	-0.00417	0.917
	(0.0352)	(0.0417)	(0.0452)	(0.0389)	(0.0394)	
	[0.963]	[0.600]	[0.956]	[0.768]	[0.922]	
Rainfall Variability (σ/μ) (7 years)	-0.0667**	-0.0657**	-0.0247	-0.00924	0.01000	0.751
	(0.0303)	(0.0304)	(0.0556)	(0.0453)	(0.0473)	
	[0.367]	[0.347]	[0.693]	[0.800]	[0.857]	
Rainfall Variability (σ/μ) (8 years)	-0.0452	-0.0766*	-0.0235	-0.0273	-0.0161	0.763
	(0.0436)	(0.0366)	(0.0424)	(0.0327)	(0.0415)	
	[0.462]	[0.402]	[0.715]	[0.517]	[0.650]	
Rainfall Variability (σ/μ) (9 years)	-0.0429	-0.0591**	-0.0348**	-0.0572**	-0.0933***	0.803
	(0.0349)	(0.0221)	(0.0127)	(0.0238)	(0.0283)	
	[0.434]	[0.122]	[0.136]	[0.068]	[0.090]	
Rainfall Variability (σ/μ) (10 years)	-0.0640**	-0.0604**	-0.0280*	-0.0170	-0.0847*	0.757
	(0.0220)	(0.0255)	(0.0149)	(0.0183)	(0.0433)	
	[0.312]	[0.188]	[0.135]	[0.470]	[0.164]	
Fixed Effects	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	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 A9: 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 (σ/μ) (2 years)	-0.0365	-0.0220	-0.0152	-0.0699**	-0.101**	0.886
	(0.0385)	(0.0265)	(0.0290)	(0.0308)	(0.0442)	
	[0.388]	[0.500]	[0.704	[0.119]	[0.238]	
Rainfall Variability (σ/μ) (3 years)	-0.0344	-0.00747	-0.00345	-0.0126	-0.0394	0.906
	(0.0355)	(0.0299)	(0.0293)	(0.0307)	(0.0467)	
	[0.506]	[0.818]	[0.941]	[0.749]	[0.519]	
Rainfall Variability (σ/μ) (4 years)	-0.0512	-0.0336	-0.0554	-0.0362	-0.0740*	0.885
	(0.0311)	(0.0281)	(0.0326)	(0.0272)	(0.0403)	
	[0.223]	[0.390]	[0.269]	[0.355]	[0.255]	
Rainfall Variability (σ/μ) (5 years)	0.0121	-0.00830	-0.0175	-0.00839	-0.0314	1.445
	(0.0306)	(0.0286)	(0.0279)	(0.0276)	(0.0268)	
	[0.655]	[0.807]	[0.664]	[0.845]	[0.385]	
Rainfall Variability (σ/μ) (6 years)	-0.0230	0.00461	-0.0201	0.00356	0.00833	0.930
	(0.0625)	(0.0551)	(0.0564)	(0.0437)	(0.0426)	
	[0.788]	[0.948]	[0.711]	[0.946]	[0.885]	
Rainfall Variability (σ/μ) (7 years)	0.0463	0.0521	0.0174	-0.0241	-0.0150	0.772
	(0.0567)	(0.0501)	(0.0787)	(0.0479)	(0.0443)	
	[0.598]	[0.519]	[0.860]	[0.662]	[0.735]	
Rainfall Variability (σ/μ) (8 years)	0.0784**	0.0597	0.0246	0.0267	0.0198	0.782
	(0.0357)	(0.0561)	(0.0678)	(0.0484)	(0.0459)	
	[0.220]	[0.527]	[0.914]	[0.724]	[0.704	
Rainfall Variability (σ/μ) (9 years)	0.0656**	0.0533**	0.0423*	0.0984***	0.122***	0.822
	(0.0274)	(0.0217)	(0.0239)	(0.0308)	(0.0321)	
	[0.155]	[0.270]	[0.449]	[0.108]	[0.071]	
Rainfall Variability (σ/μ) (10 years)	0.0593*	0.0676**	0.0465	0.0341	0.111**	0.772
	(0.0308)	(0.0281)	(0.0301)	(0.0326)	(0.0480)	
	[0.541]	[0.405]	[0.430]	[0.612]	[0.172]	
Fixed Effects	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	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 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 (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 (σ/μ) (2 years)	-0.00130	0.00304	0.00679**	0.00425	0.00541*	1.594
	(0.000805)	(0.00319)	(0.00294)	(0.00296)	(0.00269)	
	[0.238]	[0.478]	[0.172]	[0.260]	[0.126]	
Rainfall Variability (σ/μ) (3 years)	-0.00127	0.00455	0.00702**	0.00518*	0.00514*	2.051
	(0.00177)	(0.00421)	(0.00292)	(0.00243)	(0.00250)	
	[0.585]	[0.393]	[0.109]	[0.144]	[0.213]	
Rainfall Variability (σ/μ) (4 years)	0.000445	0.00209	0.00886**	0.00573**	0.00554*	1.876
	(0.00269)	(0.00424)	(0.00377)	(0.00218)	(0.00311)	
	[0.885]	[0.724]	[0.052]	[0.007]	[0.103]	
Rainfall Variability (σ/μ) (5 years)	0.000404	0.000744	0.000958	0.00466**	0.00416	2.159
	(0.00239)	(0.00320)	(0.00325)	(0.00160)	(0.00308)	
	[0.882]	[0.828]	[0.789]	[0.019]	[0.222]	
Rainfall Variability (σ/μ) (6 years)	-0.00212	-0.00469	-0.00413	0.00580	0.00486	1.617
	(0.00155)	(0.00304)	(0.00362)	(0.00410)	(0.00423)	
	[0.331]	[0.287]	[0.490]	[0.285]	[0.415]	
Rainfall Variability (σ/μ) (7 years)	0.000290	0.00172	0.000609	-0.000138	0.00296	1.861
	(0.00344)	(0.00532)	(0.00466)	(0.00327)	(0.00274)	
	[0.953]	[0.786]	[0.910]	[0.975]	[0.320]	
Rainfall Variability (σ/μ) (8 years)	-0.000108	0.00127	0.000822	-0.00261	0.00593	1.488
	(0.00392)	(0.00547)	(0.00469)	(0.00490)	(0.00347)	
	[0.976]	[0.835]	[0.890]	[0.736]	[0.132]	
Rainfall Variability (σ/μ) (9 years)	-0.000787	0.000235	-0.000168	-0.000567	0.00527**	1.826
	(0.00388)	(0.00449)	(0.00417)	(0.00332)	(0.00198)	
	[0.855]	[0.965]	[0.978]	[0.881]	[0.131]	
Rainfall Variability (σ/μ) (10 years)	0.00118	0.000785	-0.00113	-0.00378	0.00270	1.269
	(0.00651)	(0.00598)	(0.00598)	(0.00283)	(0.00405)	
	[0.891]	[0.930]	[0.888]	[0.179]	[0.632]	
Fixed Effects	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	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 A11: 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 (σ/μ) (2 years)	0.000300	0.00264	0.000468	0.00173	-0.00115	1.875
	(0.00144)	(0.00575)	(0.00370)	(0.00529)	(0.00578)	
	[0.873]	[0.781]	[0.923]	[0.817]	[0.920]	
Rainfall Variability (σ/μ) (3 years)	0.000975	0.00571	0.00499**	0.00623**	0.00653**	2.569
	(0.00201)	(0.00464)	(0.00222)	(0.00265)	(0.00269)	
	[0.661]	[0.404]	[0.133]	[0.071]	[0.186]	
Rainfall Variability (σ/μ) (4 years)	0.000900	0.00903*	0.00685*	0.00777**	0.00667*	2.459
	(0.00233)	(0.00433)	(0.00342)	(0.00343)	(0.00347)	
	[0.730]	[0.208]	[0.222]	[0.159]	[0.291]	
Rainfall Variability (σ/μ) (5 years)	0.000932	0.00387*	0.00348*	0.00192	0.00467*	2.755
	(0.00212)	(0.00199)	(0.00195)	(0.00253)	(0.00258)	
	[0.710]	[0.201]	[0.200]	[0.534]	[0.225]	
Rainfall Variability (σ/μ) (6 years)	0.000462	0.00397	0.00304	0.000814	0.00181	2.220
	(0.00263)	(0.00290)	(0.00231)	(0.00453)	(0.00341)	
	[0.894]	[0.316]	[0.368]	[0.894]	[0.702]	
Rainfall Variability (σ/μ) (7 years)	-0.00171	-0.00224	-0.00139	-0.00351	-0.00351	2.597
	(0.00296)	(0.00365)	(0.00327)	(0.00374)	(0.00357)	
	[0.730]	[0.619]	[0.772]	[0.477]	[0.513]	
Rainfall Variability (σ/μ) (8 years)	-0.000918	-0.000806	-0.00255	-0.00100	-0.00560	1.796
	(0.00354)	(0.00368)	(0.00336)	(0.00374)	(0.00580)	
	[0.890]	[0.857]	[0.578]	[0.842]	[0.567]	
Rainfall Variability (σ/μ) (9 years)	-0.00171	-0.00209	-0.00224	-0.00407	-0.00588	2.400
	(0.00375)	(0.00359)	(0.00352)	(0.00541)	(0.00614)	
	[0.790]	[0.750]	[0.831]	[0.850]	[0.825]	
Rainfall Variability (σ/μ) (10 years)	-0.00294	-0.00225	-0.000525	-0.00897	-0.00696	1.653
	(0.00472)	(0.00492)	(0.00536)	(0.00871)	(0.00610)	
	[0.569]	[0.680]	[0.936]	[0.488]	[0.435]	
Fixed Effects	Livestock × 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	

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 Slaughtered)

	(1) Number of Livestock Slaughtered	(2) Number of Livestock Slaughtered	(3) Number of Livestock Slaughtered	(4) Number of Livestock Slaughtered	(5) Number of Livestock Slaughtered	(6) Within Group Std. Dev
Rainfall Variability (σ/μ) (2 years)	-0.000118	-0.000596	-0.00102	-0.000462	-0.000578	1.875
	(0.000419)	(0.00123)	(0.000853)	(0.00139)	(0.00119)	
	[0.826]	[0.686]	[0.386]	[0.826]	[0.888]	
Rainfall Variability (σ/μ) (3 years)	-0.000287	0.000191	0.0000366	0.000262	0.00116*	2.569
	(0.000634)	(0.000890)	(0.000681)	(0.000801)	(0.000594)	
	[0.682]	[0.860]	[0.968]	[0.805]	[0.360]	
Rainfall Variability (σ/μ) (4 years)	-0.000454	0.000785	0.000536	0.000505	0.000417	2.459
	(0.000682)	(0.00104)	(0.00106)	(0.00113)	(0.00115)	
	[0.617]	[0.524]	[0.714]	[0.731]	[0.810]	
Rainfall Variability (σ/μ) (5 years)	-0.0000951	0.000331	0.000277	0.0000235	-0.0000576	2.755
	(0.000793)	(0.000523)	(0.000544)	(0.000694)	(0.000751)	
	[0.937]	[0.595]	[0.687]	[0.984]	[0.952]	
Rainfall Variability (σ/μ) (6 years)	-0.000281	0.000386	0.000281	-0.000481	-0.000499	2.220
	(0.000826)	(0.000663)	(0.000645)	(0.00117)	(0.00115)	
	[0.758]	[0.605]	[0.735]	[0.760]	[0.787]	
Rainfall Variability (σ/μ) (7 years)	-0.000861	-0.00132	-0.00136	-0.00163*	-0.000702	2.597
	(0.000566)	(0.000803)	(0.000856)	(0.000776)	(0.000664)	
	[0.443]	[0.284]	[0.338]	[0.262]	[0.423]	
Rainfall Variability (σ/μ) (8 years)	-0.000684	-0.000965	-0.00103	-0.000697	0.00103	1.796
	(0.000951)	(0.000613)	(0.000714)	(0.000785)	(0.00132)	
	[0.589]	[0.321]	[0.338]	[0.529]	[0.591]	
Rainfall Variability (σ/μ) (9 years)	-0.00112	-0.00115*	-0.00116*	-0.000234	-0.000361	2.400
	(0.000943)	(0.000635)	(0.000635)	(0.00135)	(0.00161)	
	[0.455]	[0.263]	[0.273	[0.916]	[0.867]	
Rainfall Variability (σ/μ) (10 years)	-0.00248*	-0.00162	-0.00168	-0.00193	-0.00151	1.653
	(0.00118)	(0.00105)	(0.00106)	(0.00212)	(0.00215)	
	[0.228]	[0.201]	[0.171]	[0.535]	[0.695]	
Fixed Effects	Livestock × 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	

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 (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 (σ/μ) (2 years)	0.00107**	0.000727	0.000915	0.00229	0.00188	1.875
	(0.000488)	(0.00133)	(0.00146)	(0.00182)	(0.00243)	
	[0.144]	[0.637]	[0.603]	[0.482]	[0.701]	
Rainfall Variability (σ/μ) (3 years)	0.00161*	0.000746	0.000865	0.00149	0.00198	2.567
	(0.000874)	(0.00188)	(0.00168)	(0.00179)	(0.00170)	
	[0.152]	[0.837]	[0.721]	[0.549]	[0.493]	
Rainfall Variability (σ/μ) (4 years)	0.00209*	0.00121	0.00181	0.00173	0.00156	2.459
	(0.00107)	(0.00175)	(0.00203)	(0.00179)	(0.00185)	
	[0.190]	[0.642]	[0.587]	[0.559]	[0.646]	
Rainfall Variability (σ/μ) (5 years)	0.00209**	0.000421	0.000425	0.00148	0.00171	2.755
	(0.000934)	(0.00127)	(0.00132)	(0.00122)	(0.00147)	
	[0.153]	[0.807]	[0.822]	[0.419]	[0.549]	
Rainfall Variability (σ/μ) (6 years)	0.00212*	0.000352	0.000430	0.00250	0.00257	2.220
	(0.00108)	(0.00110)	(0.00111)	(0.00206)	(0.00216)	
	[0.148]	[0.795]	[0.777]	[0.405]	[0.470]	
Rainfall Variability (σ/μ) (7 years)	0.00279**	0.00199	0.00195	0.00220	0.00295*	2.597
	(0.00130)	(0.00120)	(0.00123)	(0.00137)	(0.00148)	
	[0.138]	[0.165]	[0.174]	[0.238]	[0.249]	
Rainfall Variability (σ/μ) (8 years)	0.00357**	0.00323**	0.00339**	0.00271*	0.00524**	1.796
	(0.00157)	(0.00144)	(0.00142)	(0.00145)	(0.00229)	
	[0.073]	[0.036]	[0.075	[0.216]	[0.155]	
Rainfall Variability (σ/μ) (9 years)	0.00294*	0.00275	0.00275	0.00401*	0.00501**	2.400
	(0.00145)	(0.00162)	(0.00162)	(0.00205)	(0.00206)	
	[0.106]	[0.215]	[0.210]	[0.413]	[0.410]	
Rainfall Variability (σ/μ) (10 years)	0.00294	0.00162	0.000377	0.00158	0.000748	1.653
	(0.00202)	(0.00201)	(0.00205)	(0.00272)	(0.00248)	
	[0.224]	[0.553]	[0.911]	[0.726]	[0.869]	
Fixed Effects	Livestock × 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	

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 (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 (σ/μ) (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 (σ/μ) (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 (σ/μ) (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 (σ/μ) (5 years)	-0.00391* (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 (σ/μ) (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 (σ/μ) (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 (σ/μ) (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 (σ/μ) (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 (σ/μ) (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	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	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 A15: 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 (σ/μ) (2 years)	0.00137	0.00687*	0.00521	-0.00465	-0.000686	1.153
	(0.001000)	(0.00340)	(0.00418)	(0.00357)	(0.00499)	
	[0.146]	[0.158]	[0.447]	[0.292]	[0.893]	
Rainfall Variability (σ/μ) (3 years)	0.00191	0.00151	0.000954	-0.00692***	-0.00502	1.444
	(0.00140)	(0.00422)	(0.00481)	(0.00226)	(0.00294)	
	[0.129]	[0.721]	[0.861]	[0.048]	[0.102]	
Rainfall Variability (σ/μ) (4 years)	0.00241	-0.00647	-0.0103***	-0.00990***	-0.00881***	1.369
	(0.00163)	(0.00406)	(0.00329)	(0.00159)	(0.00246)	
	[0.097]	[0.302]	[0.078]	[0.019]	[0.090]	
Rainfall Variability (σ/μ) (5 years)	0.00113	-0.00162	0.000181	-0.00442*	-0.00312	1.418
	(0.000991)	(0.00397)	(0.00423)	(0.00234)	(0.00358)	
	[0.181]	[0.754]	[0.974]	[0.116]	[0.534]	
Rainfall Variability (σ/μ) (6 years)	0.00305	0.00478*	0.00405	-0.00466	-0.000402	1.097
	(0.00223)	(0.00262)	(0.00252)	(0.00364)	(0.00432)	
	[0.166]	[0.170]	[0.269]	[0.381]	[0.962]	
Rainfall Variability (σ/μ) (7 years)	0.00120	-0.00306	-0.00183	-0.00368*	0.00914	0.867
	(0.00140)	(0.00370)	(0.00432)	(0.00201)	(0.00525)	
	[0.356]	[0.568]	[0.805]	[0.261]	[0.461]	
Rainfall Variability (σ/μ) (8 years)	0.0000209	-0.00431	-0.00455	-0.00225	0.00739	0.664
	(0.00192)	(0.00278)	(0.00285)	(0.00373)	(0.0111)	
	[0.989]	[0.410]	[0.391]	[0.616]	[0.796]	
Rainfall Variability (σ/μ) (9 years)	-0.000120	0.00199	0.00223	0.00327	-0.000631	1.281
	(0.00248)	(0.00304)	(0.00299)	(0.00430)	(0.00406)	
	[0.954]	[0.563]	[0.534]	[0.523]	[0.870]	
Rainfall Variability (σ/μ) (10 years)	-0.000264	0.00380	0.00458	-0.00233	-0.00622	0.935
	(0.00321)	(0.00274)	(0.00300)	(0.00397)	(0.00570)	
	[0.952]	[0.223]	[0.127]	[0.668]	[0.493]	
Fixed Effects	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	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 A16: 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 (σ/μ) (2 years)	0.00700	0.0349	0.0503*	0.145***	0.191***	0.341
	(0.0113)	(0.0396)	(0.0274)	(0.0360)	(0.0372)	
	[0.778]	[0.520]	[0.254]	[0.024]	[0.375]	
Rainfall Variability (σ/μ) (3 years)	0.0162	0.0400	0.0563**	-0.00704	0.0774	0.253
	(0.0171)	(0.0437)	(0.0250)	(0.0783)	(0.0741)	
	[0.648]	[0.451]	[0.150]	[0.890]	[0.712]	
Rainfall Variability (σ/μ) (4 years)	0.0323	-0.0225	0.0671	0.00964	0.0629	0.203
	(0.0215)	(0.0892)	(0.0922)	(0.0746)	(0.116)	
	[0.392]	[0.871]	[0.526]	[0.886]	[0.558]	
Rainfall Variability (σ/μ) (5 years)	0.0325*	0.0205	0.0156	0.0676	0.0172	0.245
	(0.0181)	(0.0153)	(0.0143)	(0.0414)	(0.0979)	
	[0.461]	[0.438]	[0.387]	[0.358]	[0.785]	
Rainfall Variability (σ/μ) (6 years)	0.0441*	0.0576***	0.0476**	0.0595***	0.0265	0.445
	(0.0225)	(0.0147)	(0.0195)	(0.0111)	(0.0431)	
	[0.783]	[0.608]	[0.431]	[0.490]	[0.977]	
Rainfall Variability (σ/μ) (7 years)	0.0226	0.0188	0.0172	0.0428	-0.00112	0.418
	(0.0228)	(0.0203)	(0.0122)	(0.0480)	(0.0356)	
	[0.414]	[0.196]	[0.746]	[0.191]	[0.676]	
Rainfall Variability (σ/μ) (8 years)	0.0411	0.0537***	0.0568**	0.00132	-0.0258	0.212
	(0.0283)	(0.0145)	(0.0197)	(0.0533)	(0.0960)	
	[0.778]	[0.273]	[0.761]	[0.989]	[0.883]	
Rainfall Variability (σ/μ) (9 years)	0.0435	0.0638*	0.0720*	0.0416	-0.0699	0.309
	(0.0284)	(0.0325)	(0.0359)	(0.0720)	(0.0763)	
	[0.753]	[0.286]	[0.319]	[0.745]	[0.594]	
Rainfall Variability (σ/μ) (10 years)	0.0765***	0.0662	0.0529	0.107	-0.0432	0.316
	(0.0237)	(0.0569)	(0.0866)	(0.111)	(0.0662)	
	[0.190]	[0.494]	[0.767]	[0.707]	[0.731]	
Fixed Effects	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	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-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 A17: Disentangling Realized Income Events from Income Uncertainty: The Effects of Rainfall Variability on Rainfall Realizations

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

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 A18: 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 (σ, 100mm) (2 years)	-0.0867	-0.111	-0.160*	0.0846	0.0709	0.185
	(0.0538)	(0.0748)	(0.0808)	(0.131)	(0.127)	
	[0.386]	[0.288]	[0.210]	[0.657]	[0.675]	
Rainfall Variability (σ, 100mm) (3 years)	-0.127	-0.0385	-0.0678	0.0837	0.105*	0.241
	(0.0791)	(0.0731)	(0.0619)	(0.0586)	(0.0523)	
	[0.237]	[0.673]	[0.376]	[0.232]	[0.142]	
Rainfall Variability (σ, 100mm) (4 years)	-0.248**	-0.0926	-0.0934	-0.0229	0.0418	0.202
	(0.0853)	(0.0845)	(0.0892)	(0.128)	(0.0856)	
	[0.033]	[0.368]	[0.426]	[0.934]	[0.711]	
Rainfall Variability (σ, 100mm) (5 years)	-0.150	-0.0780	-0.0686	-0.0666	-0.0311	0.220
	(0.0917)	(0.0799)	(0.0769)	(0.107)	(0.0644)	
	[0.238]	[0.515]	[0.582]	[0.937]	[0.648]	
Rainfall Variability (σ, 100mm) (6 years)	-0.257**	-0.0985	-0.0848	-0.0761	-0.0751	0.164
	(0.0981)	(0.118)	(0.106)	(0.155)	(0.0840)	
	[0.130]	[0.555]	[0.529]	[0.836]	[0.556]	
Rainfall Variability (σ, 100mm) (7 years)	-0.225*	-0.0624	-0.190	-0.0401	-0.237**	0.166
	(0.109)	(0.118)	(0.140)	(0.101)	(0.0926)	
	[0.166]	[0.683]	[0.296]	[0.788]	[0.141]	
Rainfall Variability (σ, 100mm) (8 years)	-0.228	-0.200	-0.217	-0.0921	-0.279*	0.149
	(0.148)	(0.136)	(0.129)	(0.131)	(0.157)	
	[0.338]	[0.310]	[0.243]	[0.621]	[0.499]	
Rainfall Variability (σ, 100mm) (9 years)	-0.160	-0.184	-0.190	-0.104	-0.240	0.197
	(0.134)	(0.147)	(0.149)	(0.191)	(0.185)	
	[0.429]	[0.413]	[0.427]	[0.946]	[0.747]	
Rainfall Variability (σ, 100mm) (10 years)	-0.157	-0.0759	-0.0626	0.139	0.0584	0.164
	(0.104)	(0.121)	(0.124)	(0.129)	(0.136)	
	[0.163]	[0.579]	[0.641]	[0.423]	[0.808]	
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	

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 (Share Sold)

	(1) Share Sold	(2) Share Sold	(3) Share Sold	(4) Share Sold	(5) Share Sold	(6) Share Sold Std. Dev
Rainfall Variability (σ, 100mm) (2 years)	-0.00433	-0.0164	-0.0169	0.0226	0.0131	0.185
	(0.00905)	(0.0107)	(0.0135)	(0.0268)	(0.0290)	
	[0.637]	[0.128]	[0.240]	[0.542]	[0.742]	
Rainfall Variability (σ, 100mm) (3 years)	-0.00802	-0.00264	-0.00425	0.0284	0.0302	0.241
	(0.0127)	(0.0131)	(0.0144)	(0.0161)	(0.0182)	
	[0.604]	[0.857]	[0.800]	[0.300]	[0.295]	
Rainfall Variability (σ, 100mm) (4 years)	-0.0372**	-0.0277	-0.0268	-0.0130	-0.00179	0.202
	(0.0130)	(0.0190)	(0.0200)	(0.0216)	(0.0154)	
	[0.023]	[0.381]	[0.339]	[0.702]	[0.930]	
Rainfall Variability (σ, 100mm) (5 years)	-0.0142	-0.0199	-0.0180	-0.0177	-0.0108	0.220
	(0.0131)	(0.0122)	(0.0117)	(0.0124)	(0.0121)	
	[0.349]	[0.267]	[0.259]	[0.428]	[0.478]	
Rainfall Variability (σ, 100mm) (6 years)	-0.0281**	-0.0145	-0.0120	-0.0240	-0.0314	0.164
	(0.0107)	(0.0215)	(0.0214)	(0.0354)	(0.0290)	
	[0.091]	[0.592]	[0.654]	[0.611]	[0.448]	
Rainfall Variability (σ, 100mm) (7 years)	-0.0186	-0.00298	-0.0312	-0.000311	-0.0494*	0.166
	(0.0131)	(0.0244)	(0.0241)	(0.0249)	(0.0237)	
	[0.310]	[0.931]	[0.292]	[0.997]	[0.190]	
Rainfall Variability (σ, 100mm) (8 years)	-0.0119	-0.0172	-0.0204	-0.00761	-0.0481	0.149
	(0.0199)	(0.0243)	(0.0227)	(0.0286)	(0.0312)	
	[0.717]	[0.591]	[0.495]	[0.824]	[0.363]	
Rainfall Variability (σ, 100mm) (9 years)	-0.00706	-0.00867	-0.00932	0.0111	-0.00334	0.197
	(0.0164)	(0.0229)	(0.0226)	(0.0302)	(0.0339)	
	[0.737]	[0.769]	[0.751]	[0.798]	[0.940]	
Rainfall Variability (σ, 100mm) (10 years)	-0.0146	0.00814	0.00692	0.0469**	0.0358	0.164
	(0.0242)	(0.0195)	(0.0206)	(0.0204)	(0.0288)	
	[0.721]	[0.777]	[0.796]	[0.202]	[0.403]	
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	

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 (Prices)

	(1) log Prices	(2) log Prices	(3) log Prices	(4) log Prices	(5) log Prices	(6) Within Group Std. Dev
Rainfall Variability (σ, 100mm) (2 years)	-0.278***	-0.294**	-0.289***	-0.222**	-0.225***	0.123
	(0.0733)	(0.109)	(0.0601)	(0.0927)	(0.0433)	
	[0.049]	[0.266]	[0.164]	[0.334]	[0.027]	
Rainfall Variability (σ, 100mm) (3 years)	-0.310***	-0.305***	-0.276***	-0.330***	-0.0879	0.110
	(0.0663)	(0.0704)	(0.0459)	(0.0747)	(0.0939)	
	[0.066]	[0.222]	[0.075]	[0.182]	[0.498]	
Rainfall Variability (σ, 100mm) (4 years)	-0.180*	0.0197	-0.00417	0.147	-0.0881	0.114
	(0.0936)	(0.0751)	(0.0961)	(0.131)	(0.159)	
	[0.276]	[0.794]	[0.987]	[0.477]	[0.745]	
Rainfall Variability (σ, 100mm) (5 years)	0.0632	-0.0605	-0.0285	-0.00185	-0.169	0.117
	(0.0794)	(0.0525)	(0.0783)	(0.0292)	(0.132)	
	[0.537]	[0.350]	[0.874]	[0.923]	[0.480]	
Rainfall Variability (σ, 100mm) (6 years)	-0.279**	-0.0292	0.159	-0.0954	-0.109	0.105
	(0.119)	(0.190)	(0.183)	(0.174)	(0.114)	
	[0.198]	[0.889]	[0.568]	[0.695]	[0.469]	
Rainfall Variability (σ, 100mm) (7 years)	-0.473***	-0.287**	0.169	-0.635***	-0.270	0.069
	(0.0911)	(0.115)	(0.290)	(0.0796)	(0.167)	
	[0.048]	[0.068]	[0.686]	[0.025]	[0.304]	
Rainfall Variability (σ, 100mm) (8 years)	-0.367	-0.226	0.233	-0.107	-0.183	0.067
	(0.261)	(0.181)	(0.240)	(0.297)	(0.176)	
	[0.409]	[0.325]	[0.527]	[0.767]	[0.386]	
Rainfall Variability (σ, 100mm) (9 years)	-0.0236	-0.131	0.0794	0.262*	0.0334	0.079
	(0.220)	(0.133)	(0.117)	(0.126)	(0.140)	
	[0.996]	[0.514]	[0.642]	[0.244]	[0.769]	
Rainfall Variability (σ, 100mm) (10 years)	-0.203	-0.102	0.0506	-0.122	-0.0839	0.115
	(0.125)	(0.105)	(0.0964)	(0.132)	(0.0997)	
	[0.418]	[0.538]	[0.749]	[0.831]	[0.564]	
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	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 A21: 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 (σ, 100mm) (2 years)	0.00925	0.0600	0.0422	0.0272	0.0807	0.240
	(0.0287)	(0.0538)	(0.0628)	(0.0848)	(0.103)	
	[0.765]	[0.377]	[0.596]	[0.817]	[0.590]	
Rainfall Variability (σ, 100mm) (3 years)	0.0196	0.0292	0.000680	-0.0249	-0.0198	0.291
	(0.0452)	(0.0750)	(0.0539)	(0.0694)	(0.0689)	
	[0.673]	[0.723]	[0.994]	[0.746]	[0.823]	
Rainfall Variability (σ, 100mm) (4 years)	-0.0409	-0.00653	-0.0816	-0.118*	-0.0984**	0.254
	(0.0483)	(0.0833)	(0.0697)	(0.0561)	(0.0446)	
	[0.437]	[0.960]	[0.398]	[0.090]	[0.011]	
Rainfall Variability (σ, 100mm) (5 years)	-0.0343	0.0257	0.0202	-0.0539*	-0.0718*	0.275
	(0.0375)	(0.0461)	(0.0466)	(0.0287)	(0.0401)	
	[0.428]	[0.628]	[0.689]	[0.122]	[0.081]	
Rainfall Variability (σ, 100mm) (6 years)	-0.0123	0.108	0.0992	-0.0718	-0.112	0.201
	(0.0426)	(0.0789)	(0.0832)	(0.0865)	(0.104)	
	[0.792]	[0.244]	[0.341]	[0.571]	[0.539]	
Rainfall Variability (σ, 100mm) (7 years)	-0.0769	-0.0343	0.0601	-0.0284	-0.0308	0.217
	(0.0509)	(0.104)	(0.0880)	(0.0928)	(0.0772)	
	[0.216]	[0.781]	[0.560]	[0.841]	[0.772]	
Rainfall Variability (σ, 100mm) (8 years)	-0.104**	-0.0840	-0.0714	-0.0569	0.000600	0.192
	(0.0448)	(0.0734)	(0.0605)	(0.0859)	(0.0872)	
	[0.062]	[0.334]	[0.327]	[0.673]	[0.997]	
Rainfall Variability (σ, 100mm) (9 years)	-0.0833*	-0.109**	-0.0998**	0.0347	0.0371	0.230
	(0.0471)	(0.0458)	(0.0399)	(0.0994)	(0.128)	
	[0.147]	[0.072]	[0.088]	[0.794]	[0.928]	
Rainfall Variability (σ, 100mm) (10 years)	-0.104	-0.150**	-0.121	0.0156	0.0169	0.192
	(0.0755)	(0.0641)	(0.0755)	(0.0771)	(0.0798)	
	[0.273]	[0.196]	[0.415]	[0.912]	[0.886]	
Fixed Effects	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	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 A22: 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 (σ, 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 (σ, 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 (σ, 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 (σ, 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 (σ, 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 (σ, 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 (σ, 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 (σ, 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 (σ, 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	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	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 A23: 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 (σ, 100mm) (2 years)	-0.0170	-0.0254	-0.0756	0.358*	0.342	0.120
	(0.181)	(0.202)	(0.143)	(0.179)	(0.368)	
	[0.917]	[0.906]	[0.633]	[0.139]	[0.497]	
Rainfall Variability (σ, 100mm) (3 years)	-0.0995	-0.139	-0.147	-0.113	-0.0780	0.139
	(0.170)	(0.186)	(0.145)	(0.147)	(0.262)	
	[0.581]	[0.616]	[0.508]	[0.565]	[0.804]	
Rainfall Variability (σ, 100mm) (4 years)	-0.00352	0.150	0.217	0.109	0.398	0.120
	(0.212)	(0.225)	(0.275)	(0.205)	(0.281)	
	[0.986]	[0.705]	[0.594]	[0.705]	[0.295]	
Rainfall Variability (σ, 100mm) (5 years)	0.0326	0.0306	0.0890	0.0369	0.116	0.199
	(0.210)	(0.173)	(0.209)	(0.162)	(0.202)	
	[0.892]	[0.899]	[0.767]	[0.878]	[0.671]	
Rainfall Variability (σ, 100mm) (6 years)	-0.186	-0.258	-0.0425	-0.121	-0.0747	0.133
	(0.232)	(0.273)	(0.308)	(0.261)	(0.264)	
	[0.442]	[0.431]	[0.897]	[0.645]	[0.787]	
Rainfall Variability (σ, 100mm) (7 years)	-0.444*	-0.448*	-0.112	-0.128	0.0419	0.104
	(0.224)	(0.243)	(0.379)	(0.304)	(0.347)	
	[0.289]	[0.341]	[0.748]	[0.740]	[0.906]	
Rainfall Variability (σ, 100mm) (8 years)	-0.437	-0.503*	-0.130	-0.211	-0.117	0.103
	(0.302)	(0.273)	(0.307)	(0.224)	(0.325)	
	[0.455]	[0.394]	[0.761]	[0.510]	[0.679]	
Rainfall Variability (σ, 100mm) (9 years)	-0.317	-0.387***	-0.236**	-0.264	-0.720***	0.105
	(0.215)	(0.123)	(0.0827)	(0.184)	(0.208)	
	[0.453]	[0.102	[0.167]	[0.337]	[0.050]	
Rainfall Variability (σ, 100mm) (10 years)	-0.360***	-0.350*	-0.158	-0.0988	-0.454*	0.125
	(0.118)	(0.168)	(0.103)	(0.118)	(0.257)	
	[0.432]	[0.188]	[0.189]	[0.505]	[0.178]	
Fixed Effects	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	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 A24: 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 (σ, 100mm) (2 years)	-0.196	-0.0882	-0.0616	-0.479*	-0.696**	0.127
	(0.223)	(0.175)	(0.182)	(0.226)	(0.304)	
	[0.496]	[0.691]	[0.822]	[0.143]	[0.237]	
Rainfall Variability (σ, 100mm) (3 years)	-0.186	0.0132	0.0113	-0.0403	-0.110	0.144
	(0.224)	(0.191)	(0.185)	(0.193)	(0.273)	
	[0.584]	[0.960]	[0.957]	[0.853]	[0.728]	
Rainfall Variability (σ, 100mm) (4 years)	-0.249	-0.149	-0.294	-0.157	-0.347	0.125
	(0.227)	(0.206)	(0.272)	(0.205)	(0.273)	
	[0.631]	[0.609]	[0.414]	[0.530]	[0.372]	
Rainfall Variability (σ, 100mm) (5 years)	0.0881	0.0164	-0.0134	0.00442	-0.137	0.205
	(0.248)	(0.200)	(0.203)	(0.190)	(0.198)	
	[0.669]	[0.954]	[0.955]	[0.998]	[0.557]	
Rainfall Variability (σ, 100mm) (6 years)	-0.240	0.157	-0.0366	0.0808	0.129	0.135
	(0.384)	(0.376)	(0.406)	(0.298)	(0.289)	
	[0.702]	[0.759]	[0.909]	[0.814]	[0.707]	
Rainfall Variability (σ, 100mm) (7 years)	0.0287	0.307	-0.0346	-0.0989	-0.0624	0.107
	(0.445)	(0.390)	(0.550)	(0.347)	(0.329)	
	[0.963]	[0.530]	[0.960]	[0.800]	[0.860]	
Rainfall Variability (σ, 100mm) (8 years)	0.386	0.348	0.0745	0.188	0.138	0.105
	(0.410)	(0.434)	(0.497)	(0.340)	(0.355)	
	[0.545]	[0.684]	[0.976]	[0.762]	[0.720]	
Rainfall Variability (σ, 100mm) (9 years)	0.217	0.290	0.211	0.422	0.911***	0.107
	(0.341)	(0.165)	(0.190)	(0.301)	(0.257)	
	[0.593]	[0.661]	[0.748]	[0.480]	[0.046]	
Rainfall Variability (σ, 100mm) (10 years)	0.128	0.281	0.141	0.0524	0.356	0.127
	(0.314)	(0.279)	(0.270)	(0.263)	(0.338)	
	[0.800]	[0.605]	[0.760]	[0.900]	[0.453]	
Fixed Effects	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	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 A25: 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 (σ, 100mm) (2 years)	-0.0108*	0.0240	0.0492**	0.0304	0.0388**	0.240
	(0.00587)	(0.0230)	(0.0208)	(0.0205)	(0.0175)	
	[0.194]	[0.402]	[0.140]	[0.220]	[0.080]	
Rainfall Variability (σ, 100mm) (3 years)	-0.00973	0.0356	0.0513**	0.0399**	0.0391*	0.292
	(0.0130)	(0.0289)	(0.0205)	(0.0184)	(0.0184)	
	[0.540]	[0.360]	[0.123]	[0.143]	[0.193]	
Rainfall Variability (σ, 100mm) (4 years)	0.0127	0.0374	0.0747***	0.0592***	0.0520**	0.255
	(0.0210)	(0.0280)	(0.0229)	(0.0190)	(0.0242)	
	[0.608]	[0.283]	[0.013]	[0.005]	[0.069]	
Rainfall Variability (σ, 100mm) (5 years)	0.00694	0.0114	0.0129	0.0400***	0.0445	0.275
	(0.0183)	(0.0224)	(0.0232)	(0.0108)	(0.0253)	
	[0.738]	[0.638]	[0.617]	[0.006]	[0.151]	
Rainfall Variability (σ, 100mm) (6 years)	-0.00685	-0.0279	-0.0250	0.0604*	0.0596*	0.201
	(0.0146)	(0.0260)	(0.0296)	(0.0289)	(0.0323)	
	[0.692]	[0.402]	[0.576]	[0.150]	[0.246]	
Rainfall Variability (σ, 100mm) (7 years)	0.00399	0.0105	-0.00226	0.00451	0.0386	0.217
	(0.0256)	(0.0444)	(0.0392)	(0.0265)	(0.0264)	
	[0.862]	[0.833]	[0.962]	[0.891]	[0.207]	
Rainfall Variability (σ, 100mm) (8 years)	-0.000923	0.00586	0.00220	-0.0149	0.0562*	0.192
	(0.0280)	(0.0426)	(0.0377)	(0.0383)	(0.0279)	
	[0.971]	[0.893]	[0.960]	[0.796]	[0.091]	
Rainfall Variability (σ, 100mm) (9 years)	-0.00763	0.000697	-0.00249	-0.0110	0.0454***	0.231
	(0.0276)	(0.0349)	(0.0328)	(0.0278)	(0.0146)	
	[0.805]	[0.989]	[0.935]	[0.732]	[0.109]	
Rainfall Variability (σ, 100mm) (10 years)	0.0157	0.00679	-0.00363	-0.0302	0.00496	0.191
	(0.0418)	(0.0379)	(0.0373)	(0.0197)	(0.0281)	
	[0.809]	[0.896]	[0.934]	[0.217]	[0.885]	
Fixed Effects	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	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 A26: 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 (σ, 100mm) (2 years)	0.00478	0.0430	0.0351*	0.0621*	0.0429	.325
	(0.0103)	(0.0306)	(0.0193)	(0.0313)	(0.0297)	
	[0.675]	[0.414]	[0.268]	[0.298]	[0.491]	
Rainfall Variability (σ, 100mm) (3 years)	0.00896	0.0469	0.0441***	0.0559***	0.0575***	.367
	(0.0154)	(0.0301)	(0.0140)	(0.0163)	(0.0163)	
	[0.606]	[0.283]	[0.035]	[0.032]	[0.074]	
Rainfall Variability (σ, 100mm) (4 years)	0.00581	0.0685**	0.0563*	0.0659**	0.0599**	.323
	(0.0184)	(0.0319)	(0.0263)	(0.0242)	(0.0258)	
	[0.773]	[0.131]	[0.153]	[0.070]	[0.186]	
Rainfall Variability (σ, 100mm) (5 years)	0.00419	0.0235	0.0201	0.00605	0.0285	.346
	(0.0187)	(0.0153)	(0.0158)	(0.0212)	(0.0227)	
	[0.871]	[0.226]	[0.271]	[0.783]	[0.346]	
Rainfall Variability (σ, 100mm) (6 years)	-0.00526	0.0288	0.0236	-0.00452	0.0142	.256
	(0.0213)	(0.0232)	(0.0194)	(0.0412)	(0.0283)	
	[0.880]	[0.319]	[0.361]	[0.934	[0.689]	
Rainfall Variability (σ, 100mm) (7 years)	-0.0239	-0.0247	-0.0159	-0.0348	-0.0371	.311
	(0.0235)	(0.0298)	(0.0293)	(0.0303)	(0.0323)	
	[0.578]	[0.508]	[0.766]	[0.417]	[0.490]	
Rainfall Variability (σ, 100mm) (8 years)	-0.0189	-0.0109	-0.0234	-0.0121	-0.0537	.243
	(0.0278)	(0.0293)	(0.0269)	(0.0289)	(0.0462)	
	[0.753]	[0.793]	[0.567]	[0.773]	[0.577]	
Rainfall Variability (σ, 100mm) (9 years)	-0.0274	-0.0229	-0.0234	-0.0319	-0.0571	.316
	(0.0286)	(0.0274)	(0.0273)	(0.0391)	(0.0431)	
	[0.534]	[0.634]	[0.703]	[0.907]	[0.780]	
Rainfall Variability (σ, 100mm) (10 years)	-0.0395	-0.0356	-0.0282	-0.0738	-0.0696*	.275
	(0.0325)	(0.0350)	(0.0363)	(0.0501)	(0.0362)	
	[0.303]	[0.415]	[0.561]	[0.358]	[0.319]	
Fixed Effects	Livestock × 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	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 A27: Disentangling Realized Income Events from Income Uncertainty: Defining Rainfall Variability Over Different Time Frames (Number of Livestock Slaughtered)

	(1) Number of Livestock Slaughtered	(2) Number of Livestock Slaughtered	(3) Number of Livestock Slaughtered	(4) Number of Livestock Slaughtered	(5) Number of Livestock Slaughtered	(6) Within Group Std. Dev
Rainfall Variability (σ, 100mm) (2 years)	-0.0000718	0.00325	0.00183	0.00861	0.00416	.325
	(0.00345)	(0.00734)	(0.00619)	(0.00938)	(0.00633)	
	[0.985]	[0.746]	[0.854]	[0.585]	[0.710]	
Rainfall Variability (σ, 100mm) (3 years)	-0.00137	0.00411	0.00352	0.00590	0.0107**	.367
	(0.00525)	(0.00693)	(0.00552)	(0.00646)	(0.00406)	
	[0.800]	[0.687]	[0.758]	[0.660]	[0.259]	
Rainfall Variability (σ, 100mm) (4 years)	-0.00301	0.00971	0.00858	0.00833	0.00793	.323
	(0.00592)	(0.00776)	(0.00788)	(0.00774)	(0.00808)	
	[0.652]	[0.272]	[0.381]	[0.428]	[0.503]	
Rainfall Variability (σ, 100mm) (5 years)	-0.00119	0.00214	0.00168	-0.000731	-0.00161	.346
	(0.00589)	(0.00387)	(0.00419)	(0.00564)	(0.00612)	
	[0.814]	[0.670]	[0.748]	[0.927]	[0.879]	
Rainfall Variability (σ, 100mm) (6 years)	-0.00441	0.00408	0.00351	-0.00193	-0.00218	.256
	(0.00549)	(0.00536)	(0.00530)	(0.0100)	(0.0108)	
	[0.492]	[0.524]	[0.610]	[0.858]	[0.893]	
Rainfall Variability (σ, 100mm) (7 years)	-0.00967**	-0.0114	-0.0121	-0.0138*	-0.00700	.311
	(0.00332)	(0.00742)	(0.00812)	(0.00685)	(0.00656)	
	[0.313]	[0.321]	[0.403]	[0.263]	[0.469]	
Rainfall Variability (σ, 100mm) (8 years)	-0.00899	-0.00846	-0.00892	-0.00653	0.00394	.243
	(0.00559)	(0.00534)	(0.00600)	(0.00624)	(0.0113)	
	[0.432]	[0.302]	[0.316]	[0.492]	[0.822]	
Rainfall Variability (σ, 100mm) (9 years)	-0.0130*	-0.0111*	-0.0111*	-0.00422	-0.00689	.316
	(0.00677)	(0.00543)	(0.00544)	(0.00965)	(0.0118)	
	[0.197]	[0.188]	[0.201]	[0.803]	[0.721]	
Rainfall Variability (σ, 100mm) (10 years)	-0.0212**	-0.0153*	-0.0155*	-0.0183	-0.0176	.275
	(0.00975)	(0.00830)	(0.00815)	(0.0127)	(0.0116)	
	[0.104]	[0.205]	[0.236]	[0.414]	[0.476]	
Fixed Effects	Livestock × 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	

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 (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 (σ, 100mm) (2 years)	0.00692*	-0.00520	-0.00476	-0.00408	-0.0128	.325
	(0.00345)	(0.00875)	(0.00919)	(0.0133)	(0.0138)	
	[0.132]	[0.657]	[0.697]	[0.837]	[0.624]	
Rainfall Variability (σ, 100mm) (3 years)	0.0114*	0.00233	0.00278	0.00616	0.00829	.367
	(0.00620)	(0.0132)	(0.0120)	(0.0133)	(0.0127)	
	[0.146]	[0.909]	[0.847]	[0.731]	[0.676]	
Rainfall Variability (σ, 100mm) (4 years)	0.0155*	0.00924	0.0118	0.0107	0.00985	.323
	(0.00747)	(0.0124)	(0.0136)	(0.0139)	(0.0135)	
	[0.155]	[0.580]	[0.526]	[0.622	[0.665]	
Rainfall Variability (σ, 100mm) (5 years)	0.0168**	0.00511	0.00517	0.0138	0.0168	.346
	(0.00653)	(0.00866)	(0.00906)	(0.00820)	(0.0106)	
	[0.131]	[0.603]	[0.648]	[0.224]	[0.361]	
Rainfall Variability (σ, 100mm) (6 years)	0.0176*	0.00624	0.00668	0.0306*	0.0331**	.256
	(0.00854)	(0.00866)	(0.00867)	(0.0151)	(0.0148)	
	[0.148]	[0.582]	[0.588]	[0.155]	[0.176]	
Rainfall Variability (σ, 100mm) (7 years)	0.0223**	0.0191*	0.0192*	0.0219*	0.0306**	.311
	(0.00968)	(0.00913)	(0.00953)	(0.0107)	(0.0118)	
	[0.141]	[0.111]	[0.121]	[0.141]	[0.130]	
Rainfall Variability (σ, 100mm) (8 years)	0.0279**	0.0272**	0.0283**	0.0234**	0.0466**	.243
	(0.0111)	(0.0103)	(0.0101)	(0.0102)	(0.0157)	
	[0.090]	[0.020]	[0.062]	[0.152]	[0.097]	
Rainfall Variability (σ, 100mm) (9 years)	0.0221*	0.0226*	0.0226*	0.0311*	0.0403**	.316
	(0.0113)	(0.0119)	(0.0119)	(0.0148)	(0.0138)	
	[0.186]	[0.171]	[0.169]	[0.445]	[0.452]	
Rainfall Variability (σ, 100mm) (10 years)	0.0187	0.0107	0.00394	0.00532	0.00205	.275
	(0.0152)	(0.0147)	(0.0137)	(0.0190)	(0.0164)	
	[0.379]	[0.601]	[0.834]	[0.895]	[0.939]	
Fixed Effects	Livestock × 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	

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 (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 (σ, 100mm) (2 years)	-0.00922	0.00157	0.00950	-0.0237	0.000673	0.184
	(0.0109)	(0.0394)	(0.0455)	(0.0369)	(0.0208)	
	[0.892]	[0.975]	[0.868]	[0.677]	[0.981]	
Rainfall Variability (σ, 100mm) (3 years)	-0.0158	0.0155	0.0154	0.00707	0.0587*	0.202
	(0.0177)	(0.0480)	(0.0481)	(0.0499)	(0.0297)	
	[0.927	[0.822]	[0.827]	[0.929]	[0.267]	
Rainfall Variability (σ, 100mm) (4 years)	-0.0217	-0.0180	-0.0141	-0.0188	-0.0580	0.152
	(0.0213)	(0.0568)	(0.0572)	(0.0563)	(0.0628)	
	[0.903]	[0.840]	[0.866]	[0.823]	[0.622]	
Rainfall Variability (σ, 100mm) (5 years)	-0.0282	-0.0268	-0.0346	-0.0151	-0.0515	0.153
	(0.0193)	(0.0501)	(0.0462)	(0.0533)	(0.0621)	
	[0.834]	[0.640]	[0.539]	[0.819]	[0.587]	
Rainfall Variability (σ, 100mm) (6 years)	-0.0290	-0.0248	-0.0230	-0.0242	-0.110	0.112
	(0.0221)	(0.0368)	(0.0337)	(0.0618)	(0.0862)	
	[0.849]	[0.621]	[0.625]	[0.748]	[0.414]	
Rainfall Variability (σ, 100mm) (7 years)	-0.0369	-0.0506	-0.0754**	-0.0501	-0.0642	0.114
	(0.0224)	(0.0362)	(0.0297)	(0.0351)	(0.0398)	
	[0.762]	[0.482]	[0.215]	[0.492]	[0.159]	
Rainfall Variability (σ, 100mm) (8 years)	-0.0499*	-0.0536	-0.0436	-0.0104	-0.0229	0.102
	(0.0255)	(0.0357)	(0.0328)	(0.0424)	(0.0547)	
	[0.628]	[0.618]	[0.540]	[0.837]	[0.702]	
Rainfall Variability (σ, 100mm) (9 years)	-0.0594*	-0.0607	-0.0554	-0.0125	-0.0283	0.177
	(0.0334)	(0.0442)	(0.0447)	(0.0422)	(0.0512)	
	[0.435]	[0.310]	[0.368]	[0.797]	[0.667]	
Rainfall Variability (σ, 100mm) (10 years)	-0.0731	-0.0922	-0.106	-0.0549	-0.0214	0.136
	(0.0494)	(0.0667)	(0.0661)	(0.0572)	(0.0460)	
	[0.490]	[0.531]	[0.534]	[0.611]	[0.717]	
Fixed Effects	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	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 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 (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 (σ, 100mm) (2 years)	0.0100	0.0414	0.0299	-0.0406	-0.0146	0.184
	(0.00761)	(0.0258)	(0.0322)	(0.0232)	(0.0257)	
	[0.161]	[0.217]	[0.472]	[0.287]	[0.607]	
Rainfall Variability (σ, 100mm) (3 years)	0.0146	0.0111	0.00879	-0.0504**	-0.0364*	0.202
	(0.0109)	(0.0323)	(0.0347)	(0.0193)	(0.0195)	
	[0.129]	[0.743]	[0.833]	[0.069]	[0.054]	
Rainfall Variability (σ, 100mm) (4 years)	0.0219	-0.0571	-0.0678**	-0.0748***	-0.0629*	0.153
	(0.0141)	(0.0330)	(0.0265)	(0.0154)	(0.0317)	
	[0.083]	[0.228]	[0.114]	[0.018]	[0.249]	
Rainfall Variability (σ, 100mm) (5 years)	0.00999	-0.0205	0.00409	-0.0370	-0.0252	0.153
	(0.00893)	(0.0361)	(0.0397)	(0.0253)	(0.0410)	
	[0.207]	[0.670]	[0.937]	[0.223]	[0.693]	
Rainfall Variability (σ, 100mm) (6 years)	0.0293	0.0460**	0.0429**	-0.0298	0.00847	0.112
	(0.0186)	(0.0205)	(0.0194)	(0.0333)	(0.0446)	
	[0.103]	[0.110]	[0.175]	[0.472]	[0.906]	
Rainfall Variability (σ, 100mm) (7 years)	0.0154	-0.0281	-0.0172	-0.0314*	0.0505	0.114
	(0.0128)	(0.0329)	(0.0391)	(0.0173)	(0.0454)	
	[0.201]	[0.550]	[0.814]	[0.237]	[0.568]	
Rainfall Variability (σ, 100mm) (8 years)	0.00785	-0.0371	-0.0393	-0.0233	0.0194	0.102
	(0.0144)	(0.0237)	(0.0245)	(0.0264)	(0.0663)	
	[0.569]	[0.378]	[0.346]	[0.464]	[0.860]	
Rainfall Variability (σ, 100mm) (9 years)	0.00374	0.00677	0.00931	0.0109	-0.0105	0.177
	(0.0212)	(0.0243)	(0.0241)	(0.0275)	(0.0264)	
	[0.835]	[0.776]	[0.734]	[0.742]	[0.735]	
Rainfall Variability (σ, 100mm) (10 years)	0.00606	0.0189	0.0208	-0.0225	-0.0378	0.136
	(0.0303)	(0.0308)	(0.0300)	(0.0323)	(0.0405)	
	[0.840]	[0.583]	[0.500]	[0.604]	[0.542]	
Fixed Effects			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	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 A31: 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 (σ, 100mm) (2 years)	0.0334	0.133	0.173	1.103**	1.726***	0.042
	(0.0750)	(0.211)	(0.147)	(0.423)	(0.306)	
	[0.795]	[0.641]	[0.502]	[0.139]	[0.140]	
Rainfall Variability (σ, 100mm) (3 years)	0.108	0.202	0.270	-0.283	0.790	0.026
	(0.126)	(0.262)	(0.184)	(0.430)	(0.576)	
	[0.607]	[0.534]	[0.279]	[0.552]	[0.719]	
Rainfall Variability (σ, 100mm) (4 years)	0.266	-0.428	-0.0986	-0.418	-0.0556	0.025
	(0.171)	(0.911)	(0.868)	(0.812)	(0.962)	
	[0.299]	[0.815]	[0.830]	[0.576]	[0.959]	
Rainfall Variability (σ, 100mm) (5 years)	0.310*	0.174	0.0899	0.462	0.00657	0.036
	(0.151)	(0.134)	(0.138)	(0.331)	(0.645)	
	[0.365]	[0.451]	[0.634]	[0.435]	[0.982]	
Rainfall Variability (σ, 100mm) (6 years)	0.245	0.149	0.107	0.305	-0.195	0.049
	(0.190)	(0.169)	(0.113)	(0.389)	(0.301)	
	[0.531]	[0.606]	[0.555]	[0.522]	[0.714]	
Rainfall Variability (σ, 100mm) (7 years)	0.475**	0.469***	0.375*	0.504***	0.172	0.046
	(0.189)	(0.133)	(0.197)	(0.108)	(0.430)	
	[0.240]	[0.212]	[0.807]	[0.217]	[0.769]	
Rainfall Variability (σ, 100mm) (8 years)	0.444**	0.426***	0.458**	-0.0285	-0.237	0.025
	(0.191)	(0.121)	(0.178)	(0.437)	(0.840)	
	[0.515]	[0.381]	[0.783]	[0.962]	[0.858]	
Rainfall Variability (σ, 100mm) (9 years)	0.517**	0.600*	0.699**	0.256	-0.486	0.037
	(0.188)	(0.304)	(0.323)	(0.699)	(0.740)	
	[0.390]	[0.222]	[0.281]	[0.806]	[0.683]	
Rainfall Variability (σ, 100mm) (10 years)	0.686**	0.644	0.519	0.789	-0.334	0.046
	(0.282)	(0.608)	(0.841)	(0.967)	(0.454)	
	[0.100]	[0.531]	[0.728]	[0.664]	[0.726]	
Fixed Effects	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	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 A32: Disentangling Realized Income Events from Income Uncertainty: The Effects of Rainfall Variability on Rainfall Realizations

Outcome Variable	Treatment Variable: Rainfall Variability (σ, 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	15.63	16.42	31.09**	4.195	3.120	22.22	33.54	46.05**
	(6.028)	(14.12)	(12.32)	(14.61)	(13.27)	(15.92)	(19.28)	(17.30)	
	[0.823]	[0.279]	[0.198]	[0.040]	[0.741]	[0.787]	[0.187]	[0.111]	[0.020]
Annual Rainfall (t+3)	3.840	18.24*	27.47*	28.49**	39.72**	13.54	14.36	34.08	47.08*
	(7.506)	(8.715)	(13.45)	(11.25)	(13.38)	(16.46)	(17.15)	(21.21)	(24.77)
	[0.628]	[0.074]	[0.077]	[0.028]	[0.019]	[0.406]	[0.426]	[0.150]	[0.097]
Annual Rainfall (t+2)	-4.940	-3.513	14.15	28.43	28.74*	42.40**	22.57	28.31	50.26**
	(7.539)	(11.44)	(12.17)	(16.17)	(14.20)	(14.93)	(16.78)	(18.67)	(23.27)
	[0.513]	[0.765]	[0.264]	[0.126]	[0.079]	[0.027]	[0.210]	[0.170]	[0.061]
Annual Rainfall (t+1)	-14.99*	-10.01	-3.470	13.79	26.71*	32.00**	43.35***	26.56*	33.51*
	(8.330)	(11.39)	(11.58)	(13.57)	(14.23)	(12.48)	(12.82)	(14.87)	(17.04)
	[0.122]	[0.448]	[0.793]	[0.328]	[0.102]	[0.037]	[0.010]	[0.094]	[0.070]
Annual Rainfall (t)	-9.295	-4.727	7.529	18.66*	36.03***	47.73***	53.86***	59.52***	48.65***
	(7.265)	(10.10)	(11.27)	(10.33)	(11.30)	(11.45)	(9.271)	(11.35)	(11.63)
	[0.263]	[0.680]	[0.551]	[0.140]	[0.012]	[0.001]	[0.000]	[0.000]	[0.000]
Annual Rainfall (t-1)	9.295	-4.192	-3.096	6.994	19.60*	33.50**	45.16***	48.68***	54.52***
	(7.265)	(4.891)	(6.669)	(8.738)	(9.842)	(11.57)	(13.01)	(11.44)	(13.22)
	[0.263]	[0.382]	[0.645]	[0.444]	[0.073]	[0.011]	[0.002]	[0.003]	[0.001]
Annual Rainfall (t-2)	-5.638	8.758	-2.613	-5.061	3.413	13.18	24.50**	35.60***	41.44**
	(11.89)	(11.04)	(4.604)	(4.906)	(6.779)	(7.717)	(11.21)	(11.03)	(15.33)
	[0.668]	[0.473]	[0.608]	[0.342]	[0.713]	[0.151]	[0.072]	[0.014]	[0.021]
Annual Rainfall (t-3)	-6.825	-12.75	-3.819	-8.784	-9.351	-1.834	8.968	20.30	32.56**
	(5.801)	(11.93)	(13.91)	(8.426)	(7.131)	(6.788)	(8.301)	(13.37)	(13.04)
	[0.271]	[0.321	[0.821]	[0.336]	[0.205]	[0.802]	[0.325]	[0.158]	[0.030]
Annual Rainfall (t-4)	-32.32***	-26.25**	-27.66**	-17.54	-24.16**	-26.74***	-17.79***	-6.578	6.958
	(9.659)	(10.43)	(10.55)	(16.40)	(10.69)	(6.921)	(5.021)	(4.949)	(9.470)
	[0.030]	[0.083]	[0.020]	[0.375]	[0.082]	[0.001]	[0.000]	[0.206]	[0.466]
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	Village, Month, and Year								
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 Robustness Tests

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 A33.

Consumption First, we re-explore the effects of rainfall variability on consumption (Table A33). We find similar results when rainfall variability is defined over 2-6 years. 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 A34. We find similar results when rainfall variability is defined over all years (2-10) years. 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 A33: Rainfall Variability and Consumption

	Log Real Consumption Per Capita					Std. Dev.
	(1)	(2)	(3)	(4)	(5)	(6)
Rainfall Variability (σ/μ) (2 years)	-0.01000***	-0.0360***	-0.0369***	-0.0478***	-0.0270***	1.887
	(0.00205)	(0.00488)	(0.00743)	(0.00753)	(0.00489)	
	[0.023]	[0.002]	[0.004]	[0.013]	[0.092]	
Rainfall Variability (σ/μ) (3 years)	-0.0173***	-0.0303***	-0.0306***	-0.0318***	-0.0206***	2.598
	(0.00269)	(0.00816)	(0.00861)	(0.00921)	(0.00588)	
	[0.033]	[0.016]	[0.019]	[0.027]	[0.039]	
Rainfall Variability (σ/μ) (4 years)	-0.0259***	-0.0364***	-0.0373***	-0.0411***	-0.0340***	2.494
	(0.00361)	(0.00657)	(0.00827)	(0.00761)	(0.00463)	
	[0.041]	[0.012]	[0.005]	[0.008]	[0.012]	
Rainfall Variability (σ/μ) (5 years)	-0.0189***	-0.0139***	-0.0120**	-0.0183***	-0.0326***	2.808
	(0.00307)	(0.00457)	(0.00529)	(0.00588)	(0.00485)	
	[0.034]	[0.019]	[0.078]	[0.066]	[0.006]	
Rainfall Variability (σ/μ) (6 years)	-0.0181***	-0.00564	0.0000331	-0.00906	-0.0158*	2.257
	(0.00406)	(0.00906)	(0.00659)	(0.0114)	(0.00776)	
	[0.110]	[0.631]	[0.997]	[0.602]	[0.295]	
Rainfall Variability (σ/μ) (7 years)	-0.0166**	0.000946	-0.00448	0.00210	-0.00573	2.694
	(0.00606)	(0.00843)	(0.00604)	(0.00829)	(0.00721)	
	[0.314]	[0.935]	[0.639]	[0.835]	[0.685]	
Rainfall Variability (σ/μ) (8 years)	-0.0198**	-0.0103	-0.00579	-0.000781	0.00193	1.866
	(0.00795)	(0.00806)	(0.00595)	(0.00787)	(0.00971)	
	[0.328]	[0.630]	[0.530]	[0.930]	[0.895]	
Rainfall Variability (σ/μ) (9 years)	-0.0168*	-0.0178**	-0.0179***	0.00445	-0.00359	2.449
	(0.00895)	(0.00744)	(0.00525)	(0.0101)	(0.00905)	
	[0.394]	[0.374]	[0.217]	[0.745]	[0.792]	
Rainfall Variability (σ/μ) (10 years)	-0.0245*	-0.0166	-0.0253	0.0194	0.0138	1.651
	(0.0119)	(0.0133)	(0.0165)	(0.0116)	(0.0156)	
	[0.415]	[0.529]	[0.417]	[0.191]	[0.565]	
Fixed Effects	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	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 °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 A34: 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 (σ/μ) (2 years)	-0.0104***	-0.0278**	-0.0313**	-0.0413***	-0.0370***	1.683
	(0.00284)	(0.00975)	(0.0107)	(0.0100)	(0.0113)	
	[0.192]	[0.049]	[0.108]	[0.055]	[0.238]	
Rainfall Variability (σ/μ) (3 years)	-0.0182***	-0.0240**	-0.0262**	-0.0290**	-0.0252**	2.270
	(0.00399)	(0.0105)	(0.00995)	(0.0102)	(0.00961)	
	[0.087]	[0.096]	[0.118]	[0.101]	[0.212]	
Rainfall Variability (σ/μ) (4 years)	-0.0259***	-0.0262***	-0.0289**	-0.0360***	-0.0310***	2.096
	(0.00353)	(0.00848)	(0.0107)	(0.0107)	(0.00909)	
	[0.041]	[0.022]	[0.040]	[0.036]	[0.033]	
Rainfall Variability (σ/μ) (5 years)	-0.0192***	-0.0145**	-0.0132*	-0.0213**	-0.0323***	2.393
	(0.00455)	(0.00672)	(0.00687)	(0.00786)	(0.00569)	
	[0.116]	[0.108]	[0.129]	[0.048]	[0.001]	
Rainfall Variability (σ/μ) (6 years)	-0.0227***	-0.0126*	-0.0108	-0.0351***	-0.0408***	1.920
	(0.00467)	(0.00638)	(0.00654)	(0.00937)	(0.00858)	
	[0.123]	[0.136]	[0.197]	[0.029]	[0.019]	
Rainfall Variability (σ/μ) (7 years)	-0.0270***	-0.0210***	-0.0242***	-0.0218***	-0.0308***	2.384
	(0.00466)	(0.00574)	(0.00530)	(0.00660)	(0.00643)	
	[0.070]	[0.043]	[0.026]	[0.077]	[0.042]	
Rainfall Variability (σ/μ) (8 years)	-0.0313***	-0.0278***	-0.0266***	-0.0263***	-0.0317***	1.669
	(0.00661)	(0.00330)	(0.00402)	(0.00324)	(0.00912)	
	[0.115]	[0.001]	[0.008]	[0.003]	[0.069]	
Rainfall Variability (σ/μ) (9 years)	-0.0302***	-0.0319***	-0.0319***	-0.0249**	-0.0296**	2.122
	(0.00679)	(0.00398)	(0.00388)	(0.00987)	(0.0103)	
	[0.129]	[0.050]	[0.043]	[0.247]	[0.258]	
Rainfall Variability (σ/μ) (10 years)	-0.0463***	-0.0379***	-0.0371**	-0.0104	-0.0132	1.429
	(0.00699)	(0.00979)	(0.0128)	(0.0127)	(0.0124)	
	[0.009]	[0.084]	[0.120]	[0.771]	[0.503]	
Fixed Effects	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	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. 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 Using the Standard Deviation of Rainfall as an Alternative Measure of Rainfall Variability

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 A35, A36. The inferences made about the main results are robust across different timing definitions (Tables A35, A36.

Table A35: Rainfall Variability and Consumption

	Log Real Consumption Per Capita					Std. Dev.
	(1)	(2)	(3)	(4)	(5)	(6)
Rainfall Variability (σ, 100mm) (2 years)	-0.0695***	-0.185***	-0.177**	-0.220**	-0.123**	0.330
	(0.0162)	(0.0502)	(0.0649)	(0.0775)	(0.0417)	
	[0.025]	[0.029]	[0.049]	[0.114]	[0.156]	
Rainfall Variability (σ, 100mm) (3 years)	-0.122***	-0.186**	-0.184**	-0.182**	-0.119**	0.372
	(0.0262)	(0.0651)	(0.0676)	(0.0787)	(0.0443)	
	[0.032]	[0.050]	[0.054]	[0.110]	[0.087]	
Rainfall Variability (σ, 100mm) (4 years)	-0.199***	-0.280***	-0.271***	-0.300***	-0.259***	0.328
	(0.0219)	(0.0537)	(0.0612)	(0.0523)	(0.0306)	
	[0.007]	[0.003]	[0.001]	[0.005]	[0.005]	
Rainfall Variability (σ, 100mm) (5 years)	-0.141***	-0.0907***	-0.0765*	-0.113*	-0.242***	0.352
	(0.0305)	(0.0298)	(0.0375)	(0.0571)	(0.0404)	
	[0.031]	[0.009]	[0.058]	[0.185]	[0.006]	
Rainfall Variability (σ, 100mm) (6 years)	-0.139***	-0.0233	0.0117	-0.0194	-0.124	0.258
	(0.0348)	(0.0750)	(0.0546)	(0.106)	(0.0818)	
	[0.106]	[0.801]	[0.875]	[0.905]	[0.376]	
Rainfall Variability (σ, 100mm) (7 years)	-0.129**	0.0321	-0.0222	0.0318	-0.0356	0.322
	(0.0481)	(0.0694)	(0.0545)	(0.0693)	(0.0612)	
	[0.296]	[0.692]	[0.754]	[0.725]	[0.749]	
Rainfall Variability (σ, 100mm) (8 years)	-0.160***	-0.0686	-0.0350	-0.00475	0.0236	0.251
	(0.0493)	(0.0658)	(0.0489)	(0.0604)	(0.0708)	
	[0.286]	[0.656]	[0.629]	[0.953]	[0.811]	
Rainfall Variability (σ, 100mm) (9 years)	-0.131*	-0.122*	-0.124**	0.0231	-0.0266	0.323
	(0.0679)	(0.0665)	(0.0511)	(0.0693)	(0.0641)	
	[0.389]	[0.425]	[0.307]	[0.767]	[0.792]	
Rainfall Variability (σ, 100mm) (10 years)	-0.162	-0.0841	-0.121	0.115	0.0921	0.275
	(0.101)	(0.105)	(0.123)	(0.0724)	(0.0903)	
	[0.299]	[0.567]	[0.498]	[0.294]	[0.550]	
Fixed Effects	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	2,686	2,686	2,686	2,686	2,686	

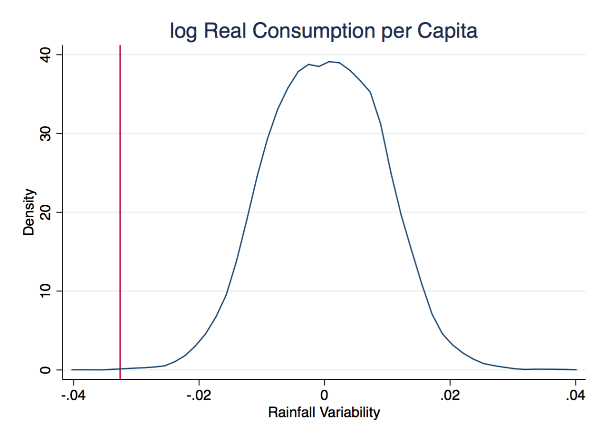
Notes: Significance levels are indicated as * 0.10 ** 0.05 *** 0.01. The unit of analysis is the household. Rainfall variability is defined as the standard deviation of rainfall. Historical measures of atmospheric parameters correspond to the time period, over which rainfall variability is measured. 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 A36: Rainfall Variability and Life Satisfaction

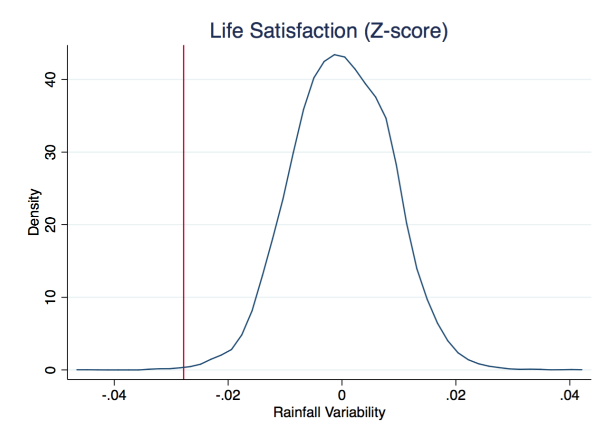
	(1) Life Satisfaction	(2) Life Satisfaction	(3) Life Satisfaction	(4) Life Satisfaction	(5) Life Satisfaction	(6) Within Group Std. Dev
Rainfall Variability (σ, 100mm) (2 years)	-0.0661**	-0.0851	-0.0862	-0.0855	-0.0534	0.285
	(0.0266)	(0.0591)	(0.0723)	(0.0933)	(0.0975)	
	[0.257]	[0.243]	[0.345]	[0.549]	[0.768]	
Rainfall Variability (σ, 100mm) (3 years)	-0.123***	-0.116	-0.126	-0.127	-0.103	0.322
	(0.0389)	(0.0743)	(0.0746)	(0.0870)	(0.0866)	
	[0.141]	[0.261]	[0.308]	[0.292]	[0.412]	
Rainfall Variability (σ, 100mm) (4 years)	-0.191***	-0.162**	-0.161**	-0.216**	-0.191**	0.277
	(0.0317)	(0.0648)	(0.0734)	(0.0833)	(0.0721)	
	[0.028]	[0.038]	[0.075]	[0.071]	[0.059]	
Rainfall Variability (σ, 100mm) (5 years)	-0.142***	-0.0892	-0.0784	-0.135*	-0.233***	0.300
	(0.0410)	(0.0508)	(0.0526)	(0.0677)	(0.0605)	
	[0.140]	[0.177]	[0.232]	[0.152]	[0.017]	
Rainfall Variability (σ, 100mm) (6 years)	-0.196***	-0.102*	-0.0895	-0.285***	-0.386***	0.221
	(0.0307)	(0.0530)	(0.0537)	(0.0930)	(0.0660)	
	[0.041]	[0.128]	[0.185]	[0.047]	[0.007]	
Rainfall Variability (σ, 100mm) (7 years)	-0.235***	-0.176***	-0.216***	-0.180***	-0.269***	0.284
	(0.0301)	(0.0507)	(0.0363)	(0.0596)	(0.0495)	
	[0.026]	[0.044]	[0.015]	[0.077]	[0.024]	
Rainfall Variability (σ, 100mm) (8 years)	-0.271***	-0.223***	-0.214***	-0.205***	-0.250***	0.223
	(0.0311)	(0.0248)	(0.0298)	(0.0251)	(0.0596)	
	[0.023]	[0.001]	[0.003]	[0.002]	[0.039]	
Rainfall Variability (σ, 100mm) (9 years)	-0.261***	-0.253***	-0.254***	-0.192**	-0.225***	0.277
	(0.0427)	(0.0273)	(0.0263)	(0.0661)	(0.0718)	
	[0.055]	[0.022]	[0.024]	[0.265]	[0.354]	
Rainfall Variability (σ, 100mm) (10 years)	-0.343***	-0.269***	-0.255***	-0.0963	-0.0970	0.245
	(0.0750)	(0.0722)	(0.0841)	(0.0708)	(0.0704)	
	[0.031]	[0.073]	[0.084]	[0.360]	[0.354]	
Fixed Effects			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	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 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).

Figure A1: Randomization Inference Distributions



(a) log Real Consumption per Capita



(b) Life Satisfaction (z-score)

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-values < 0.01.

A.3.3 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. 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 A2). 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 β's that are higher in absolute value than the original estimate of β, 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.

A.3.4 Alternative Functional Form Assumptions for Contemporaneous and Historical Weather Realizations

This section demonstrates that the results are robust to alternative functional forms for contemporaneous and historical weather realizations. Following Jayachandran (2006) we define low rainfall shocks as occurring if rainfall is within the bottom 20^{th} percentile of the historical rainfall distribution for each village. High rainfall shocks are defined to occur if rainfall is above the 80^{th} percentile of the historical rainfall distribution. Comparable measures are defined for temperature. We include a binary variable for contemporaneous realizations of these shocks, as well as a variable that calculates the total number of each shock type that occurred in the previous 5 years. Our results are broadly robust to the use of these alternative variables. In Table A37 we estimate that increases in rainfall variability controlling for shocks (columns 2 and 4) are associated with reductions in consumption and life satisfaction that are similar in magnitude to the main specification (columns 1 and 3).

Table A37: The Effects of Rainfall Variability on Consumption and Life Satisfaction (Weather Shocks Controls)

	(1) Real Consumption per Capita	(2) Real Consumption per Capita	(3) Life Satisfaction	(4) Life Satisfaction
Rainfall Variability (σ/μ)	-0.0326***	-0.0355***	-0.0323***	-0.0356***
	(0.00485)	(0.00234)	(0.00569)	(0.00234)
	[0.006]	[0.074]	[0.001]	[0.027]
Household Fixed Effects	Yes	Yes	–	–
Individual Fixed Effects	No	No	Yes	Yes
Time Fixed Effects	Year and Month			
Weather Shocks	No	Yes	No	Yes
Treatment Std. Dev.	2.808	2.865	2.393	2.609
Observations	2,686	2,686	4,033	4,033

Notes: Significance levels are indicated as * 0.10 ** 0.05 *** 0.01. The unit of analysis is the household level in column (1) and the individual level in columns (2) and (3). 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. All regressions include binary variables that indicate whether a low rainfall shock, high rainfall shock, low temperature shock, or high temperature shock occurred contemporaneously, as well as the sum of each type of shock over the previous 5 years. 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.3.5 Alternative Fixed Effects

This section presents results showing that our results are robust to alternative fixed effect choices. Specifically, we show that our results are robust to controlling for month-of-data fixed effects, i.e. year $\times$ month fixed effects, rather than year fixed effects and month-of-year fixed effects. This allows us to control for seasonality as before, alongside aggregate factors that vary month-to-month alongside aggregate factors that vary year-to-year.

Table A38: Rainfall Variability and Consumption

	Log Real Consumption Per Capita				
	(1)	(2)	(3)	(4)	(5)
Rainfall Variability (σ/μ)	-0.0212***	-0.0184***	-0.0168***	-0.0236***	-0.0353***
	(0.00321)	(0.00430)	(0.00473)	(0.00529)	(0.00441)
	[0.038]	[0.010]	[0.037]	[0.019]	[0.002]
Fixed Effects	Household & Month-Year				
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.	5.728	3.230	3.209	2.923	2.755
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 A39: Rainfall Variability and Life Satisfaction

	Life Satisfaction (Standardized)				
	(1)	(2)	(3)	(4)	(5)
Panel A:					
Rainfall Variability (σ/μ)	-0.0209***	-0.0167**	-0.0154**	-0.0234***	-0.0326***
(Total Effect)	(0.00455)	(0.00659)	(0.00713)	(0.00756)	(0.00568)
	[0.115]	[0.066]	[0.118]	[0.047]	[0.005]
Panel B:					
Rainfall Variability (σ/μ)	-0.0164***	-0.0128*	-0.0119	-0.0192**	-0.0278***
(Direct Effect)	(0.00433)	(0.00646)	(0.00687)	(0.00702)	(0.00549)
	[0.117]	[0.064]	[0.116]	[0.038]	[0.008]
Direct Effect Share (%)	78	76	77	82	85
Fixed Effects	Individual & Month-Year				
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.	4.997	2.863	2.838	2.570	2.357
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. 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).

A.3.6 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 A41 shows that rainfall variability has smaller effects on contemporaneous happiness.

Table A40: 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 (σ/μ)	-0.0132*	-0.0136**	-0.0364***	-0.0309***	-0.0375***
	(0.00685)	(0.00489)	(0.00440)	(0.00745)	(0.00428)
	[0.225]	[0.109]	[0.012]	[0.061]	[0.005]
Fixed Effects	Individual, Year, Month				
Weather Controls	Yes	Yes	Yes	Yes	Yes
Quadratic Weather Controls	Yes	Yes	Yes	Yes	Yes
Weather Interactions	Yes	Yes	Yes	Yes	Yes
Observations	4,029	4,027	4,031	4,029	4,033

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 A41: Rainfall Variability and Happiness

	Happiness (Standardized)				
	(1)	(2)	(3)	(4)	(5)
Rainfall Variability (σ/μ)	-0.00695*	-0.00324	-0.00454	-0.0145*	-0.0158**
	(0.00348)	(0.00592)	(0.00597)	(0.00708)	(0.00682)
	[0.188]	[0.698]	[0.612]	[0.084]	[0.080]
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	2.393
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).

A.4 Heterogeneous Effects: Uncertainty and Insurance

In the presence of partial insurance, uncertainty relating to future income will have an additional direct impact on welfare beyond the *ex post* realization of income shocks. Evidence of this was presented in the main results above. In this section we explore the degree to which households may be differentially able to mitigate this effect.

Specifically, we explore the degree to which membership in "Eqqub", a voluntary association that regularly pools funds and rotates among members, can affect the impact of rainfall variability on life satisfaction and real per capita consumption. "Eqqub" are the dominant form of informal insurance in Ethiopia and are a balanced reciprocity risk sharing mechanism. While rotary savings are often used to allow savings to purchase an indivisable durable good, that they are also used for insurance, whereby members may pay another member to receive the pot at a time of need (Anderson and Baland, 2002; Calomiris and Rajaraman, 1998; Klonner, 2001). Given the aggregate nature of rainfall variability it may not be obvious as to how eqqub can help. Members of Eqqub can join from distant villages, although we have no way of determining whether this is the case. A more important issue relates to the interpretation of this exercise. Eqqub's are self-organized groups and so Eqqub membership is indeed endogenous. To minimize this concern we focus on households that have always been eqqub members to avoid selection based on changes in rainfall variability. Consequently, our measure of eqqub membership is orthogonal to changes in rainfall variability. Furthermore, household that enter into are of course a selective group and so the moderating effect of eqqub on rainfall variability may also capture the unobservable characteristics of households that led them to select into membership. Consequently, any moderating effect should be interpreted carefully.

This exercise serves to provide further evidence in support of our interpretation of results: that rainfall variability captures the effects of income uncertainty, rather than a realized shock. In response to an increase in uncertainty, "insurance" should attenuate the effects of rainfall variability on life satisfaction. It should not have an effect on real per capita consumption as households will not have received a payout. In fact, expenditures may increase, exacerbating the effects on consumption, if households decide to invest more in "Eqqub". By contrast, if rainfall variability captures the effects of realized shocks then "insurance" should mitigate both the life satisfaction and real per capita consumption effects, as households would have received payouts over this period.

We explore the moderating effect of insurance by estimating the following regression,

$$\begin{aligned} Y_{it} &= \beta_1 \text{Rainfall Variability}_{v\underline{t,\ldots,t-4}} \\ &\quad + \beta_2[\text{Rainfall Variability}_{v\underline{t,\ldots,t-4}} \times \text{Eqqub}_i] \\ &\quad + \gamma f(\mathrm{w}_{v\underline{t,\ldots,t-4}}) + \alpha_i + \alpha_m + \alpha_t + \epsilon_{ivt} \end{aligned} \tag{5}$$

where Y_{it} is either life satisfaction or real per capita consumption, and β_2 captures the interaction between rainfall variability and membership in "Eqqub".

We define a household to be insured if an individual is part of a household that has always been part of Eqqub. Consequently, we do not explore variation in membership that could be associated with changes in rainfall variability. We compare individuals who are part of households who have always been part of Eqqub to households that have not always been part of Eqqub. Consequently, the level effect is absorbed by the individual fixed effects. The interaction term is identified as long as "always being a member of Eqqub" is not correlated with any other omitted variables that could also affect the relationship between rainfall variability and the outcomes of interest. This identifying assumption is valid even if membership is endogenous to the outcome variables themselves. Nevertheless, the focus of this exercise is to provide a consistency check for the interpretation of the previous results, and should not be thought of as identifying the causal effect of Eqqub.

In Table A42 we explore the moderating effects of Eqqub membership on life satisfaction and consumption. Panel A presents the results relating to life satisfaction and Panel B presents the results relating to consumption. In Panel A we find that, across all specifications, if a household is "insured", this completely offsets the negative effects of rainfall variability on life satisfaction, consistent with the premise that Eqqub (or other time-invariant factors associated with membership) may play a role in providing insurance for these households. These findings are robust across specifications and to adjusting standard errors to account for the small number of clusters.

By contrast, Panel B provides little evidence to suggest that Eqqub membership (or other time-invariant factors associated with membership) attenuates the effects of rainfall variability on consumption. In the event of a realized shock, we would expect that access to insurance would attenuate the negative effects on consumption. Indeed, the point estimate suggests that Eqqub membership exacerbates the effects on consumption, suggesting that Eqqub may be a mechanism through which households engage in precautionary saving. This effect is not robust across specifications and does not remain statistically significant after accounting for the small number of clusters.

Table A42: Insurance Effects: Rainfall Variability, Life Satisfaction, and Consumption

	Life Satisfaction (Standardized)				
	(1)	(2)	(3)	(4)	(5)
Panel A:					
Rainfall Variability (σ/μ)	-0.0195***	-0.0145**	-0.0132*	-0.0213**	-0.0326***
	(0.00452)	(0.00663)	(0.00677)	(0.00784)	(0.00566)
	[0.110]	[0.102]	[0.127]	[0.048]	[0.000]
Rainfall Variability × Insured	0.0319**	0.0332**	0.0318**	0.0351*	0.0339*
	(0.0138)	(0.0148)	(0.0136)	(0.0165)	(0.0170)
	[0.052]	[0.051]	[0.044]	[0.072]	[0.219]
H_0: Rainfall Variability + (Rainfall Variability × Insured) = 0	0.0124	0.0186	0.0185	0.0138	0.0013
	(0.0139)	(0.0196)	(0.0184)	(0.0200)	(0.0198)
	Log Real Consumption Per Capita				
	(1)	(2)	(3)	(4)	(5)
Panel B:					
Rainfall Variability (σ/μ)	-0.0187***	-0.0141***	-0.0122**	-0.0184***	-0.0325***
	(0.00303)	(0.00445)	(0.00522)	(0.00587)	(0.00480)
	[0.035]	[0.016]	[0.076]	[0.068]	[0.004]
Rainfall Variability × Insured	-0.0207	-0.0190	-0.0218	-0.0152	-0.0107**
	(0.0139)	(0.0119)	(0.0136)	(0.00995)	(0.00404)
	[0.469]	[0.466]	[0.485]	[0.481]	[0.163]
H_0: Rainfall Variability + (Rainfall Variability × Insured) = 0	-0.0393**	-0.0330**	-0.0340**	-0.0335***	-0.0432***
	(0.0149)	(0.0116)	(0.0131)	(0.0104)	(0.0063)
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	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. "Insured" is a binary variable equal to 1 if the household has been a member of eqqub for both rounds and zero otherwise. 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. All regressions include linear, quadratic, rainfall and temperature controls, as well as interactions between rainfall and temperature measures. 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).

References

Anderson, S. and J.-M. Baland (2002). The economics of roscas and intrahousehold resource allocation. *Quarterly Journal of Economics 117*(3), 963–995.

Calomiris, C. and I. Rajaraman (1998). The role of roscas: Lumpy indivisibles or event insurance. *Journal of Development Economics 56*(1), 207–216.

Colmer, J. (2021a). Rainfall variability, child labor, and human capital accumulation in rural ethiopia. *American Journal of Agricultural Economics 103*(3), 858–877.

Colmer, J. (2021b). Temperature, labor reallocation, and industrial production: Evidence from india. *American Economic Journal: Applied Economics*.

Dercon, S. (2004). Growth and shocks: Evidence from rural ethiopia. *Journal of Development Economics 74*(2), 309–329.

Foster, A. and M. Rosenzweig (2004). Agricultural productivity growth, rural economic diversity, and economic reforms: India 1970 - 2000. *Economic Development and Cultural Change 52*(3), 509–542.

Jayachandran, S. (2006). Selling labor low: Wage responses to productivity shocks in developing countries. *Journal of Political Economy 114*(3), 538–575.

Kaur, S. (2019). Nominal wage rigidity in village labor markets. *American Economic Review 109*(10), 3585–3616.

Klonner, S. (2001). How roscas perform as insurance. *Mimeo*.

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