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Evidence from Rural Households

Carolina Bernal
Razvan Vlaicu

Inter-American Development Bank
Department of Research and Chief Economist

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Carolina Bernal*
Razvan Vlaicu**

* Universidad del Rosario
** Inter-American Development Bank

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Abstract. This paper examines how rural households cope with climate change related rainfall shocks by re-allocating children's time between domestic activities and school attendance. Households affected by an unanticipated rainfall shock face an inter-temporal trade-off between current household income and future potential earnings. Financial inclusion may mitigate or exacerbate the human capital impacts of rainfall shocks depending on whether it relaxes or constrains household budgets. The data come from a three-round panel household survey in rural Colombia collected between 2010-2016. The main findings are that rainfall shocks induce households to choose immediate benefits over long-run investments in education by increasing the incidence of child labor and household chores at the expense of school attendance. Over-indebtedness through pre-existing formal loans reinforces the likelihood that a child works due to rainfall shocks, whereas asset insurance, foreign remittances, and natural disaster aid mitigate or eliminate the shock-induced shift toward domestic activities and away from schooling.

JEL classifications: D14, J13, J22, O15, Q54

Keywords: Child labor, Human capital, Rainfall shocks, Climate change, Financial inclusion, Rural households

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C. Bernal, School of Economics, Universidad del Rosario, Calle 12C # 4-79, Bogotá, Colombia. Email: carolina.bernalmac@urosario.edu.co. R. Vlaicu, Research Department, Inter-American Development Bank, 1300 New York Ave NW, Washington, DC 20577, United States. Email: vlaicu@iadb.org. The findings and interpretations in this paper are those of the authors and do not necessarily reflect the views of the Inter-American Development Bank or the governments it represents.

1. Introduction

As a result of climate change, extreme weather events are likely to increase in frequency (IPCC, 2012). Developing countries are especially vulnerable to the effects of extreme weather events, and Colombia is one of the most exposed countries in Latin America. Particularly in rural areas, climate change directly affects the health and well-being of households that depend on natural resources for their basic subsistence (Patz et al., 2005). These households usually rely on climate-sensitive resources such as local water supplies and agricultural land and engage in climate-sensitive activities such as growing crops and raising livestock (Morton, 2007). Climate change can decrease the availability or quality of these local natural resources, restricting the options of rural households dependent on them for consumption, production, or trade.[1]

Furthermore, some of the most vulnerable countries to climate change, according to the Climate Vulnerability Index, also display various barriers to access and usage of financial services such as formal credit or insurance. More specifically, the population most vulnerable to climate change has limited access to formal insurance and credit to cope with risky scenarios such as floods, droughts, or temperature anomalies (Dercon, 2002; Karlan et al., 2014; Moore et al., 2019). Consequently, households might resort to informal risk coping mechanisms, such as child labor, to smooth their consumption, perpetuating the cycle of poverty into the next generations by forcing families to decrease investment in their children's human capital (Skoufias, 2003; Ferreira and Schady, 2009). Thus, if households regard child labor as a potential buffer against weather shocks, higher household financial inclusion could help mitigate these shocks' impacts by covering for current household needs through intertemporal risk management.

[1] According to the University of Notre Dame Global Adaptation Index (ND Gain), the majority of developing countries have high vulnerability indexes, with Somalia and Niger in 2017 reaching 0.67. In addition, Kompas et al. (2018) show that developing countries have the largest long-run impacts of climate change scenarios on world GDP. If the temperature raises 1°C, it is estimated that Colombia would lose 1.104% of GDP annually, which is above the median in this group.

The use of insurance, in particular, has been shown to mitigate shock-induced income uncertainty, as it improves the capacity to evaluate and deal with risks, smooths consumption cycles in the presence of adverse shocks, protects savings, avoids over-borrowing, and increases the ability to invest in productive activities (Mahul and Stutley, 2010; Cai et al., 2015; Cai, 2016; Cole et al., 2017).

This paper examines the effect of rainfall shocks on rural households' time allocations between children's domestic activities (labor and chores) and school attendance. Specifically, using data from a panel household survey from rural Colombia, the paper investigates the extent to which these transitory shocks lead households to increase child labor supply at the expense of schooling and whether different types of household financial inclusion mitigate or exacerbate these choices.

Data on household outcomes and characteristics are drawn from three rounds of a longitudinal survey of Colombian rural households, Encuesta Longitudinal Colombiana (ELCA), matched with station-level meteorological data from the Institute of Hydrology, Meteorology and Environmental Studies (IDEAM). The paper uses difference-in-differences empirical strategies that exploit the time and space variation in rainfall shocks to estimate the relationship between weather variability and child labor. Several measures of rainfall shocks are considered and validated with shocks households self-report to have experienced.[2]

Rainfall is the most important dimension of weather variation in Colombia. Because of its position on both the Caribbean and Pacific oceans, Colombia is prone to extreme weather caused by the El Niño-Southern Oscillation (ENSO) climate patterns, which implies that precipitation amounts vary widely over time and space, with some periods characterized by heavy rainfall and others by intense droughts (Cai et al., 2020; Carrillo, 2020). As a result, Colombia experiences a high incidence of extreme weather events and is highly vulnerable to

[2]The main reasons behind using this survey instead of the Demographic and Health Survey (DHS) are that the ELCA allows for household-level analysis and the ELCA has information related to the use of formal and informal financial services.

the effects of climate change. According to the Global Climate Risk Index 2012, Colombia was the third most affected country by weather-related economic losses.

The economic literature has examined how extreme weather events influence economic outcomes, including human capital accumulation (Dell et al., 2014). The weather impacts on human capital can operate through multiple channels: higher temperatures are associated with a decrease in income (Dell et al., 2009; Schlenker and Roberts, 2009; Fisher et al., 2012); agricultural- and non-agricultural wages are related to rainfall variations (Rosenzweig and Udry, 2014; Mahajan, 2017); the occurrence of floods is strongly associated with worsening food security and child stunting (Dornan et al., 2014); higher early-life rainfall has statistically significant causal effects on anthropometric measures (Maccini and Yang, 2009; Tiwari et al., 2013; Thai and Falaris, 2014).

Regarding schooling and child labor, the literature has generally found that weather events tend to reduce children's participation in educational activities while increasing their domestic activities (Jensen, 2000; Maccini and Yang, 2009; Björkman-Nyqvist, 2013; Thai and Falaris, 2014; Marchetta et al., 2018). This literature focused on low-income countries in Africa and Asia, with less work being done in upper middle-income countries like Colombia. In this context, we find that rainfall shocks increase the likelihood of child labor by 5 percentage points and of chores by 9 percentage points, while decreasing the probability that a child attends school by 4 percentage points. These findings are consistent with a household demand mechanism rather than being driven by school closings or damaged public infrastructure.[3]

The effects of financial services on child labor have been studied by several papers. The majority of the literature has studied the role of financial inclusion as a direct effect, however, not as a moderating factor. When credit and insurance markets function poorly or do not exist, children act as an insurance asset to smooth household consumption in the presence

[3]We define a rainfall shock as monthly rainfall exceeding one standard deviation of the monthly rainfall distribution of the last 30 years for a municipality. Alternative measures yield similar results.

of uncertainty about future income (Jacoby and Skoufias, 1997; Pörtner, 2001; Beegle et al., 2006; Guarcello et al., 2010; Bandara et al., 2015). Imperfections in the credit (financial) market show two main opposing effects of household access to credit (Wydick, 1999). The first one is where child labor is used as a substitute for hired labor in a family enterprise in the presence of labor-capital binding constraints. Therefore, when a household has access to credit these constraints are relaxed, allowing the family to replace child labor with hired labor (Ranjan, 2001; Ersado, 2005; Edmonds, 2006; Dumas, 2013; Becchetti and Conzo, 2014). The other effect is that as the family business becomes more capitalized, the marginal product of family labor increases, increasing the opportunity cost of schooling. Suppose this second effect dominates the first effect. In that case, theoretically, investment in schooling would decrease as credit constraints are relaxed for the family business (Casabonne, 2006; Hazarika and Sarangi, 2008; Menon, 2010; Islam and Choe, 2013; Lakdawala, 2018).

Given this research, it seems likely that financial inclusion may act as a moderating factor in the households' response to weather shocks through the re-allocation of child activities. This is mostly true in our data. We find that holding asset insurance, being a recipient of foreign remittances, and receiving natural disaster aid, indeed mitigate the substitution of child labor and chores for schooling in response to rainfall shocks. However, we also find that over-indebted households that held more than two formal loans before the shock show a more pronounced increase in child labor as they adjust more on this margin. This suggests that prior responsible use of access to finance is an important factor in overcoming significant budget shortfalls.

The rest of the paper is organized as follows. Section 2 provides a theoretical framework, and section 3 summarizes the data sources. Section 4 describes the identification strategy to estimate the effect of rainfall shocks on child labor. Section 5 reports the main findings and performs robustness checks. Section 6 investigates the role of household financial inclusion, and Section 7 concludes.

2. Hypotheses and Mechanisms

In the presence of weather shocks, rural households that mainly depend on agricultural production for their living may lose part of the production (e.g., a flood that leads to crop failure), or part of its physical capital, representing an income shock to the household. If households want to succeed in smoothing their consumption profile but are credit constrained or lack insurance, they are forced to resort to potentially costlier mechanisms to cope with weather shocks, such as child labor (Beegle et al., 2006).

The way this works is that when hit by a weather shock, households may choose to increase child labor and chores, either by sending children to work for pay or by having children complement adult labor in domestic activities such as gathering firewood and collecting water (Basu and Van, 1998; Beegle et al., 2006). The required child time and effort can even lead to a decrease in school attendance. Therefore, households are induced to alter the allocation of children's time among studying, working, and leisure. Depending on the magnitude of the shock, households may be forced to take children out of school to dedicate their time exclusively to work or modify their leisure time.

At the household level, child labor comes from an intertemporal trade-off between immediate benefits (increased current household income) and long-run benefits (higher potential future earnings). These immediate benefits interfere with the accumulation of the child's human capital, implying potential long-run costs (Akabayashi and Psacharopoulos, 1999). By entering the job market at an early age, an individual can make an immediate contribution to the household income and perhaps gain labor market experience. However, this increase in household earnings potentially carries a long-term cost to the extent that the time children spend working could be used instead for building up their long-run human capital (Dehejia and Gatti, 2005). The nature of this cost depends on the alternatives to child labor, such as schooling or time spent playing, which also contributes to cognitive development.

An important moderation channel that allows households to deal with this trade-off optimally is access to credit and insurance. Households may borrow against future income and/or have financial protection against potential losses, allowing them to smooth weather-induced income fluctuations without resorting to child labor (Bandara et al., 2015). Thus, when faced with a transitory weather shock, households would use credit or insurance to offset the shock.

However, there could be unexpected implications of credit access in this context, as mentioned before, because as a family farm (or business) becomes more capitalized, the marginal product of family labor increases due to better access to complementary inputs (physical capital) and intermediates (e.g., fertilizer), increasing the opportunity cost of schooling (Wydick, 1999). In other words, when households have access to credit for the family farm, child productivity goes up, raising the returns to child labor. This occurs when children play an important role in the family farm's initial growth because, as the farm grows, children provide the additional labor required at times when the returns are not high enough to hire an adult employee. Therefore, in the presence of a weather shock, a farm that does not have the resources to hire an adult employee may need to resort to child labor to cope with production declines.

There could be another explanation for the unintended effects of credit taken before the occurrence of the rainfall shock. For example, Duygan-Bump and Grant (2009) show that delays in credit repayments are the result of adverse events that affect a household, such as bad health or unemployment. Since a rainfall shock works as an income shock, households might have more pressure to make their credit repayments on time. Therefore, to find additional income resources to repay on time, households have an added incentive to resort to child labor. However, if the household received the credit after the shock, it can relieve some pressures by increasing the capital available to replenish lost physical capital and restore production levels.

The type of credit taken by the household is also important, because if the household receives an agricultural loan, this capital can better contribute to avoiding child labor, either by allowing the acquisition of adult labor or by increasing the productivity of the farm and thus reducing the number of hours a child would have to work. A similar point can be made about insurance. Asset insurance is more likely to help smooth over the effects of a rainfall shock compared to less relevant types of insurance, such as health insurance or life insurance.[4]

If the household is a beneficiary of a conditional cash transfer program, such as *Familias en Acción* in Colombia, children might be less prone to engage in labor activities in response to weather shocks. Here, the government provides educational subsidies conditional on regular school attendance. The program thus motivates parents to support their children's continued school attendance. However, it is unclear whether these types of programs eliminate the possibility of child labor because households may prefer to combine schooling and labor, considering that cash transfers are perhaps not large enough to eliminate the incentive to forgo children's labor income completely (Bourguignon et al., 2003; Cardoso and Souza, 2004).

Lastly, the literature has found evidence regarding financial assistance and its impact on child labor. For example, cash transfers reduce children's participation in work (Datt and Uhe, 2019) and hours worked (De Hoop and Rosati, 2014). Also, foreign remittances sent by migrant workers to their families reduce the labor supply of children in developing countries (Ebeke, 2012; Cuadros-Menaca and Gaduh, 2020), and remittances received through mobile money apps allow households to smooth their consumption in the aftermath of rainfall shocks (Riley, 2018). In addition to this, the survey provides information on whether the household

[4]Using a panel household survey in a rural region of Tanzania, Beegle et al. (2006) find evidence implying that insurance or access to credit might reduce the extent of child labor. Using data from rural Bangladesh, Islam and Choe (2013) show evidence that children who are taken out of school are more likely to work in household enterprises dependent on credit than in other types of work. In another study from Bangladesh, Hossain (2023) exploits an agricultural credit expansion program and finds that it increases child self-employment, but detects no effects on schooling.

received any assistance due to the occurrence of a natural disaster. This help does not necessarily have to come from the government; it can also come from NGOs, family, and friends, among others. On this account, when the household receives this type of help, it directly targets the need engendered by the shock; therefore, it should help to mitigate all the effects resulting from the shock, at least partially.

To sum up, what can be expected is that a rainfall shock acts as an income shock on the household, generating an increase in child labor or chores and a reduction in school attendance. Additionally, the levels of credit taken prior to the shock may lead to ambiguous effects. However, households that receive another type of assistance (e.g., aid for natural disasters) should mitigate the effects of the rainfall shock.

3. Data

This paper exploits two different data sources: a multi-round household panel survey (ELCA) and weather station data (IDEAM).

3.1. Household panel survey (ELCA). The Colombian Longitudinal Survey (ELCA) comes from the Center for Studies on Economic Development (CEDE) at Universidad de los Andes in Bogota, Colombia. It contains geocoded information on households, children, and land use collected during three rounds: 2010, 2013, and 2016. The literature has defined child labor to refer to children aged between 5 and 17, and we follow that convention in the paper to the extent possible.[5]

Child labor can be defined at the extensive margin, capturing whether a child does any type of work in the past week, and similarly for whether a child does any household chores, or attends school. Child labor can also be defined at the intensive margin, using the total number of hours spent in economic activities in the past week; a related measure is the time

[5]The first round does not contain information on children between 10 and 17 years old. The third round did not collect information about child labor for some 5-year-old children. All results remain robust when restricting the sample to children between 6 and 17 years old in the last two rounds.

spent doing chores for the household.[6] While the distinction may not always be clear-cut, the survey questions attempt to differentiate between working and doing chores related to agricultural activities in the household.[7]

In order to examine the household financial inclusion moderating channel, we use the information on the use of financial services or assistance, such as whether someone in the household has a loan with a formal institution, the acquisition date and type of the loan, whether the household holds different types of insurance, whether it receives remittances from abroad, and whether it has received natural disaster aid.

In addition, the longitudinal survey has other relevant variables such as age, gender, household size, age of the household head, level of education attained by the parents, parents' employment, amount of land available for cultivation by the household, and participation in social programs.[8]

The sample included 3,090 rural households in the 2010 round, 2,848 in the 2013 round, and 2,346 in the 2016 round; see Table 1. The number of children varies across survey rounds as well, with older children about twice as many as younger children; see Table 2. The sample is probabilistic, stratified, multistage, and cluster, selecting municipalities based on demographic and socioeconomic characteristics. The rural sample is representative of small farmers in four rural micro-regions, with differences in their economic model: Mid-Atlantic, Coffee Region, Cundiboyacense, and Center-East; see Figure A.1 for the geographic locations of the surveyed municipalities. Between survey rounds, households in the panel may move, in which case they are interviewed in the new location to the extent that the survey team is able to reestablish contact.

[6]In 2010, there is only information on the hours that children between 5 and 9 years old worked in the last week prior to the survey. In 2013 and 2016, since the working age population is measured from 10 years old, the number of hours worked varies slightly as follows: How many hours a week do you usually work in your job?

[7]The survey question on household chores applies to children between 5 and 13 years old for the second round, and 6 and 16 years old for the third round.

[8]For detailed variable definitions based on the original CEDE survey questions, see Appendix A.3.

3.2. Weather station data (IDEAM). Rainfall and temperature data come from Instituto de Hidrología, Meteorología y Estudios Ambientales (IDEAM), which has geocoded monthly data by weather station for the last 30 years. As input for the *rainfall shock*, we consider the monthly precipitation levels recorded at each weather station. The rainfall shock at the household level is based on the nearest weather station; in total, we match a maximum of 130 stations to households over the three rounds. The average distance of a household from a weather station is 6.3 km.[9]

Following Jensen (2000); Kazianga and Udry (2006), we define a rainfall shock as a dummy variable that takes value one if the household experienced at least one monthly rainfall one standard deviation above average monthly rainfall of the last 30 years for the municipality, within the three months prior to the survey interview. We also tried narrower and wider time windows of one month and six months, respectively.

To check whether this measure of rainfall shock is capturing a meaningful event, we validate the IDEAM rainfall-based definition of the shocks with a household self-reported measure of flood exposure from the ELCA survey. We also perform sensitivity checks by changing the definition of rainfall shock to alternative ones proposed in the literature. Burke, Hsiang, and Miguel (2015) define rainfall shocks above or below specific percentiles of the sampling distribution of rainfall. Above the 80^{th} percentile is a weak shock, above the 85^{th} percentile is a moderate shock, and above the 90^{th} percentile is a severe shock.[10]

3.3. Descriptive statistics. The first round of the ELCA survey began collecting data on 6,376 children from 3,090 households. The main outcomes for this study vary across age and gender in predictable ways. Figure 2 shows the patterns graphically by plotting the means of the outcomes by age and gender group. We notice that the prevalence of labor and chores

[9]See Tables A.1 and A.2 on the number of unique weather stations matched to each municipality for the whole sample and by year.

[10]Dell, Jones, and Olken (2014); Marchetta, Sahn, and Tiberti (2018) define shocks as the deviation from the long-run mean. Dell, Jones, and Olken (2014); Deschênes and Greenstone (2011) define the shock as the number of days or months exposed to the shock.

increases with age, while school attendance decreases with age, particularly after age 13. In the bottom figure, girls are less involved in labor and more involved with chores than boys, whereas school attendance is roughly equal across genders.[11]

Summary statistics of the outcome variables are in Table 4. Overall across the three survey rounds, 12% of the children 5-17 years old did labor in the week prior to the interview, and 71% of children helped with chores around the house. About 93% of the children in the surveyed households attended school. In the sample, 48% of the children are female, and the average age of a child is around 11 years.[12]

Table 3 reports the number of children affected by a rainfall shock, by survey round. Figure A.1 plots the municipalities that were affected by a rainfall shock in each round. Darker colors indicate later rounds.

Table A.3 shows that alternative measures of rainfall shocks correlate well with survey self-reported flood exposure in the last three years. Our preferred measure of rainfall shocks appears in columns (1)-(2) and is again based on rainfall that exceeds one standard deviation of the 30-year rainfall distribution at the weather station.

Table 4 shows summary statistics on different types of self-reported shocks affecting the household in the last three years, such as flooding, job loss of the household head or any household member, animal death or disease, crop failure, or other agricultural shocks. About 15% of responses indicate that a flood event has taken place in the past three years.

Table 4 also reports summary statistics for various household characteristics. On average, children live in a household composed of 5.78 people. The average age of the household head is around 46 years. About 19% of the children within the sample live in a female-headed household, and about the same fraction live in a household where the household head achieved high school education or more. Around 40% of the households have had formal

[11]Figure A.2 further divides the age distributions of outcomes by gender, which reveals that the labor-age gradient for boys is steeper than for girls.

[12]See Table 2 for a breakdown of the samples between younger children 5-9 years old, and older children 10-17 years old.

loans before the shock, and 23% have some form of insurance, with 4% of households holding asset insurance (covering crop, machinery, car, or building loss). About 2% of households receive remittances from abroad, and 1% benefited from natural disaster relief.

4. Empirical Strategy and Specifications

The main objective of the paper is to estimate the impact of rainfall shocks on child labor and the alternative activities of household chores and school attendance. We exploit the available variation in rainfall to study the incidence of extreme rainfall within households over time to identify these effects.

Before doing so, however, it is important to provide some validation for the rainfall shock measure we created based on the approach proposed by Jensen (2000); Kazianga and Udry (2006). The survey rounds contained questions about disruptive household events happening in the three years prior to the interview, for example experiencing flood damage, a crop failure, or a job loss. Thus, we can check if the rainfall shocks based on geolocated rainfall data are correlated with these self-reported events. The self-reported shock with the strongest correlation should be flood shocks, while other types of shocks should correlate less or show no correlation. This exercise can be done using the following specification:

$$Event_{jmt} = \alpha Shock_{jt} + \mu_j + \mu_m + \mu_{dt} + \varepsilon_{jmt} \tag{4.1}$$

where $Event_{jmt}$ is the shock event reported by household j from municipality m in survey round t, $Shock_{jt}$ is the rainfall shock indicator for when precipitation exceeds one standard deviation from its long-run mean, the indexed constants μ_j, μ_m and μ_{dt} are household, municipality, and department-time fixed effects respectively, and ε_{jmt} is the error term.[13]

[13]The reason behind including household and municipality fixed effects at the same time is that some households migrate to different municipalities. For example, 72 households out of 3,247 moved to a different municipality between rounds two (2013) and three (2016), meaning 2.22% of households moved.

The main specification for the effect of rainfall shocks on whether the child worked, did any household chores in the past week, or attended school, takes the following form:

$$y_{ijmt} = \beta Shock_{jt} + \gamma' X_{ijmt} + \mu_j + \mu_m + \mu_{dt} + \mu_\tau + \varepsilon_{ijmt} \tag{4.2}$$

where y_{ijmt} is an indicator of whether child i in household j participates in labor activities, $Shock_{jt}$ is the measure of rainfall shock at the household level. As in equation (4.1), we include several levels of fixed effects. Here we also add μ_τ, which are month fixed effects. This is to control for seasonality effects, i.e., the possibility that the timing of recurring school time and vacations may be correlated with the timing of the rainy season as well as with child activities.

Equation (4.2) is a type of a two-way (household and time) fixed effects specification, which means that we are identifying the effects of rainfall shocks based on within-household variation in a difference-in-differences design. The reason for relying on within-household variation is that rainfall shocks affect groups of, usually closely located, households rather than individual households; in other words, they are aggregate shocks rather than idiosyncratic shocks. The implication is that sample households may not be as-if randomly assigned to treatment, thus not completely ruling out correlations between the rainfall shocks and household characteristics.[14] At the same time, given their unusual magnitude, the rainfall shocks are likely unexpected. Thus there should be no anticipation of treatment, making a difference-in-differences design appropriate.

The vector X_{ijmt} contains a set of covariates measuring individual and household characteristics such as household head's education, household head's age, gender, household size, participation in governmental programs, household engaged in at least one agricultural activity, distance to the nearest weather station, presence of children over 10 years old in the household, the child's age, and child's gender. Standard errors are clustered at the household

[14]In Table A.4 we check for balance in pre-shock characteristics and find some statistically significant, if mostly small, differences using municipality fixed effects.

(treatment) level to control for the possible correlation of another type of shock within the household across years.

As discussed in Section 2, we expect rainfall shocks to increase child labor on average, that is $\beta > 0$. Here β measures the change, expressed in percentage points, in the likelihood that a child works after their household is exposed to a rainfall shock versus when the household is unaffected by a rainfall shock. The main outcome is based on the number of hours the child spent working the past week.[15]

In addition to this two-way fixed effects specification, we also work with a canonical two-groups/two-periods difference-in-differences specification, obtained by time differencing equation (4.2) as follows:[16]

$$\Delta y_{ijm} = \beta \Delta Shock_j + \gamma' \Delta X_{ijm} + \Delta \mu_d + \Delta \varepsilon_{ijm} \tag{4.3}$$

We estimate this equation separately for the periods 2010-2013 and 2013-2016, in each case restricting the sample to households that were not treated in the pre-period. Some of these will be treated in the post-period. Thus, the impact of the shock is identified by comparing the pre-versus-post difference in outcomes of the households that received the rainfall shock in the post-period versus those that did not. Note that in this case, $Shock_{jt-1} = 0$ and therefore $\Delta Shock_j = Shock_{jt} - Shock_{jt-1} = Shock_{jt}$.

We also investigate the role of financial factors as potential moderators of the impact of rainfall shocks. This can be achieved by estimating the following specification:

$$y_{ijmt} = \beta_1 Shock_{jt} + \beta_2 Shock_{jt} \times Fin_{jt} + \beta_3 Fin_{jt} + \mu_j + \mu_m + \mu_{dt} + \varepsilon_{ijmt} \tag{4.4}$$

where Fin_{jt} is a financial factor, capturing either financial services or financial assistance. The coefficient of interest is β_2, which captures the differential impact of a shock between

[15]We also report versions of equation (4.2) estimated at the household level, in which case the outcome is the fraction of children living in the same household who are engaged in labor.

[16]Goodman-Bacon (2021) shows that the two-way fixed effects estimator is equivalent to a weighted average of canonical two-groups/two-periods difference-in-differences estimators.

households with access to financial services or resources versus those without. Some of these financial factors may mitigate the effect of rainfall shocks on child labor, i.e., $\beta_2 < 0$, while others may exacerbate it, in which case $\beta_2 > 0$.[17]

Insured households or those benefiting from foreign remittances or receiving natural disaster aid should be better positioned to smooth their consumption through time following the income shock they experienced, by helping circumvent the inter-temporal trade-off between increasing current household income and reducing future potential earning through the accumulation of the children's human capital (Akabayashi and Psacharopoulos, 1999).

5. Empirical Results

We begin by investigating whether the weather-station-based rainfall shocks accurately measure a shock as experienced and reported by a household in the sample. The relationship should not be perfect, as the precipitation-based measure refers to the previous three months, whereas the survey-based measure refers to the previous three years. Nevertheless, we check if the former predicts the second, using the model in equation (4.1). This is a linear probability model where the self-reported shock is a function of the rainfall shock, using municipality and department-year fixed effects in the first column and adding household fixed effects in the second column.

The results are presented in Table A.5. The estimates show that the coefficient on the rainfall shock in columns (1) and (2) is positive and statistically significant. The occurrence of a recent rainfall shock is associated with a 9-11 percentage point increase in the probability that a household reports having experienced a flood in the past three years. In contrast, the relationship between rainfall shocks and other types of shocks, such as job loss or agricultural losses, shown in the following columns, is not as clear.

[17]Note that the results coming from this exercise are suggestive about potential moderators, but not necessarily causal, as the data do not contain purely exogenous variation in financial inclusion factors.

5.1. Main Results. We now turn to the relationship between rainfall shocks and child activities. Table 5 presents the main result of the paper, based on equation (4.2). We estimate two-way (unit and time) fixed effects models that take advantage of the panel structure of the dataset. Specifications differ in the level of the fixed effects: we first include municipality and department-year fixed effects; then we add in household fixed effects; then we add covariates; finally, we add month fixed effects. The covariates control for the age of the child, gender, education level and age of the household head, household size, whether the household has children older than 10, whether the household participates in Familias en Acción, and the distance of the household to the nearest weather station. Standard errors are clustered at the household level.

The coefficient estimates for the three child outcomes, labor, chores, and schooling, suggest that households adjust child activities in response to a rainfall shock. The estimated probability that a child worked in the week prior to the interview increases by about 5 percentage points after a recent rainfall shock; this is a substantial effect given that the incidence of child labor in this sample is 12.2% (see the bottom row labeled "Mean DV" reporting the means of the dependent variables). The estimated probability that a child does chores increases by about 9 percentage points after a recent exposure to excessive rainfall; the sample average for chores is 72.3%. Finally, the occurrence of a rainfall shock comes with about 4 percentage points decline in the probability that a child attends school relative to children who did not live in a household exposed to a rainfall shock. This pattern of effects is consistent with a scenario where part of the reason why children drop out of school is the increased need for them to contribute to household recovery through labor and/or chores.[18]

The survey sometimes treats children 9 years old and younger differently than children 10 years old or older. Below we refer to these two groups as younger children and older children. In Table 6, we split the sample according to this convention, and estimate the same models

[18]The data used in these estimations is at the child level. Table A.7 presents analogous estimates based on data aggregated at the household level.

separately for the two groups. The pattern of results is similar between the two groups, with positive coefficients for labor and chores, and negative coefficients for schooling, suggesting that neither group is exclusively responsible for the results obtained when the two groups are combined.

The child outcomes so far were measured as zero-one variables. Follow-up questions elicit the number of hours children spent on labor and chore activities. This allows us to also study the intensive margin of adjustment to rainfall shocks, although the response rate to these more detailed questions is not as high. Table A.6 presents the results for the intensive margin. The estimates are positive and the magnitudes are consistent with the extensive margin results in Table 5, although less precisely estimated. One should also keep in mind that the survey asks how many hours the child spent working and doing chores in the past week, while the rainfall shock refers to three months prior to the interview; thus, to the extent that the shock was experienced earlier, the adjustment in child hours may have ended by the time of the interview.

An alternative explanation for the main results in Table 5 is that rainfall shocks damage school and/or road infrastructure, making them unusable and thus preventing children from attending school. Parents then perhaps choose to fill their children's unoccupied time by requiring them to take a paid job or do more chores. If this mechanism is driving the results, then the magnitude of the drop in school attendance after a rainfall shock should not depend on the family's financial situation, as children with different economic situations would be similarly unable to attend school. As we will see below, this is not the case in our data. What we find instead is that students whose families are remittance recipients, for example, are more likely to attend school after a rainfall shock compared to students whose families are not. These results are reported below in Table 9.

Complementary evidence of household reactions to rainfall shocks comes from direct survey questions. Following a question about household experience with flooding, the survey asked about the main way of coping with flood events. Table A.8 lists the answers ordered by the frequency of responses. We note that 10.64% of households mention that a working household member increased working hours and 2.22% mention that a non-working household member started looking for a job or started working. Jointly with the results presented above, this suggests that when a rainfall shock occurs, rural households that depend mainly on weather-dependent agricultural production for their living and want to smooth their consumption are forced to resort to informal mechanisms to cope with it, such as child labor (Beegle et al., 2006) by increasing the child labor supply (on the extensive margin). However, this competes with the time children spend in school. Therefore, some households might be forced to pull children out of school to increase current household income at the expense of future potential earnings brought about by the child's education.

5.2. Robustness Analysis. To examine the robustness of the main results, we perform a series of additional empirical exercises. These include using a canonical two-periods/two-groups difference-in-differences identification of the rainfall effects, alternative clustering method for the standard errors, changing the cutoff defining the rainfall shock, and altering the sample composition according to household distance from the weather station and by excluding households that move between rounds.

In the previous section, equation (4.3) describes how the data can be analyzed using a basic two-periods/two-groups difference-in-differences strategy. This involves separating the full sample of three survey rounds (2010, 2013, 2016) into two-period subsamples, namely the pairs 2010-2013 and 2013-2016. In the middle of each subperiod, a subset of households experiences a rainfall shock. Those that do will constitute the treated and those that do not will constitute the controls. We may also restrict the subsamples further by including in each case only the households untreated in the pre-period, i.e., those households that were not exposed to the rainfall shock in the first period. The results from implementing this strategy are presented in Table 7. The top two panels represent the subperiod 2010-2013 and the bottom two panels represent the subperiod 2013-2016.

For each subperiod, the second panel restricts the sample to the households that were not treated in the pre-period. The sample for the first subperiod is more limited because the 2010 round of the survey did not collect data on children between 10-17 years old. Focusing on the second subperiod, shown in the bottom two panels, the results from the main specification are confirmed, particularly for the subsample of households that were not treated in the pre-period. We also note that the coefficient magnitudes are about twice the size of those estimated with the two-way fixed effects specification shown in Table 5.[19]

The main results reported standard errors clustered at the household level, as the panel structure implies that households are observed repeatedly over time. This seems sensible as household potential outcomes will likely be correlated over time. An alternative strategy, however, would be to cluster standard errors at the level where the variation in treatment occurs. In our case, this is the weather station level, as households are matched to the nearest weather station based on geographic coordinates. Tables A.10 and A.11 present the results with this alternative standard error definition. In both tables, the standard errors under this definition tend to be smaller, which generally improves the statistical significance of the coefficients relative to the main results using household-level clustering, shown previously in Tables 5 and 7.

Next, we perform a sensitivity analysis with respect to the rainfall shock definition and with respect to sample alterations. The results are reported in Table 8. For the definition of the shock, we first use the methodology of Burke, Hsiang, and Miguel (2015), which is to classify a rainfall shock if rainfall is above a certain percentile of the entire sample of rainfall measurements. We consider three cutoffs. A weak rainfall shock occurs when the precipitation falls above the 80^{th} percentile, a moderate shock is above the 85^{th} percentile, and a severe shock is above the 90^{th} percentile. Columns 1-3 of Table 8 show the estimated coefficients. Overall, we note that estimates for child labor and chores increase with the severity of the shock, from 3.9pp to 6.7pp in the case of labor, and from 3.2pp to 9.4pp in

[19] Table A.9 presents analogous results using data aggregated at the household level.

the case of chores. The magnitudes of the estimates for schooling are less materially affected by the shock definition.

Regarding sensitivity to sample alterations, columns (4)-(5) of Table 8 show how results change after removing households located further away from the weather station. Column 4 shows the results excluding households further away than the 95^{th} percentile of the distribution of distances, and column (5) shows the results excluding households beyond the 99^{th} percentile. The estimates are minimally sensitive to restricting the sample to households located within a certain distance of the nearest weather station. Magnitudes and statistical significance are very similar to the ones reported in the main results in Table 5.

Another way to restrict the sample is by removing those households that moved between rounds. Moving to a different location should alter the pattern of household activities in the aftermath of the move, including how children allocate their time between home and school activities. Thus, if the move was prompted by the rainfall shock and entered the time window of the survey, this could bias the estimates upward. Columns (6)-(7) of Table 8 perform this analysis. Column (6) considers only households that stayed in the same location for at least two rounds, the vast majority of which are consecutive rounds. Column (7) includes only households that stayed in the same location for all three rounds. As the estimates indicate, even though sample size now declines significantly and consequently estimation precision drops, the same coefficient pattern remains where labor and chores have positive rainfall coefficients while schooling has negative rainfall coefficients.

6. Household financial inclusion

When faced with an unexpected and temporary income shock, rural households may resort to various financial mechanisms to smooth their consumption and preserve their productivity. In our context, access to or use of finance may be used as a substitute for other potentially costlier adjustments, such as redirecting child time and effort away from schooling and toward paid work or household chores. In this section, we examine whether households with better access to finance prior to a rainfall shock respond differently in terms of adjusting child activities after the shock. We consider several sources of finance, such as formal loans, asset insurance, foreign remittances, and natural disaster aid.[20],[21]

The results are presented in Table 9. Financial variables are grouped into two categories based on the source of finance, namely financial services and financial assistance. Each financial variable is defined as a dummy and is interacted with the rainfall shock variable. The coefficient on the interaction term thus measures the difference in response to shocks between households with more pre-shock access to finance and those with less. See equation (4.4) above. For each variable, we report two specifications, one without household fixed effects and one with household fixed effects. In all cases, we include municipality and department-year fixed effects.

The literature has found that access to credit can either mitigate or reinforce the effects of transitory income shocks on child labor (Beegle et al., 2006). We find evidence consistent with a reinforcement mechanism. From columns (1)-(2) of Table 9, we see that households that had more than two formal loans before the rainfall shock occurred are significantly more likely to respond to the shock by increasing child labor compared to households with fewer or no formal loans. At the same time, from Panel B, we see that households with more formal loans are less likely to increase chores for children than households with fewer formal loans. From Panel C, we see no significant difference in schooling responses to rainfall shocks between the two types of households. In Table A.13, we present analogous results using a different measure of loans, namely the actual number of formal loans instead of a cutoff-derived dummy variable; see columns (1)-(2). This specification also detects a reinforcing effect of pre-existing household formal loans on child labor increases in response to a rainfall

[20]See Table A.12 on the yearly frequency of children who lived in a household with any source of finance, such as formal loans, asset insurance, foreign remittances, and natural disaster aid.

[21]The survey contains information about other financial variables such as ownership of bank accounts or amounts of formal and informal savings. However, these variables reflect the household status after the rainfall shock, and thus they may be jointly determined with child-related activities. Therefore, we restrict attention to financial variables reflecting pre-shock finance access or use. See Chiapa et al. (2016) for positive effects of savings accounts on girls' schooling in Nepal.

shock. A similar pattern is apparent when we look at the number of debts before a shock, in columns (3)-(4) of Table A.13.

These results suggest that when a household has loans with formal financial institutions, or is generally over-indebted, before the shock and then an income shock occurs, it may become constrained by the pressure of making the payments on time (Duygan-Bump and Grant, 2009). Thus households may not be able to afford the cost of sending children to school even when education is free, as other related costs such as transportation, school uniforms, books and supplies, and even the opportunity cost of not working, are a binding constraint on households. This can potentially result in a persistent effect, since although children stopped attending school to help with the household income temporarily, the formalities of completing the paperwork to go back to school after the shock may deter them from re-enrolling. Therefore some of these children may not work and still miss school at the same time.

When we consider asset insurance, on the other hand, we find evidence consistent with a mitigating mechanism. The estimates are presented in columns (3)-(4) of Table 9. Here the interaction coefficients measure the difference in response to rainfall shocks between households with asset insurance and those without. While we notice no clear difference in child labor responses, the differential responses in terms of child chores and schooling are sizable and statistically significant, implying that insured households do not significantly adjust child activities in these dimensions. Asset insurance, therefore, does seem to act as a buffer that allows households to cope with the losses caused by a rainfall shock without having to resort to significant disruptions in children's education.

So far, we have looked at formal financial services acquired by households. Next, we turn to financial assistance received by households in the form of foreign remittances or natural disaster aid. In both cases, assistance is measured through a dummy variable that indicates whether any amount of that type of assistance was received. The results are reported in the second half of Table 9.

Remittances received from family members working abroad have been shown to play the role of insurance against weather-related income shocks in other contexts, e.g., the study by Yang and Choi (2007) in the Philippines. To the extent that this informal type of insurance is available, households may be able not only to overcome income shortfalls but also to avoid relying on children to generate income or labor to bridge the temporary disruption. In our data, we find evidence consistent with this argument. The estimates are reported in Table 9 columns (5)-(6). We find a clear mitigating effect of foreign remittances on child labor and schooling. Compared to households that do not receive remittances, those that do are not likely to increase child labor or decrease child schooling in the aftermath of a rainfall shock. On the other hand, these households are more likely to have their children perform non-income-generating chores. Table A.13 columns (5)-(6) show analogous results when remittances are measured as a continuous variable capturing the monetary value of the transfer.

Regarding disaster aid, we find statistically significant evidence suggesting that children living in a household that received any type of aid for natural disasters in the past 12 months are not likely to do paid work after a rainfall shock; their likelihood of working in response to a shock drops significantly relative to children living in a household that did not receive that type of aid. See Table 9 columns (7)-(8). This means that emergency aid helps households smooth their consumption profile and/or production activities without having to resort as much to child labor. In the lower panels we see similar mitigating effects on child chores and schooling. When a household receives this type of help, it directly targets the need engendered by the shock; therefore, it should help to mitigate all the effects resulting from the shock, at least partially, depending on the size of the aid.

Because household adjustments to rainfall shocks depend on the household's financial situation, e.g., having insurance or receiving remittances, it seems unlikely that children's school attendance would drop due to damaged school and/or road infrastructure. If this were the case, most students would be prevented from going to school and the household's financial situation would not play a role. Given the results in Table 9, the more plausible scenario is that those households lacking a financial cushion are more likely to redirect children's time and effort away from school and toward work responsibilities.

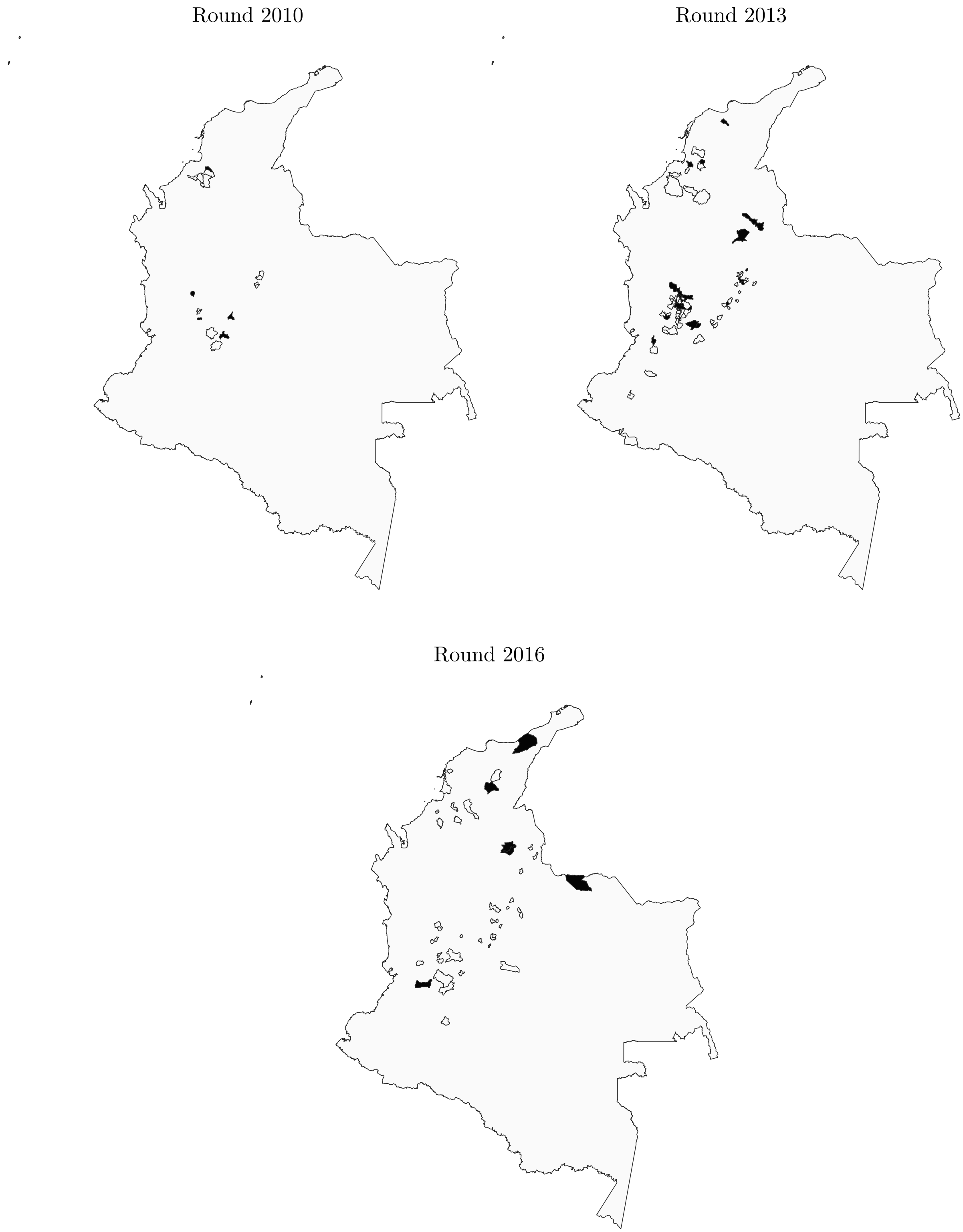
7. Conclusion

This paper uses recent panel data from rural Colombia to examine household adjustment to rainfall shocks through children's activities, and the role of financial inclusion in this adjustment. It employs difference-in-differences empirical strategies to identify the impact of rainfall shocks on the allocation of child time for labor, chores, and schooling. The evidence presented suggests that after a rainfall shock, the probability that a child works increases considerably, and to a smaller degree, child involvement in household chores, while the probability that a child attends school decreases. These results are robust to a number of checks and suggest that children's time is used as part of affected households' coping mechanisms against shocks that affect their consumption and productivity. When a rainfall shock occurs, children, on average, increase their labor supply on the extensive margin, competing with their time spent in school. Therefore, some households may be forced to take children out of school to increase current household income at the expense of future potential earnings through the child's education.

We also find that financial inclusion may either amplify or moderate child-related margins of adjustment. Households with more than two formal loans acquired prior to the shock respond by increasing child labor more than those with fewer or no formal loans. This likely reflects the extra pressure households face to make payments on time. Thus, households resort to child labor for immediate benefits to generate income and repay debt, suggesting the importance of ex post loan restructuring or ex ante payment flexibility in loan contracts (Barboni, 2017), particularly in rural areas subject to frequent weather-related income shocks. On the other hand, households that possess asset insurance are able to avoid reductions in child school attendance. Similar mitigating effects are associated with financial assistance received by households through foreign remittances and natural disaster aid.

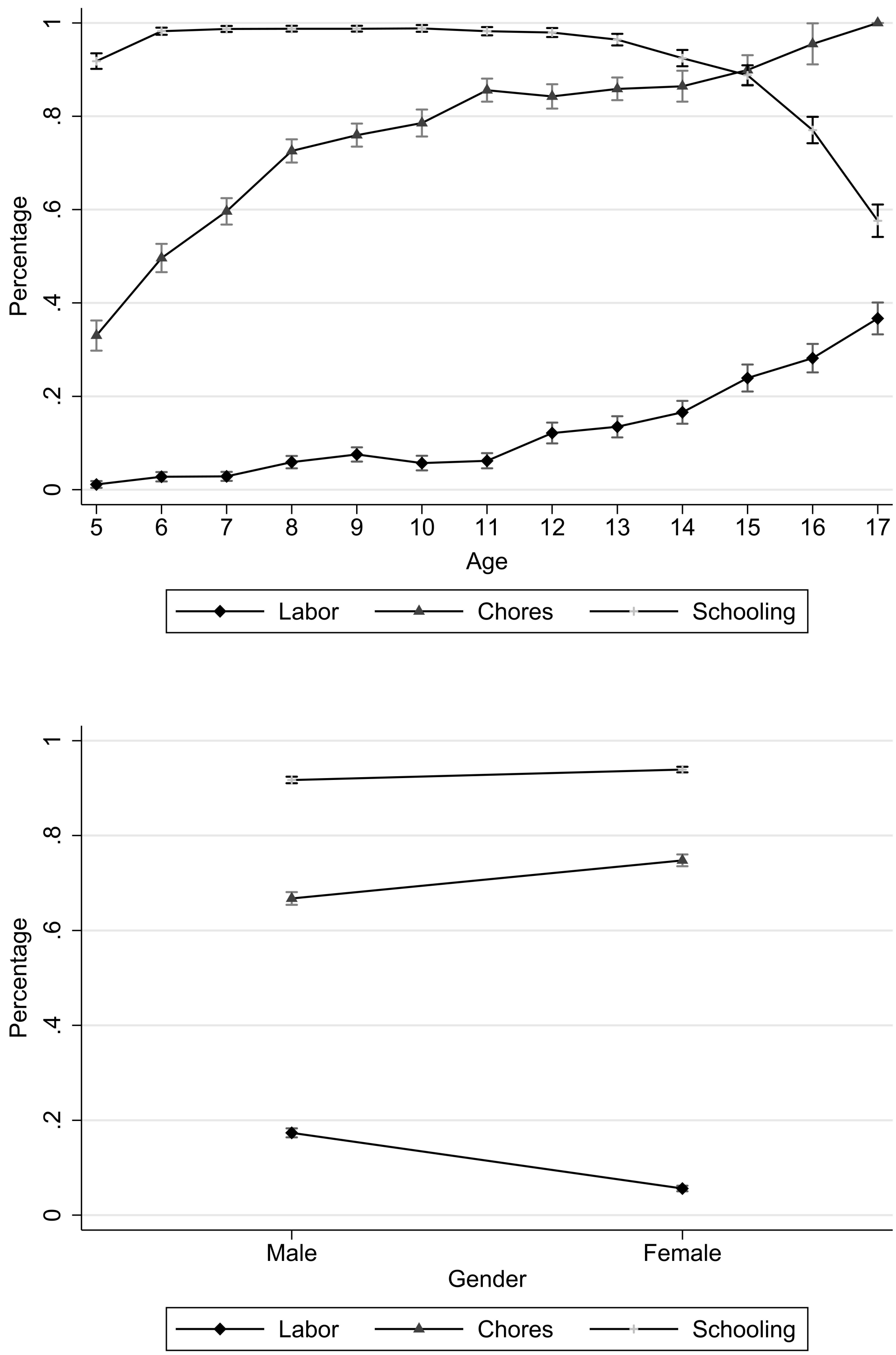
Considering the current and future impacts of climate change on the frequency and intensity of extreme weather events, and its effects on human capital formation, it is essential to promote appropriate financial inclusion in rural Colombia as a public policy goal. It is important to facilitate access to affordable loans and agricultural insurance for small producers. At the same time, allowances must be made for the most vulnerable households to restructure debt in cases of adverse events to alleviate pressures on household consumption and productive capacity. Rural financial inclusion should help mitigate the adverse impacts of weather-related shocks, improve the capacity to smooth consumption, protect savings, and avoid informal financial mechanisms such as moneylenders, or child labor at the expense of schooling. Since extreme weather events produce aggregate shocks, local informal networks of support are limited in serving as a coping mechanism; digital technologies may help tap into wider networks (Riley, 2018). Finally, it is important to promote rural financial education to spread awareness of the benefits of having and actively using financial services such as asset insurance and low-cost remittance channels.

Figure 1. Sample municipalities



Notes: Figure 1 shows the map of the municipalities that had at least one household treated each round. That is, dark-shaded municipalities mean that the municipality had at least one household exposed to a rainfall shock.

FIGURE 2. Age and gender distribution by outcome



Notes: This figure shows the share of children that work, do chores, and attend school by age and gender. The upper figure shows the share of labor, chores, and schooling by age 5 to 17. The bottom figure shows the share of children that work, do chores, and attend school by gender between male and female children. Confidence intervals are at a 95% level.

TABLE 1. Sample distribution

	Round 1 (2010)	Round 2 (2013)	Round 3 (2016)
Children	6,376	5,735	4,587
Households	3,090	2,848	2,346
Municipalities	17	92	107
Departments	8	15	20

Notes: This table shows the number of children, households, municipalities, and departments in each round.

TABLE 2. Age range distribution per round

	Round 1 (2010)	Round 2 (2013)	Round 3 (2016)
Young children (5-9)	2,343	2,035	1,554
Old children (10-17)	4,033	3,700	3,033

Notes: This table shows the number of younger and older children in each round. Younger children are children between the ages of 5 and 9, and older children are children between the ages of 10 and 17. The reason for dividing the children into these two groups is because, from the age of 10, the work-related question in the survey changes since the definition of the working age population in rural areas in Colombia is considered from the age of 10.

TABLE 3. Treated children per round

Rainfall shock	Round 1 (2010)	Round 2 (2013)	Round 3 (2016)
No	6,286	5,148	4,352
Yes	90	544	235

Notes: This table shows the number of children that were and were not exposed to a rainfall shock during each round.

Table 4. Summary statistics

	(1) Mean	(2) Standard deviation	(3) Min	(4) Max	(5) Obs
Children characteristics					
Labor	0.12	0.32	0.00	1.00	12142
Chores	0.71	0.45	0.00	1.00	9465
Schooling	0.93	0.26	0.00	1.00	12644
Hours labor	0.52	3.14	0.00	60.00	8606
Hours chores	2.96	4.25	0.00	56.00	6556
Female	0.48	0.50	0.00	1.00	16698
Age	11.19	3.64	5.00	17.00	16698
Age group	0.64	0.48	0.00	1.00	16698
Financial variables					
Asset insurance	0.04	0.18	0.00	1.00	16698
Insurance	0.23	0.42	0.00	1.00	16698
Number of pre-shock debts	0.55	0.84	0.00	11.00	16698
Pre-shock debts	0.38	0.49	0.00	1.00	16698
Number of pre-shock formal loans	0.40	0.72	0.00	11.00	16698
Pre-shock formal loans	0.29	0.46	0.00	1.00	16698
Familias en Acción	0.66	0.47	0.00	1.00	16698
Natural disaster aid	0.01	0.09	0.00	1.00	16698
Foreign remittances	0.02	0.12	0.00	1.00	16698
Amount of remittances (100k pesos)	1.03	14.58	0.00	552.00	16698
Rainfall shocks					
Rainfall shock	0.05	0.22	0.00	1.00	16655
Weak rainfall shock (80th percentile)	0.08	0.27	0.00	1.00	16655
Moderate rainfall shock (85th percentile)	0.05	0.22	0.00	1.00	16655
Severe rainfall shock (90th percentile)	0.03	0.18	0.00	1.00	16655
Self-reported shocks					
Flood shock	0.15	0.36	0.00	1.00	10322
Job loss shock	0.09	0.28	0.00	1.00	16698
Livestock shock	0.17	0.38	0.00	1.00	16698
Crop shock	0.26	0.44	0.00	1.00	16698
Agricultural shock	0.35	0.48	0.00	1.00	16698
Household characteristics					
Household size	5.78	2.13	2.00	19.00	16698
Household Head female	0.19	0.39	0.00	1.00	16698
Household Head age	46.34	11.41	15.00	90.00	16698
Household Head education	0.19	0.40	0.00	1.00	16541
Agricultural activity	0.76	0.43	0.00	1.00	11574
Distance to the nearest weather station (in km)	6.30	3.05	0.02	25.54	16653

Notes: This table presents the summary statistics of household and child characteristics for the whole sample (2010-2016) at the child level. Panel A considers the children characteristics, Panel B considers the household characteristics, Panel C considers the financial variables, Panel D considers the shocks reported by the household, and Panel E considers the rainfall shocks built from the weather station information. The characteristics included are labor, chores, schooling, gender, age, age group (dummy that takes value one if the child is 10 and over), household size, head of household age, head of the household gender, head of household educational attainment, indicator of whether the household carries out any agricultural activity, distance to the nearest weather station in kilometers, indicator of whether the household receives benefits from Familias en Acción, indicator of whether the household received any assistance due to natural disasters, indicator of whether the household received foreign remittances, the value of the received remittances from the last 12 months, self-reported shocks, rainfall shock. Female is a discrete measure that takes the value of one for girls and zero for boys. Household size is the number of people that live in a household. Female HH is an indicator that takes value one if the head of the household is female. Rainfall shock is a discrete measure that takes the value one for households with rainfall above one standard deviation from the long-run mean.

Table 5. Children activities and rainfall shock exposure: Extensive margin

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	Labor				Chores				Schooling			
Rainfall shock	0.093***	0.067**	0.063**	0.050*	0.042*	0.105***	0.091***	0.087**	-0.040**	-0.042**	-0.038*	-0.039*
	(0.020)	(0.030)	(0.030)	(0.030)	(0.030)	(0.040)	(0.040)	(0.040)	(0.020)	(0.020)	(0.020)	(0.020)
Observations	8832	8832	8832	8832	6514	6514	6514	6514	9223	9223	9223	9223
Households	2200	2200	2200	2200	1817	1817	1817	1817	2265	2265	2265	2265
R-squared	0.061	0.381	0.448	0.449	0.054	0.420	0.493	0.493	0.027	0.349	0.396	0.396
Household FE	No	Yes	Yes	Yes	No	Yes	Yes	Yes	No	Yes	Yes	Yes
Municipality FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Dept-Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Month FE	No	No	No	Yes	No	No	No	Yes	No	No	No	Yes
Covariates	No	No	Yes	Yes	No	No	Yes	Yes	No	No	Yes	Yes
Mean DV	0.122	0.122	0.122	0.122	0.723	0.723	0.723	0.723	0.931	0.931	0.931	0.931
SD DV	0.327	0.327	0.327	0.327	0.448	0.448	0.448	0.448	0.254	0.254	0.254	0.254

Notes: This table presents the results from the main specification in equation (4.2) at the child level. The main outcomes on the extensive margin are labor (columns 1, 2, 3 and 4), chores (columns 5, 6, 7 and 8), and schooling (columns 9, 10, 11 and 12). *Rainfall shock* is defined as a discrete measure that takes the value one for households with rainfall above one standard deviation from the long-run mean. The covariates included are gender, age, household size, head of household age and age squared, head of the household gender, head of household educational attainment, indicator of whether the household carries out any agricultural activity, distance to the nearest weather station, indicator of older children (older than 10) and indicator of whether the household receives benefits from Familias en Acción. Robust standard errors are clustered at the household level and presented in parenthesis. * is significant at the 10% level, ** is significant at the 5% level, *** is significant at the 1% level.

Table 6. Children activities and rainfall shock exposure by age group

	(1)	(2)	(3)	(4)	(5)	(6)
	Ages 5-9			Ages 10-17		
Panel A: Labor						
Rainfall shock	0.044	0.088**	0.087**	0.128***	0.064	0.056
	(0.030)	(0.040)	(0.040)	(0.030)	(0.050)	(0.050)
Observations	2687	2687	2687	5012	5012	5012
Households	980	980	980	1554	1554	1554
R-squared	0.048	0.494	0.510	0.068	0.438	0.508
Mean DV	0.042	0.042	0.042	0.176	0.176	0.176
SD DV	0.200	0.200	0.200	0.380	0.380	0.380
Panel B: Chores						
Rainfall shock	0.031	0.110	0.100	0.063**	0.127***	0.111**
	(0.050)	(0.070)	(0.070)	(0.030)	(0.040)	(0.050)
Observations	2693	2693	2693	2653	2653	2653
Households	983	983	983	975	975	975
R-squared	0.054	0.488	0.566	0.059	0.499	0.521
Mean DV	0.592	0.592	0.592	0.853	0.853	0.853
SD DV	0.492	0.492	0.492	0.355	0.355	0.355
Panel C: Schooling						
Rainfall shock	-0.009	-0.050	-0.053	-0.057**	-0.012	-0.001
	(0.030)	(0.030)	(0.030)	(0.020)	(0.030)	(0.030)
Observations	3048	3048	3048	5003	5003	5003
Households	1090	1090	1090	1551	1551	1551
R-squared	0.061	0.465	0.478	0.031	0.401	0.478
Household FE	No	Yes	Yes	No	Yes	Yes
Municipality FE	Yes	Yes	Yes	Yes	Yes	Yes
Dept-Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Covariates	No	No	Yes	No	No	Yes
Mean DV	0.977	0.977	0.977	0.895	0.895	0.895
SD DV	0.151	0.151	0.151	0.306	0.306	0.306

Notes: This table presents the results from the main specification in equation (4.2) by age group at the child level. Columns 1, 2, and 3 are the results from the main specification for children nine and younger. Columns 4, 5, and 6 contain the analysis for children ten and older. The main outcomes on the extensive margin are labor (Panel A), chores (Panel B), and schooling (Panel C). *Rainfall shock* is defined as a discrete measure that takes the value one for households with rainfall above one standard deviation from the long-run mean. The covariates included are gender, age, household size, head of household age and age squared, head of the household gender, head of household educational attainment, indicator of whether the household carries out any agricultural activity, distance to the nearest weather station, indicator of older children (older than 10) and indicator of whether the household receives benefits from Familias en Acción. Robust standard errors are clustered at the household level and presented in parentheses. * is significant at the 10% level, ** is significant at the 5% level, *** is significant at the 1% level.

Table 7. Canonical difference-in-differences specifications

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
		Δ Labor			Δ Chores			Δ Schooling	
Panel A: 2010-2013 (full)									
Δ Rainfall shock	0.129**	0.097	0.091	-0.025	-0.069	-0.092	-0.066	-0.075	-0.081
	(0.060)	(0.060)	(0.060)	(0.100)	(0.110)	(0.110)	(0.080)	(0.070)	(0.080)
Observations	734	734	734	720	720	720	739	739	739
Households	544	544	544	534	534	534	547	547	547
R-squared	0.014	0.072	0.104	0.000	0.061	0.071	0.011	0.060	0.084
Mean DV	0.020	0.020	0.020	0.134	0.134	0.134	0.020	0.020	0.020
SD DV	0.277	0.277	0.277	0.564	0.564	0.564	0.167	0.167	0.167
Panel B: 2010-2013 (untreated pre-period)									
Δ Rainfall shock	0.185**	0.172	0.145	-0.015	-0.083	-0.123	0.015	0.013	0.009
	(0.080)	(0.110)	(0.120)	(0.130)	(0.160)	(0.170)	(0.030)	(0.040)	(0.040)
Observations	717	717	717	703	703	703	722	722	722
Households	535	535	535	525	525	525	538	538	538
R-squared	0.018	0.075	0.106	0.000	0.066	0.077	0.000	0.025	0.051
Mean DV	0.020	0.020	0.020	0.133	0.133	0.133	0.015	0.015	0.015
SD DV	0.281	0.281	0.281	0.565	0.565	0.565	0.152	0.152	0.152
Panel C: 2013-2016 (full)									
Δ Rainfall shock	0.072**	0.057	0.052	0.100***	0.062	0.053	-0.023	-0.062***	-0.055**
	(0.030)	(0.040)	(0.040)	(0.030)	(0.040)	(0.040)	(0.020)	(0.020)	(0.020)
Observations	2620	2620	2620	2011	2011	2011	2659	2659	2659
Households	1551	1551	1551	1322	1322	1322	1569	1569	1569
R-squared	0.004	0.060	0.070	0.005	0.045	0.050	0.001	0.024	0.040
Mean DV	0.080	0.080	0.080	0.138	0.138	0.138	-0.058	-0.058	-0.058
SD DV	0.424	0.424	0.424	0.521	0.521	0.521	0.286	0.286	0.286
Panel D: 2013-2016 (untreated pre-period)									
Δ Rainfall shock	0.123***	0.137***	0.128**	0.179***	0.174***	0.163**	-0.053*	-0.082**	-0.083**
	(0.050)	(0.050)	(0.050)	(0.060)	(0.070)	(0.070)	(0.030)	(0.030)	(0.030)
Observations	2372	2372	2372	1808	1808	1808	2408	2408	2408
Households	1437	1437	1437	1214	1214	1214	1454	1454	1454
R-squared	0.004	0.070	0.083	0.006	0.052	0.057	0.002	0.022	0.037
Household FE	No	No	No	No	No	No	No	No	No
Municipality FE	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
Δ Covariates	No	No	Yes	No	No	Yes	No	No	Yes
Mean DV	0.085	0.085	0.085	0.144	0.144	0.144	-0.058	-0.058	-0.058
SD DV	0.413	0.413	0.413	0.522	0.522	0.522	0.287	0.287	0.287

Notes: This table presents the results from the *difference-in-difference* specification in equation (4.3) at the child level. Panel A considers the sample from 2010 to 2013, and Panel B considers the sample from 2013 to 2016. The main outcomes are in differences ($\Delta Y = Y_t - Y_{t-1}$): Δ labor (columns 1, 2, and 3), Δ chores (columns 4, 5, and 6), and Δ schooling (columns 7, 8, and 9). Δ *Rainfall shock* is defined as the difference of the discrete measure that takes the value one for households with rainfall above one standard deviation from the long-run mean ($\Delta Shock = Shock_t - Shock_{t-1}$). The covariates are also in differences ($\Delta X = X_t - X_{t-1}$) included are gender, age, household size, head of household age and age squared, head of the household gender, head of household educational attainment, indicator of whether the household carries out any agricultural activity, distance to the nearest weather station, indicator of older children (older than 10) and indicator of whether the household receives benefits from Familias en Acción. Robust standard errors are clustered at the household level and presented in parenthesis. * is significant at the 10% level, ** is significant at the 5% level, *** is significant at the 1% level.

Table 8. Sensitivity analysis

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Rainfall			Distance		Stayers	
	80^{th} perc	90^{th} perc	95^{th} perc	95^{th} perc	99^{th} perc	2 rounds	3 rounds
Panel A: Labor							
Rainfall shock	0.039*	0.061**	0.067*	0.061**	0.062**	0.071**	0.053
	(0.020)	(0.030)	(0.030)	(0.030)	(0.030)	(0.030)	(0.040)
Observations	8832	8832	8832	8415	8737	7528	4280
Households	2200	2200	2200	2099	2181	1951	1282
R-squared	0.448	0.448	0.448	0.449	0.447	0.458	0.480
Mean DV	0.123	0.122	0.124	0.121	0.121	0.127	0.129
SD DV	0.328	0.327	0.330	0.326	0.327	0.333	0.335
Panel B: Chores							
Rainfall shock	0.032	0.066*	0.094**	0.090**	0.089**	0.079**	0.077*
	(0.030)	(0.040)	(0.040)	(0.040)	(0.040)	(0.040)	(0.040)
Observations	6514	6514	6514	6203	6443	5557	3374
Households	1817	1817	1817	1731	1800	1607	1045
R-squared	0.492	0.492	0.492	0.495	0.492	0.483	0.462
Mean DV	0.723	0.723	0.723	0.722	0.722	0.742	0.792
SD DV	0.447	0.447	0.447	0.448	0.448	0.438	0.406
Panel C: Schooling							
Rainfall shock	-0.033**	-0.039*	-0.025	-0.033	-0.038*	-0.032	-0.042*
	(0.020)	(0.020)	(0.020)	(0.020)	(0.020)	(0.020)	(0.020)
Observations	9223	9223	9223	8781	9124	7584	4290
Households	2265	2265	2265	2158	2245	1964	1285
R-squared	0.396	0.396	0.396	0.395	0.397	0.404	0.451
Household FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Municipality FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Dept-Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Covariates	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Mean DV	0.931	0.930	0.929	0.930	0.930	0.932	0.943
SD DV	0.254	0.255	0.256	0.255	0.255	0.251	0.231

Notes: This table presents the results from the sensitivity analysis at the child level for the three main outcomes. The first three columns analyze the results considering a different measure for the rainfall shock, defining them as discrete measures that take the value one for households with rainfall above the 80^{th}, 90^{th}, and 95^{th} percentile from the distribution. The farthest households from the weather stations are excluded from the analysis in Columns 4 and 5, leaving only households whose distance to the nearest weather station falls within the 95^{th} or 99^{th} percentile, respectively. The last two columns consider the following households: 2 rounds column means that the analysis includes households that did not move for 2 out of the three survey rounds, meaning they remained in the same municipality during those two rounds. The second column, three rounds, means that the analysis considers households that remained in the same municipality for the three rounds. All columns include the covariates, household, municipality, and department-year fixed effects. Robust standard errors are clustered at the household level and presented in parenthesis. * is significant at the 10% level, ** is significant at the 5% level, *** is significant at the 1% level.

Table 9. Heterogeneous effects: Financial inclusion

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Financial Services (Z)				Financial Assistance (Z)			
	Pre-shock formal loans		Asset insurance		Foreign Remittances		Natural disaster aid	
Panel A: Labor								
Rainfall shock	0.086***	0.057**	0.086***	0.058**	0.092***	0.063***	0.092***	0.064***
	(0.020)	(0.020)	(0.020)	(0.020)	(0.020)	(0.020)	(0.020)	(0.020)
Rainfall shock × Z	0.208**	0.282**	0.094	0.124	-0.165***	-0.146***	-0.219***	-0.182***
	(0.100)	(0.110)	(0.100)	(0.120)	(0.040)	(0.050)	(0.080)	(0.050)
Z	0.008	-0.017	0.047**	0.050*	-0.015	0.003	0.055	0.055
	(0.020)	(0.030)	(0.020)	(0.030)	(0.020)	(0.030)	(0.040)	(0.050)
Observations	12070	11345	12072	11347	12072	11347	12072	11347
Households	3231	2507	3231	2507	3231	2507	3231	2507
R-squared	0.059	0.341	0.059	0.342	0.058	0.341	0.059	0.341
Mean DV	0.109	0.106	0.109	0.106	0.109	0.106	0.109	0.106
SD DV	0.312	0.308	0.312	0.308	0.312	0.308	0.312	0.308
Panel B: Chores								
Rainfall shock	0.047**	0.114***	0.049**	0.117***	0.043*	0.107***	0.050**	0.112***
	(0.020)	(0.030)	(0.020)	(0.030)	(0.020)	(0.030)	(0.020)	(0.030)
Rainfall shock × Z	-0.130	-0.247***	-0.102	-0.217***	0.239***	0.513***	-0.512***	-0.157
	(0.170)	(0.090)	(0.070)	(0.080)	(0.060)	(0.160)	(0.100)	(0.150)
Z	0.014	-0.004	0.021	0.015	0.020	0.015	0.009	0.093
	(0.030)	(0.050)	(0.030)	(0.030)	(0.040)	(0.050)	(0.060)	(0.060)
Observations	9400	8761	9402	8764	9402	8764	9402	8764
Households	2760	2124	2760	2125	2760	2125	2760	2125
R-squared	0.051	0.386	0.051	0.386	0.051	0.386	0.051	0.386
Mean DV	0.705	0.706	0.705	0.706	0.705	0.706	0.705	0.706
SD DV	0.456	0.456	0.456	0.456	0.456	0.456	0.456	0.456
Panel C: Schooling								
Rainfall shock	-0.034**	-0.049***	-0.035**	-0.050***	-0.034**	-0.047***	-0.034**	-0.048***
	(0.020)	(0.020)	(0.020)	(0.020)	(0.020)	(0.020)	(0.020)	(0.020)
Rainfall shock × Z	0.063	0.138	0.058	0.097***	0.069***	0.062**	0.079*	0.100*
	(0.070)	(0.100)	(0.050)	(0.040)	(0.020)	(0.030)	(0.040)	(0.060)
Z	0.013	0.004	-0.007	-0.001	0.027*	0.019	0.004	-0.016
	(0.020)	(0.020)	(0.010)	(0.020)	(0.010)	(0.020)	(0.020)	(0.030)
Observations	12575	11851	12577	11853	12577	11853	12577	11853
Households	3305	2582	3305	2582	3305	2582	3305	2582
R-squared	0.023	0.321	0.023	0.321	0.023	0.321	0.023	0.321
Household FE	No	Yes	No	Yes	No	Yes	No	Yes
Municipality FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Dept-Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Covariates	No	No	No	No	No	No	No	No
Mean DV	0.931	0.934	0.931	0.934	0.931	0.934	0.931	0.934
SD DV	0.254	0.248	0.254	0.248	0.254	0.248	0.254	0.248

Notes: This table presents the results for the heterogeneous effects from the equation (4.4) for the three main outcomes. The main outcomes on the extensive margin are labor (Panel A), chores (Panel B), and schooling (Panel C). Columns 1, 3, 5, and 7 include municipality and department-year fixed effects. Columns 2, 4, 6, and 8 include household, municipality, and department-year fixed effects. Columns 1 and 2 consider having more than 2 formal loans before the shock. Columns 3 and 4 consider having asset insurance, i.e., house, car, crop, or machinery insurance. Columns 5 and 6 consider receiving remittances from abroad. Finally, columns 7 and 8 include receiving assistance for natural disasters. All these variables are dichotomous; they only take two values, 0 and 1. Rainfall shock is defined as a discrete measure that takes the value one for households with rainfall above one standard deviation from the long-run mean. Robust standard errors are clustered at the household level and presented in parenthesis. * is significant at the 10% level, ** is significant at the 5% level, *** is significant at the 1% level.

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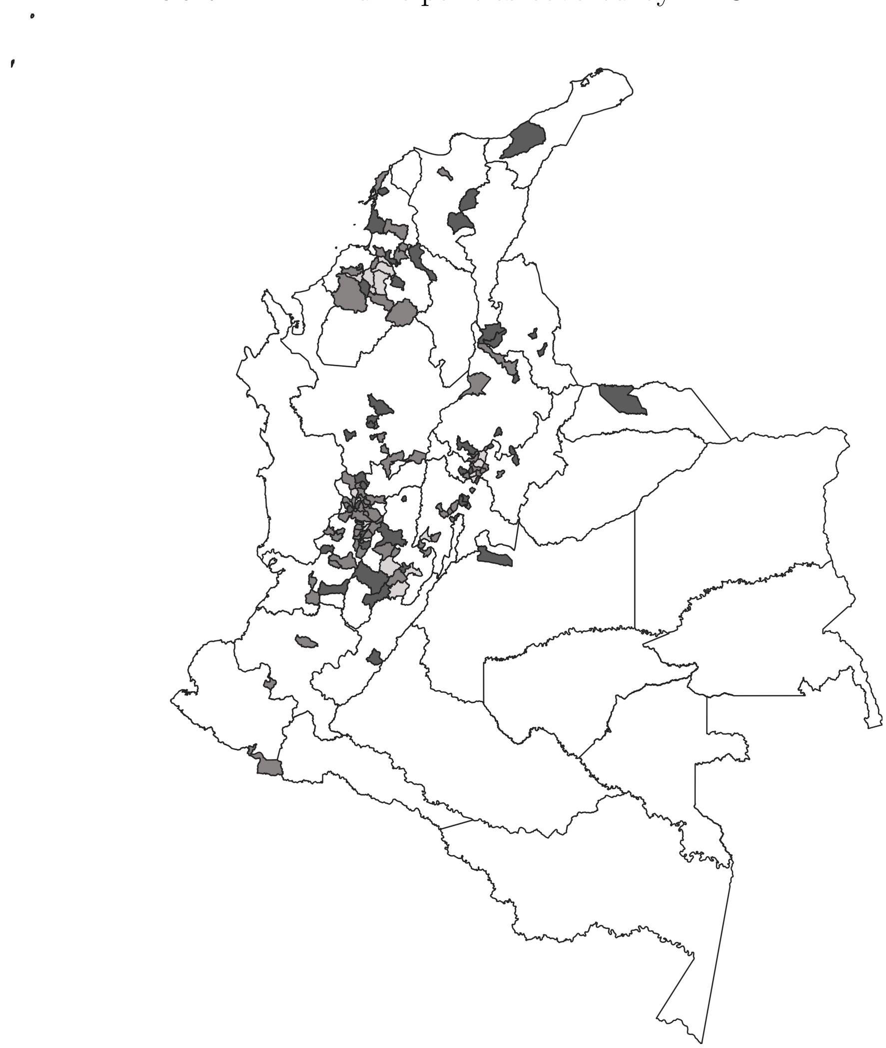
ONLINE APPENDIX

A.1. Supplementary Figures.

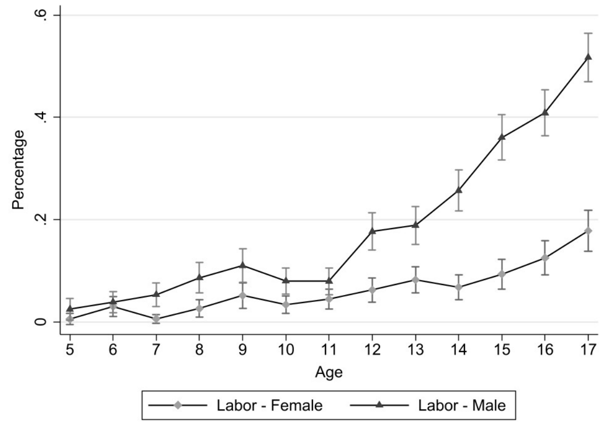
Figure A.1. Municipalities covered by ELCA



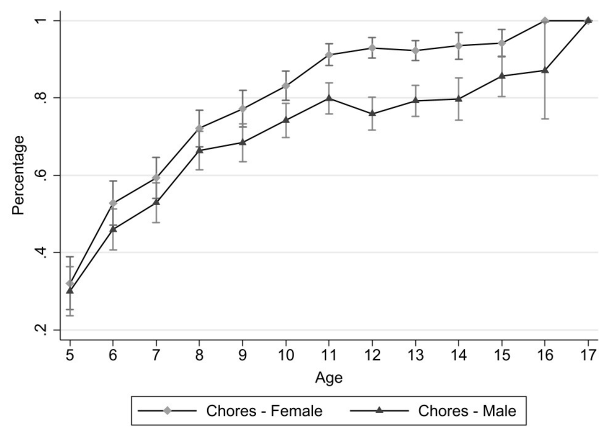
Notes: Figure 1 presents the map of the municipalities surveyed in the longitudinal survey (ELCA). The lightest shade is for the municipalities where the surveyed households were located in 2010; the medium shade is for the municipalities in 2013 where the surveyed 2010 households were located. Finally, the darkest shade is for the municipalities in 2016 where the surveyed households were located.

Figure A.2. Age and gender distribution by outcome

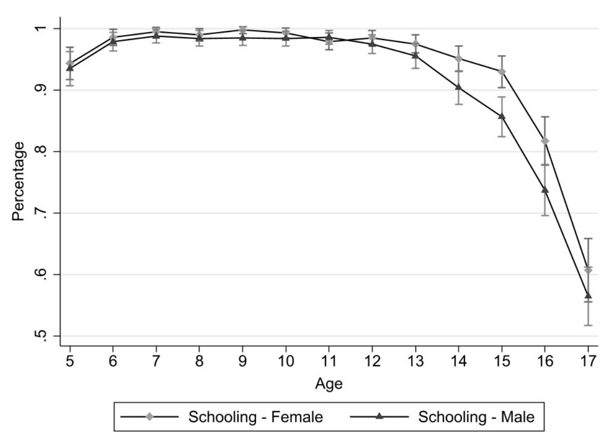
Labor



Chores



Schooling



Notes: This figure shows the share of children who work, do chores, and attend school by age and gender. Figure A shows the share of boys and girls who work from age 5 to 17. Figure B shows the share of boys and girls who do chores by age 5 to 17. Figure C shows the share of boys and girls who attend school by age 5 to 17. Confidence intervals are at a 95% level.

A.2. Supplementary Tables.

Table A.1. Unique weather stations matched to each municipality

Weather stations	Freq.	Percent	Cum.
1	87	62.59	62.59
2	22	15.83	78.42
3	9	6.47	84.89
4	5	3.6	88.49
6	2	1.44	89.93
7	5	3.6	93.53
8	2	1.44	94.96
9	3	2.16	97.12
10	2	1.44	98.56
12	1	0.72	99.28
20	1	0.72	100
Total	139	100	

Notes: This table shows the number of unique weather stations matched to a single municipality for the whole sample.

Table A.2. Unique weather stations matched to each municipality by year

Weather stations	2010	2013	2016	Total
1	0	58	75	133
2	1	13	13	27
3	2	6	8	16
4	3	2	5	10
5	2	6	3	11
6	3	2	1	6
7	2	1	2	5
8	1	3	0	4
9	2	1	0	3
20	1	0	0	1
Total	17	92	107	216

Notes: This table shows the number of unique weather stations matched to a single municipality by year.

Table A.3. Self-reported flood shock and weather-based rainfall shock (2013-2016)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Dep. Var. = Self-reported flood shock							
	Z = 1 std dev		Z = 90^{th} perc		Z = 85^{th} perc		Z = 80^{th} perc	
Z rainfall shock	0.086***	0.114***	0.045	0.059*	0.069**	0.094***	0.107***	0.157***
	(0.030)	(0.030)	(0.030)	(0.040)	(0.030)	(0.030)	(0.020)	(0.020)
Observations	3784	3784	3784	3784	3784	3784	3784	3784
Households	1892	1892	1892	1892	1892	1892	1892	1892
R-squared	0.180	0.609	0.178	0.606	0.179	0.608	0.183	0.614
Household FE	No	Yes	No	Yes	No	Yes	No	Yes
Municipality FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Dept-Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Mean DV	0.133	0.133	0.136	0.136	0.133	0.133	0.132	0.132
SD DV	0.339	0.339	0.342	0.342	0.340	0.340	0.339	0.339

Notes: This table presents the results of the correlation of different shock measures and the self-reported flood shock measure at the household level for 2013-2016. The dependent variable is the self-reported flood shock. Columns 1-2 consider the *rainfall shock* defined as a discrete measure that takes the value one for households with rainfall above one standard deviation from the long-run mean. Columns 3-4 consider the *severe shock* defined as a discrete measure that takes the value one for households with rainfall above the 90th percentile from the long-run distribution. Columns 5-6 consider the *moderate shock* defined as a discrete measure that takes the value one for households with rainfall above the 85th percentile from the long-run distribution. Columns 7-8 consider the *weak shock* defined as a discrete measure that takes the value one for households with rainfall above the 80th percentile from the long-run distribution. Robust standard errors are clustered at the household level and presented in parenthesis. * is significant at the 10% level, ** is significant at the 5% level, *** is significant at the 1% level

Table A.4. Pre-Shock Balance Tests with Municipality FEs

	(1)	(2)	(3)	(4)	(5)	(6)
	Child level			Household level		
Characteristics at baseline	N	Mean	Diff	N	Mean	Diff
Panel A: Characteristics for 2010						
Female	4078	0.482	-0.027	2356	0.481	-0.032
Age	4078	9.614	-0.211	2356	10.566	-0.215
Household size	4078	5.892	0.339	2356	5.328	0.364*
HH Age	4078	44.025	-2.572**	2356	44.622	-2.708***
HH Female	4078	0.172	-0.001	2356	0.181	-0.026
HH education	4026	0.169	0.014	2325	0.184	-0.003
Agricultural activity	1576	0.616	0.048	912	0.604	0.011
Distance	4078	6.492	-0.718**	2356	6.523	-0.724***
Older children	4078	0.807	-0.018	2356	0.749	-0.014
Familias en Acción	4078	0.624	0.020	2356	0.575	0.024
Rainfall shock	4078	0.015	-0.006**	2356	0.018	-0.009***
Labor	1980	0.039	0.013	1488	0.042	0.013
Chores	1981	0.630	-0.018	1490	0.641	-0.022
Schooling	1982	0.965	0.069***	1492	0.967	0.059***
Panel B: Characteristics for 2013						
Female	3350	0.490	-0.122***	1900	0.481	-0.096**
Age	3350	9.537	0.179	1900	10.516	0.878***
Household size	3350	5.864	0.442*	1900	5.319	0.475**
HH Age	3350	45.810	0.090	1900	46.641	-0.561
HH Female	3350	0.188	-0.105**	1900	0.186	-0.112***
HH education	3342	0.199	0.005	1896	0.220	-0.003
Agricultural activity	3056	0.838	-0.121**	1735	0.835	-0.131***
Distance	3324	6.119	0.166	1891	6.118	0.265
Older children	3350	0.806	0.052	1900	0.754	0.085*
Familias en Acción	3350	0.712	0.007	1900	0.656	0.004
Rainfall shock	3326	0.093	0.006	1892	0.074	0.010
Labor	3322	0.078	0.016	1890	0.111	0.020
Chores	3011	0.692	-0.128**	1744	0.699	-0.110**
Schooling	3341	0.977	0.005	1898	0.942	-0.018

Notes: This table presents the balance of household and child characteristics using municipality FE and clustered errors at the household level. Panel A considers the sample from 2010 to 2013, and Panel B considers the sample from 2013 to 2016. Columns 1-3 present the balance at the child level, and columns 4-6 at the household level. The child-level characteristics presented in columns 3-6 are the mean for the household, e.g., the variable Age is the mean age of the children in the household. Columns 1 and 4 show the sample size, columns 2 and 4 show the mean of each variable at the baseline for the control group, and columns 3 and 6 show the difference in characteristics between the treated and control groups in the baseline. The characteristics included are gender, age, household size, head of household age and age squared, head of the household gender, head of household educational attainment, indicator of whether the household carries out any agricultural activity, distance to the nearest weather station, indicator of older children (older than 10) and indicator of whether the household receives benefits from Familias en Acción, rainfall shock, labor, chores, and schooling. Female is a discrete measure that takes the value of one for girls and zero for boys. Household size is the number of people that live in a household. Female HH is an indicator that takes value one if the head of the household is female. Rainfall shock is a discrete measure that takes the value one for households with rainfall above one standard deviation from the long-run mean. * is significant at the 10% level, ** is significant at the 5% level, *** is significant at the 1% level.

TABLE A.5. Self-reported shocks and rainfall shock exposure (2013-2016)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	Flood shock		Job loss shock		Agro shock		Crop shock		Animal shock	
Rainfall shock	0.086***	0.114***	-0.002	0.005	0.009	-0.024	0.022	0.002	-0.020	-0.044**
	(0.030)	(0.030)	(0.020)	(0.020)	(0.030)	(0.030)	(0.030)	(0.030)	(0.020)	(0.020)
Observations	3784	3784	7138	7138	7138	7138	7138	7138	7138	7138
Households	1892	1892	2757	2757	2757	2757	2757	2757	2757	2757
R-squared	0.180	0.609	0.058	0.462	0.151	0.551	0.118	0.546	0.120	0.512
Household FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Municipality FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Dept-Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Mean DV	0.133	0.133	0.085	0.085	0.361	0.361	0.273	0.273	0.179	0.179
SD DV	0.339	0.339	0.279	0.279	0.480	0.480	0.445	0.445	0.383	0.383

Notes: This table presents the results from the first specification in equation (4.1) for different self-reported shocks. The list includes floods (columns 1 and 2), the loss of a job by any member of the household (columns 3 and 4), crop failure or pests, animal death or illness (columns 5 and 6), crop failure or pests (columns 7 and 8), and animal death or illness (columns 9 and 10). Rainfall shock is defined as a discrete measure that takes the value one for households with rainfall above one standard deviation from the long-run mean. Robust standard errors are clustered at the household level and presented in parenthesis. * is significant at the 10% level, ** is significant at the 5% level, *** is significant at the 1% level.

TABLE A.6. Intensive margin: Trimmed sample (2010-2016)

	(1)	(2)	(3)	(4)	(5)	(6)
	Hours Labor			Hours Chores		
Rainfall shock	0.238**	0.217	0.204	0.209	0.307	0.175
	(0.110)	(0.160)	(0.160)	(0.280)	(0.380)	(0.380)
Observations	8082	8082	8082	6365	6365	6365
Households	2095	2095	2095	1785	1785	1785
R-squared	0.051	0.361	0.369	0.053	0.398	0.466
Household FE	No	Yes	Yes	No	Yes	Yes
Municipality FE	Yes	Yes	Yes	Yes	Yes	Yes
Dept-Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Covariates	No	No	Yes	No	No	Yes
Mean DV	0.261	0.261	0.261	2.871	2.871	2.871
SD DV	1.338	1.338	1.338	4.211	4.211	4.211

Notes: This table presents the results from the main specification in equation (4.2) considering instead the outcomes on the intensive margin at the child level. Columns 1, 2, and 3 are the results from the main specification for working hours, here the sample is trimmed. Columns 4, 5, and 6 contain the analysis for hours doing labor. *Rainfall shock* is defined as a discrete measure that takes the value one for households with rainfall above one standard deviation from the long-run mean. The covariates included are gender, age, household size, head of household age and age squared, head of the household gender, head of household educational attainment, indicator of whether the household carries out any agricultural activity, distance to the nearest weather station, indicator of older children (older than 10) and indicator of whether the household receives benefits from Familias en Acción. Robust standard errors are clustered at the household level and presented in parentheses. * is significant at the 10% level, ** is significant at the 5% level, *** is significant at the 1% level.

Table A.7. Children activities and rainfall shock exposure: Extensive margin - household level (2010-2016)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	Labor				Chores				Schooling			
Rainfall shock	0.109***	0.089***	0.086***	0.065**	0.046	0.087**	0.086**	0.076*	-0.016	-0.042**	-0.039*	-0.033
	(0.030)	(0.030)	(0.030)	(0.030)	(0.030)	(0.040)	(0.040)	(0.040)	(0.020)	(0.020)	(0.020)	(0.020)
Observations	3761	3761	3761	3761	3276	3276	3276	3276	3849	3849	3849	3849
Households	1681	1681	1681	1681	1444	1444	1444	1444	1723	1723	1723	1723
R-squared	0.087	0.560	0.577	0.580	0.070	0.592	0.596	0.596	0.033	0.571	0.601	0.602
Household FE	No	Yes	Yes	Yes	No	Yes	Yes	Yes	No	Yes	Yes	Yes
Municipality FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Dept-Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Month FE	No	No	No	Yes	No	No	No	Yes	No	No	No	Yes
Covariates	No	No	Yes	Yes	No	No	Yes	Yes	No	No	Yes	Yes
Mean DV	0.112	0.112	0.112	0.112	0.723	0.723	0.723	0.723	0.939	0.939	0.939	0.939
SD DV	0.270	0.270	0.270	0.270	0.399	0.399	0.399	0.399	0.195	0.195	0.195	0.195

Notes: This table presents the results from the main specification in equation (4.2) at the household level. The main outcomes on the extensive margin are labor (columns 1, 2, 3 and 4), chores (columns 5, 6, 7 and 8), and schooling (columns 9, 10, 11 and 12). *Rainfall shock* is defined as a discrete measure that takes the value one for households with rainfall above one standard deviation from the long-run mean. The covariates included are gender, age, household size, head of household age and age squared, head of the household gender, head of household educational attainment, indicator of whether the household carries out any agricultural activity, distance to the nearest weather station, indicator of older children (older than 10) and indicator of whether the household receives benefits from Familias en Acción. Robust standard errors are clustered at the household level and presented in parenthesis. * is significant at the 10% level, ** is significant at the 5% level, *** is significant at the 1% level.

Table A.8. Household responses to flooding

Main coping mechanism	Freq.	Percent (%)	Cum. (%)
Asked relatives, friends, or other people in the community for help	70	15.52	15.52
They wanted to do something, but they couldn't because they didn't have resources	70	15.52	31.04
It was not necessary to do something that altered the household	55	12.2	43.24
Working household members increased working hours	48	10.64	53.88
They got into debt with relatives or friends	45	9.98	63.86
They spent their savings	33	7.32	71.18
They got into debt with a bank or financial entity	28	6.21	77.39
Food expenses decreased	26	5.76	83.15
Relocated within the same municipality	22	4.88	88.03
Asked for help from national or international organizations	14	3.1	91.13
Other	14	3.1	94.23
Non-working household members started looking for a job or started working	10	2.22	96.45
Sold goods or assets	9	2	98.45
They sacrificed animals	5	1.11	99.56
They had to change their municipality of residence	1	0.22	99.78
They used some insurance	1	0.22	100
One or more household members left the country	-	-	-
They mortgaged some assets (house, car, farm, etc.)	-	-	-
They withdrew their children from school or university	-	-	-
They sent their children to a cheaper school or university	-	-	-
They took insurance	-	-	-
Increased the use of fungicides or medicines for animals	-	-	-
Total	451	100	

Notes: This table presents a ranking of the main mechanisms used to deal with flooding between 2013 and 2016. This table has the frequency of households that reported each mechanism, the percentage, and the cumulative percentage. Each household could only choose one mechanism at the time of the survey.

TABLE A.9. Canonical difference-in-differences specifications: Household level

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
		Δ Labor			Δ Chores			Δ Schooling	
Panel A: 2010-2013 (full)									
Δ Rainfall shock	0.153***	0.053	0.051	-0.002	-0.162	-0.190*	-0.058	-0.025	-0.036
	(0.060)	(0.060)	(0.060)	(0.080)	(0.110)	(0.110)	(0.040)	(0.050)	(0.050)
Observations	536	536	536	523	523	523	538	538	538
Households	536	536	536	523	523	523	538	538	538
R-squared	0.017	0.083	0.143	0.000	0.049	0.080	0.007	0.040	0.063
Mean DV	0.058	0.058	0.058	0.076	0.076	0.076	-0.011	-0.011	-0.011
SD DV	0.276	0.276	0.276	0.507	0.507	0.507	0.168	0.168	0.168
Panel B: 2010-2013 (untreated pre-period)									
Δ Rainfall shock	0.206***	0.083	0.042	-0.008	-0.205	-0.234*	-0.042	0.018	0.000
	(0.080)	(0.100)	(0.100)	(0.100)	(0.140)	(0.140)	(0.030)	(0.040)	(0.040)
Observations	527	527	527	514	514	514	529	529	529
Households	527	527	527	514	514	514	529	529	529
R-squared	0.021	0.083	0.144	0.000	0.057	0.087	0.003	0.034	0.056
Mean DV	0.058	0.058	0.058	0.076	0.076	0.076	-0.012	-0.012	-0.012
SD DV	0.278	0.278	0.278	0.507	0.507	0.507	0.163	0.163	0.163
Panel C: 2013-2016 (full)									
Δ Rainfall shock	0.085**	0.062	0.062*	0.119***	0.098**	0.100**	-0.029	-0.049*	-0.049*
	(0.030)	(0.040)	(0.040)	(0.030)	(0.050)	(0.050)	(0.020)	(0.030)	(0.030)
Observations	1483	1483	1483	1249	1249	1249	1516	1516	1516
Households	1483	1483	1483	1249	1249	1249	1516	1516	1516
R-squared	0.006	0.060	0.102	0.009	0.050	0.061	0.001	0.012	0.085
Mean DV	0.041	0.041	0.041	0.099	0.099	0.099	-0.020	-0.020	-0.020
SD DV	0.378	0.378	0.378	0.459	0.459	0.459	0.263	0.263	0.263
Panel D: 2013-2016 (untreated pre-period)									
Δ Rainfall shock	0.076	0.079	0.077	0.233***	0.231***	0.227***	-0.060	-0.064	-0.073*
	(0.050)	(0.060)	(0.060)	(0.060)	(0.070)	(0.070)	(0.040)	(0.040)	(0.040)
Observations	1376	1376	1376	1151	1151	1151	1407	1407	1407
Households	1376	1376	1376	1151	1151	1151	1407	1407	1407
R-squared	0.002	0.062	0.102	0.014	0.063	0.075	0.003	0.015	0.087
Household FE	No	No	No	No	No	No	No	No	No
Municipality FE	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
Δ Covariates	No	No	Yes	No	No	Yes	No	No	Yes
Mean DV	0.048	0.048	0.048	0.103	0.103	0.103	-0.021	-0.021	-0.021
SD DV	0.370	0.370	0.370	0.465	0.465	0.465	0.264	0.264	0.264

Notes: This table presents the results from the *difference-in-difference* specification in equation (4.3) at the household level. Panel A considers the sample from 2010 to 2013, and Panel B considers the sample from 2013 to 2016. The main outcomes are in differences ($\Delta Y = Y_t - Y_{t-1}$): Δ labor (columns 1, 2, and 3), Δ chores (columns 4, 5, and 6), and Δ schooling (columns 7, 8, and 9). Δ *Rainfall shock* is defined as the difference of the discrete measure that takes the value one for households with rainfall above one standard deviation from the long-run mean ($\Delta Shock = Shock_t - Shock_{t-1}$). The covariates are also in differences ($\Delta X = X_t - X_{t-1}$ included are gender, age, household size, head of household age and age squared, head of the household gender, head of household educational attainment, indicator of whether the household carries out any agricultural activity, distance to the nearest weather station, indicator of older children (older than 10) and indicator of whether the household receives benefits from Familias en Acción. * is significant at the 10% level, ** is significant at the 5% level, *** is significant at the 1% level.

TABLE A.10. Clustering at the weather station level

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	Labor				Chores				Schooling			
Rainfall shock	0.093***	0.067**	0.063**	0.050**	0.042*	0.105**	0.091*	0.087*	-0.040*	-0.042***	-0.038**	-0.039**
	(0.020)	(0.030)	(0.030)	(0.020)	(0.020)	(0.050)	(0.050)	(0.050)	(0.020)	(0.020)	(0.020)	(0.020)
Observations	8832	8832	8832	8832	6514	6514	6514	6514	9223	9223	9223	9223
Stations	135	135	135	135	122	122	122	122	139	139	139	139
R-squared	0.061	0.381	0.448	0.449	0.054	0.420	0.493	0.493	0.027	0.349	0.396	0.396
Household FE	No	Yes	Yes	Yes	No	Yes	Yes	Yes	No	Yes	Yes	Yes
Municipality FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Dept-Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Month FE	No	No	No	Yes	No	No	No	Yes	No	No	No	Yes
Covariates	No	No	Yes	Yes	No	No	Yes	Yes	No	No	Yes	Yes
Mean DV	0.122	0.122	0.122	0.122	0.723	0.723	0.723	0.723	0.931	0.931	0.931	0.931
SD DV	0.327	0.327	0.327	0.327	0.448	0.448	0.448	0.448	0.254	0.254	0.254	0.254

Notes: This table presents the results from the main specification in equation (4.2) at the child level. The main outcomes on the extensive margin are labor (columns 1, 2, 3, and 4), chores (columns 5, 6, 7, and 8), and schooling (columns 9, 10, 11, and 12). *Rainfall shock* is defined as a discrete measure that takes the value one for households with rainfall above one standard deviation from the long-run mean. The covariates included are gender, age, household size, head of household age and age squared, head of the household gender, head of household educational attainment, indicator of whether the household carries out any agricultural activity, distance to the nearest weather station, indicator of older children (older than 10) and indicator of whether the household receives benefits from Familias en Acción. Robust standard errors are clustered at the weather station level and presented in parenthesis. * is significant at the 10% level, ** is significant at the 5% level, *** is significant at the 1% level.

Table A.11. Canonical difference-in-differences specifications clustering at the weather station level

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
		Δ Labor			Δ Chores			Δ Schooling	
Panel A: 2010-2013									
Δ Rainfall shock	0.129**	0.097**	0.091**	-0.025	-0.069	-0.092	-0.066	-0.075	-0.081
	(0.060)	(0.050)	(0.050)	(0.090)	(0.090)	(0.090)	(0.080)	(0.070)	(0.070)
Observations	734	734	734	720	720	720	739	739	739
Stations	59	59	59	59	59	59	59	59	59
R-squared	0.014	0.072	0.104	0.000	0.061	0.071	0.011	0.060	0.084
Mean DV	0.020	0.020	0.020	0.134	0.134	0.134	0.020	0.020	0.020
SD DV	0.277	0.277	0.277	0.564	0.564	0.564	0.167	0.167	0.167
Panel B: 2010-2013 subsample									
Δ Rainfall shock	0.185***	0.172***	0.145**	-0.015	-0.083	-0.123	0.015	0.013	0.009
	(0.070)	(0.070)	(0.070)	(0.120)	(0.150)	(0.150)	(0.020)	(0.020)	(0.010)
Observations	717	717	717	703	703	703	722	722	722
Stations	59	59	59	59	59	59	59	59	59
R-squared	0.018	0.075	0.106	0.000	0.066	0.077	0.000	0.025	0.051
Mean DV	0.020	0.020	0.020	0.133	0.133	0.133	0.015	0.015	0.015
SD DV	0.281	0.281	0.281	0.565	0.565	0.565	0.152	0.152	0.152
Panel C: 2013-2016									
Δ Rainfall shock	0.072**	0.057	0.052	0.100***	0.062	0.053	-0.023*	-0.062***	-0.055**
	(0.040)	(0.040)	(0.040)	(0.030)	(0.040)	(0.040)	(0.010)	(0.020)	(0.020)
Observations	2620	2620	2620	2011	2011	2011	2659	2659	2659
Stations	72	72	72	66	66	66	72	72	72
R-squared	0.004	0.060	0.070	0.005	0.045	0.050	0.001	0.024	0.040
Mean DV	0.080	0.080	0.080	0.138	0.138	0.138	-0.058	-0.058	-0.058
SD DV	0.424	0.424	0.424	0.521	0.521	0.521	0.286	0.286	0.286
Panel D: 2013-2016 subsample									
Δ Rainfall shock	0.123**	0.137**	0.128**	0.179***	0.174***	0.163***	-0.053**	-0.082***	-0.083***
	(0.060)	(0.060)	(0.060)	(0.060)	(0.030)	(0.040)	(0.020)	(0.030)	(0.020)
Observations	2372	2372	2372	1808	1808	1808	2408	2408	2408
Households	70	70	70	64	64	64	70	70	70
R-squared	0.004	0.070	0.083	0.006	0.052	0.056	0.002	0.022	0.037
Household FE	No	No	No	No	No	No	No	No	No
Municipality FE	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
Δ Covariates	No	No	Yes	No	No	Yes	No	No	Yes
Mean DV	0.085	0.085	0.085	0.144	0.144	0.144	-0.058	-0.058	-0.058
SD DV	0.413	0.413	0.413	0.522	0.522	0.522	0.287	0.287	0.287

Notes: This table presents the results from the *difference-in-difference* specification in equation (4.3) at the child level. Panel A considers the sample from 2010 to 2013, and Panel B considers the sample from 2013 to 2016. The main outcomes are in differences ($\Delta Y = Y_t - Y_{t-1}$): Δ labor (columns 1, 2, and 3), Δ chores (columns 4, 5, and 6), and Δ schooling (columns 7, 8, and 9). Δ *Rainfall shock* is defined as the difference of the discrete measure that takes the value one for households with rainfall above one standard deviation from the long-run mean ($\Delta Shock = Shock_t - Shock_{t-1}$). The covariates are also in differences ($\Delta X = X_t - X_{t-1}$) included are gender, age, household size, head of household age and age squared, head of the household gender, head of household educational attainment, indicator of whether the household carries out any agricultural activity, distance to the nearest weather station, indicator of older children (older than 10) and indicator of whether the household receives benefits from Familias en Acción. Robust standard errors are clustered at the weather station level and presented in parenthesis. * is significant at the 10% level, ** is significant at the 5% level, *** is significant at the 1% level.

TABLE A.12. Yearly frequency of financial variables

	2010	2013	2016	Total
Panel A: Asset insurance				
No	3,043	2,740	2,327	8,110
Yes	47	171	114	332
Panel B: Debts before the shock				
No	2,134	1,683	1,371	5,188
Yes	956	1,228	1,070	3,254
Panel C: Formal loans before the shock				
No	2,375	2,020	1,495	5,890
Yes	715	891	946	2,552
Panel D: Foreign remittances				
No	3,055	8,307	2,408	2,844
Yes	35	135	33	67
Panel E: Natural disaster aid				
No	3,082	2,862	2,428	8,372
Yes	8	49	13	70
Total	3,090	2,911	2,441	8,442

Notes: This table shows the number of households that had insurance, debts, or received assistance each year. Panel A shows how many households had relevant insurance, i.e., house, car, crop, or machinery insurance. Panel B shows the number of households that had any debt before the shock, i.e., three months before the survey. Panel C shows the number of households that had at least one formal loan before the shock, i.e., three months before the survey. Finally, Panel D shows the number of children that lived in a household that received assistance due to a natural disaster.

Table A.13. Heterogeneous effects: Alternative measures

	(1)	(2)	(3)	(4)	(5)	(6)
	Financial Services (Z)				Financial assistance (Z)	
	Number of formal loans before shock		Number of debts before shock		Amount of remittances (100,000)	
Panel A: Labor						
Rainfall shock	0.070***	0.044*	0.051**	0.028	0.092***	0.062***
	(0.020)	(0.020)	(0.020)	(0.020)	(0.020)	(0.020)
Rainfall shock × Z	0.044**	0.045*	0.051**	0.047**	-0.003***	-0.002***
	(0.020)	(0.020)	(0.020)	(0.020)	(0.000)	(0.000)
Z	0.016***	0.020***	0.014***	0.017***	0.000	0.000
	(0.010)	(0.010)	(0.000)	(0.010)	(0.000)	(0.000)
Observations	12072	11347	12072	11347	12072	11347
Households	3231	2507	3231	2507	3231	2507
R-squared	0.061	0.342	0.062	0.343	0.058	0.341
Mean DV	0.109	0.106	0.109	0.106	0.109	0.106
SD DV	0.312	0.308	0.312	0.308	0.312	0.308
Panel B: Chores						
Rainfall shock	0.057**	0.126***	0.051*	0.124***	0.044*	0.108***
	(0.030)	(0.030)	(0.030)	(0.030)	(0.020)	(0.030)
Rainfall shock × Z	-0.030	-0.039	-0.013	-0.022	0.003	0.004*
	(0.020)	(0.020)	(0.020)	(0.020)	(0.000)	(0.000)
Z	0.013*	0.010	0.010	0.001	0.000	0.001
	(0.010)	(0.010)	(0.010)	(0.010)	(0.000)	(0.000)
Observations	9402	8764	9402	8764	9402	8764
Households	2760	2125	2760	2125	2760	2125
R-squared	0.051	0.386	0.051	0.386	0.051	0.386
Mean DV	0.705	0.706	0.705	0.706	0.705	0.706
SD DV	0.456	0.456	0.456	0.456	0.456	0.456
Panel C: Schooling						
Rainfall shock	-0.028	-0.043**	-0.025	-0.044**	-0.034**	-0.047***
	(0.020)	(0.020)	(0.020)	(0.020)	(0.020)	(0.020)
Rainfall shock × Z	-0.015	-0.011	-0.014	-0.004	0.001**	0.001*
	(0.020)	(0.020)	(0.010)	(0.020)	(0.000)	(0.000)
Z	0.008**	0.000	0.007**	-0.003	0.000**	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Observations	12577	11853	12577	11853	12577	11853
Households	3305	2582	3305	2582	3305	2582
R-squared	0.023	0.321	0.023	0.321	0.023	0.321
Household FE	No	Yes	No	Yes	No	Yes
Municipality FE	Yes	Yes	Yes	Yes	Yes	Yes
Dept-Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Covariates	No	No	No	No	No	No
Mean DV	0.934	0.934	0.934	0.934	0.931	0.934
SD DV	0.254	0.248	0.254	0.248	0.254	0.248

Notes: This table presents the results for the heterogeneous effects from the equation (4.4) for the three main outcomes. The main outcomes on the extensive margin are labor (Panel A), chores (Panel B), and schooling (Panel C). Columns 1, and 3 include municipality and department-year fixed effects. Columns 2, and 4 include household, municipality, and department-year fixed effects. Columns 1-4 consider financial services variables such as the number of formal loans before the shock or the number of debts before the shock. Columns 5 and 6 consider financial assistance variables such as the value of remittances the household received during the last 12 months. Rainfall shock is defined as a discrete measure that takes the value one for households with rainfall above one standard deviation from the long-run mean. Robust standard errors are clustered at the household level and presented in parenthesis. * is significant at the 10% level, ** is significant at the 5% level, *** is significant at the 1% level.

A.3. Variable definitions and sources.

(a) Individual-Level Variables. *Source*: Encuesta Longitudinal Colombiana de la Universidad de Los Andes (ELCA) - 2010-2016.

Labor: Indicator variable takes value one if one of the following conditions is met, and zero otherwise. *Scale*: 0,1.

- If children between 5 and 9 years old did child work, collaborated or helped someone in their job last week (excluding the housework contained in chores).
- If children over ten years old, last week, worked at least one hour in an activity that generated some income, worked for at least one hour and looked for a job, worked as a family helper without pay for at least one hour, or the child did not work but had a job for which they received an income.

Chores: Indicator variable takes value one if, last week, the child did or helped with household chores. These chores include laundry, ironing, cooking, cleaning, maintenance, fetching water, running errands, doing groceries, and taking care of younger children and sick or disabled people, and zero otherwise. *Scale*: 0,1.

Schooling: Indicator variable takes value one if the child is currently studying (attending school), zero otherwise. *Scale*: 0,1.

Age: Child age in completed years. *Scale*: 5,6,7,8,...,17.

Female: Indicator variable takes value one if child's gender is female, and zero otherwise. *Scale*: 0,1.

Younger children: Indicator variable takes value one if the child is between 5 and 9 years old, and zero otherwise. *Scale*: 0,1.

Older children: Indicator variable takes value one if the child is between 10 and 17 years old, and zero otherwise. *Scale*: 0,1.

(b) Household-Level Variables. *Source*: Encuesta Longitudinal Colombiana de la Universidad de Los Andes (ELCA) - 2010-2016.

Relevant insurance: Indicator variable takes value one if the household owns any relevant insurance, such as crop, livestock, house, machinery, or vehicle insurance, and zero otherwise. *Scale*: 0,1.

Insurance: Indicator variable takes value one if the household members have insurance, and zero otherwise. *Scale*: 0,1.

Natural disaster assistance: Indicator variable takes value one if, during the last 12 months, the household received or has been a beneficiary of natural disaster assistance, and zero otherwise. *Scale*: 0,1.

Debt before the shock: Indicator variable takes value one if the household currently has any credit, loan, or debt with entities, relatives, friends, or people, acquired before the rainfall shock, i.e., 3 months before the survey, and zero otherwise. *Scale*: 0,1.

Formal loans before the shock: Indicator variable takes value one if the household currently has any credit, loan, or debt with banks or financial institutions in Colombia or abroad, employee or cooperative funds, chain stores, hypermarkets or Codensa, compensation funds, unions or associations, employers, and Icetex, acquired before the rainfall shock, i.e., 3 months before the survey, and zero otherwise.[22][23][24] *Scale*: 0,1.

Household size: Number of people who live in the household. *Scale*: 1,2,3,...,19.

HH Age: Head of the household age in completed years. *Scale*: 15,16,...,90.

HH Female: Indicator variable takes value one if the head of the household is female, and zero otherwise. *Scale*: 0,1.

HH educational attainment: Indicator variable takes value one if the head of the household completed, at least, high school education, and zero otherwise. *Scale*: 0,1.

Agricultural activity: Indicator variable takes value one if someone in the household works in agricultural activities, and zero otherwise. *Scale*: 0,1.

Distance: Distance from the household to the nearest weather station in meters. *Scale*: continuous.

Familias en Acción: Indicator variable takes value one if the household participates in a conditional cash transfer program where they receive an economic incentive conditioned to school attendance and health care for children and adolescents, and zero otherwise. *Scale*: 0,1.

Self-reported shocks:

[22]Codensa S.A. ESP is an electricity distribution and marketing company in Cundinamarca, Boyacá, Tolima, Caldas, and Meta. In 2001, they began to offer a new service, Crédito Fácil Codensa, which allows people who cannot access formal credit or the banking system to purchase products and goods that improve their quality of life and that of their families, likewise building their credit history. Additionally, they have the facility to pay installments with the energy bill.

[23]The purpose of the Compensation Funds is to pay the beneficiary worker a monthly monetary subsidy per child or dependent disabled person and subsidies in kind and services, such as school supplies, recreation, education, health, training, etc.

[24]ICETEX is a State entity that grants educational credits and their collection, with its own resources or from third parties, to the population with less economic possibilities and good academic performance.

1. **Flood shock**: Indicator variable takes value one if the household reported experiencing a flood during the last three years, and zero otherwise. *Scale*: 0,1.
2. **Job loss shock**: Indicator variable takes value one if the household reported experiencing a job loss from someone within the household during the last three years, and zero otherwise. *Scale*: 0,1.
3. **Animal shock**: Indicator variable takes value one if the household reported experiencing the loss or death of animals during the last three years, and zero otherwise. *Scale*: 0,1.
4. **Crop shock**: Indicator variable takes value one if the household reported experiencing pests of crop losses during the last three years, and zero otherwise. *Scale*: 0,1.
5. **Agricultural shock**: Indicator variable takes value one if the household reported experiencing the loss or death of animals, pests, or crop losses during the last three years, and zero otherwise. *Scale*: 0,1.

(c) Weather station-Level Variables. *Source*: IDEAM - 1980-2016.

Rainfall shock: Indicator variable takes value one if the household experienced the total monthly rainfall one standard deviation above the average rainfall of the last 30 years for the weather station three months before the survey, and zero otherwise. *Scale*: 0,1.

Severe rainfall shock: Indicator variable takes value one if the household experienced the total monthly rainfall above the 90^{th} percentile of the last 30 years three months before the survey, and zero otherwise. *Scale*: 0,1.

Moderate rainfall shock: Indicator variable takes value one if the household experienced the total monthly rainfall above the 85^{th} percentile of the last 30 years three months before the survey, and zero otherwise. *Scale*: 0,1.

Weak rainfall shock: Indicator variable takes value one if the household experienced the total monthly rainfall above the 80^{th} percentile of the last 30 years three months before the survey, and zero otherwise. *Scale*: 0,1.