# Early-Life Circumstances and Adult Locus of Control: Evidence from 46 Developing Countries

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Abstract

Early-life circumstances have a long-term impact on adult outcomes such as health, wealth, and happiness. Using exogenous variation in weather conditions across 46 developing countries over time, this study examines the impact of experiencing weather shocks in childhood on adult non-cognitive skills, namely, locus of control. The results show that those who experienced rainfall shortage before age five are more likely to believe that they cannot control their life outcomes. However, the impact diminishes by their early forties. This study also demonstrates the negative impact of weather shocks on voting behavior. Finally, underlying mechanisms for this relationship are explored.

Keywords: locus of control; non-cognitive skills; early life circumstances; climate change
JEL classifications:

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## 1. Introduction

Early-life circumstances are a key determinant of an individual's human development. Existing studies provide evidence that experience of disease pandemic and conflict, parents' socio-economic status, family instability, and macro-economic conditions in childhood have a persistent impact on individuals' education, physical/mental health, wealth, and happiness (Adhvaryu et al. 2019; Akresh et al. 2012; Almond 2006; Banerjee et al. 2010; Behrman and Rosenzweig 2004; Bertoni 2015; Bleakley 2007; 2010; Cui et al. 2019; Currie and Hyson 1999; Gould et al. 2011; Kesternich et al. 2014; Kesternich et al. 2015; Lo Bue 2019; Maccini and Yang 2009).

While insightful, existing studies leave three issues unaddressed. First, relative to the other adult outcomes, the long-term impact on non-cognitive skills is largely unexplored. This is crucial because it has been well acknowledged that non-cognitive skills play pivotal roles in human development, and childhood is an important period in acquiring such skills (Borghans et al. 2008; Heckman et al. 2006). Furthermore, examining this impact also may allow researchers to uncover the mechanism of the long-term impact of early-life circumstances on adult socio-economic and health status, given the effects on these outcomes of non-cognitive skills. Second, existing studies do not address how long the impact of early-life circumstances persists. A longer-term impact would suggest that it is more important for policymakers to protect children from adverse conditions. However, it is theoretically ambiguous whether the impact diminishes with age or persist until later life. Third, earlier studies rely on the unique conditions in a country, such as a disease pandemic (Almond 2006; Banerjee et al. 2010; Bleakley 2007, 2010) or a civil war (Akresh et al. 2012; Singhal 2018). This raises a potential issue regarding the external validity of their findings.

This study bridges these gaps in the literature by examining whether and how long the experience of weather shocks during childhood affects adult locus of control (LOC). Earlier studies show that LOC—individual beliefs regarding the causal relationship between one's own efforts and one's life outcomes—predicts individuals' socio-economic status, health, and subjective well-being.[1] Therefore, it is relevant to understand its formation process. Weather shocks exogenously affect household economy, particularly in agricultural countries, and there are various reasons to believe that they affect children's LOC, as discussed in the next section.

The main empirical analysis employs data from the World Values Survey (WVS) and the weather data of Barrios et al. (2010). The WVS has preferable feature that it has been conducted worldwide for a long period, ensuring its high external validity. The analysis of large-scale repeated cross-sectional data and frequent weather shocks also allows me to isolate the age and cohort effects and identify the persistent impact of the shock. The identification strategy relies on the exogenous variation in the timing of weather shocks across countries over time. I discuss potential threats to identification, such as sample selection and measurement errors in reported age and weather conditions.

The results from a quantile regression show that adults who experienced rainfall shortage between birth and age five are more likely to believe in external control—the belief that they cannot control their life outcomes—than those who did not experience

[1] The definition of LOC is provided in detail in Section 2.1. Prior studies show that LOC predicts individuals' earnings (Andrisani 1977; Heineck and Anger 2010), job search efforts (Caliendo et al. 2015), human capital investment (Chiteji 2010; Cobb-Clark et al. 2014; Coleman and DeLeire 2003; Findley and Cooper 1983), and subjective well-being (Verme 2009). See Cobb-Clark (2015) for a comprehensive overview.

such a shortage. The impact is larger for females from agricultural countries. However, the impact diminishes gradually with age and almost disappears by one's early forties. I also provide suggestive evidence that this impact might be mediated by the changes in parenting quality, that is, increases in physical/psychological punishment by parents during drought years.

These findings contribute to the economic literature as follows: First, existing studies show the short-term impact of negative events, such as natural disasters and conflicts, on adults' time, risk, and social preferences (Callen 2015; Cameron and Shah 2015; Cassar et al., 2017; Hanaoka et al., 2018). However, it is not well understood how long the impact persists. This is one of the first studies to address the question. The second contribution is to the literature on belief formation. Existing studies demonstrate the role of experiences in beliefs about the returns to financial assets (Koudijs and Voth 2016; Malmendier and Nagel 2011, 2016) and returns to pro-sociality (Camerer and Hua Ho 1999; Gneezy et al. 2016; Shoji 2018a). This study shows that a similar pattern is observed even for the belief about returns to efforts.

This study also makes three contributions to the psychological literature on LOC formation. Rotter's social learning theory (1954, 1966) stipulates that LOC is formed through the accumulation of lifetime experiences. This predicts that the impact of early-life experiences on LOC could slowly diminish with age, but this conjecture has not been explored in the literature heretofore. Therefore, this study is the first to test the validity of this aspect of the theory. Second, as indicated by Carton and Nowicki (1994), studies on adolescent LOC rely on self-reported information to characterize the experiences, and rigorous evidence is scarce. This study attempts to resolve this issue by adding evidence from a natural experiment. Finally, existing studies examine LOC of those in developed countries. This study exploits the data from developing countries and confirms that the observed pattern is similar across the countries.

Finally, the findings of this study are closely related to those of Krutikova and Lilleør (2015) and Giuliano and Spilimbergo (2013). Krutikova and Lilleør (2015) find that droughts during childhood negatively affect Tanzanian adults' non-cognitive skills. However, this study differs from theirs in many aspects. For example, using the longitudinal WVS data allows me to provide evidence with high external validity and identify the persistence of the impact. On the other hand, Krutikova and Lilleør's (2015) regional-level Tanzanian rainfall data allows them to analyze the impact of rainfall shortage more accurately. Giuliano and Spilimbergo (2013) evaluate the impact of experiencing a recession between the ages of 18 and 25 on individuals' preferences for redistribution and pessimism, whereas this study focuses on experiences even earlier in life. Therefore, these and the present study should be considered as complementing one another.

The rest of this study is organized as follows: Section 2 summarizes previous studies in a discussion of potential mechanisms through which weather conditions affect LOC. Sections 3 and 4 describe the dataset and identification strategy. Section 5 presents the results, and Section 6 tests their robustness. Section 7 discusses the underlying mechanisms and, finally, Section 8 concludes.

## 2. Conceptual Framework

### 2.1. Theory and Empirics of LOC Formation

LOC is a psychological concept measuring the generalized attitude, belief, or expectancy regarding the nature of the causal relationship between one's own behavior and its consequences (Rotter 1966, 1990). The belief is termed *internal control* if persons perceive that an outcome of their behavior is contingent on their own behavior or personal characteristics. On the other hand, it is labeled *external control* if persons interpret that it is not entirely contingent on their actions but rather determined by chance, luck, fate, or powerful others.[2]

LOC is not an innate personality trait, rather it changes through the accumulation of experiences related to belief and outcome over time. According to Rotter's (1954, 1966) social learning theory, belief in internal control develops by the experience of perceiving that an outcome is contingent on the individual's behavior. Once such a belief is established, the outcome strengthens the belief that the particular behavior or event will be followed by the outcome in the future. On the contrary, the failure of the outcome to occur will weaken the belief. In particular, experiences involving powerful external forces can influence individuals' perception of external control.

Since LOC is determined by the history of lifetime experiences, the effect of each experience on an individual's LOC becomes smaller, as he/she has more experiences. This theory yields two key conjectures on LOC's formation process. First, LOC changes significantly with a new experience during childhood since an individual has relatively fewer life experiences then. Second, as experiences become repetitive with age, a new experience has a smaller effect on changing LOC, and it becomes more stable.

In line with the first conjecture, existing studies have shown that childhood

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[2] The concept of LOC is related to Bandura's (1982) self-efficacy and Maier and Seligman's (1976) learned helplessness. See Judge et al. (2002) for a comprehensive discussion.

experiences have a large impact on the LOC of adolescents.[3] In particular, children's LOC is influenced by their parents (Cunha and Heckman 2007; Bono et al. 2016; Hill et al. 2001); consistent parental discipline and reward are associated with children's internal control (Ahlin and Antunes 2015; Skinner 1986). In addition, children are more likely to perceive internal control if their parents are warm, emotionally supportive, accepting, and nurturant. By contrast, they grow up to believe in external control if their parents are over-protective and controlling and frequently use physical/psychological punishment (Ahlin 2014; Spokas and Heimberg 2009). Those who experience family instability, such as parents' divorce and death, are also shown to perceive external control (Bryant and Trockel 1976; Fomby and Bosick 2013; Fomby and Cherlin 2007; Peter and Spiess 2016).

Additionally, peer and neighborhood characteristics during childhood also influence the perception of controllability. Rotter (1954, 1966) argues that more pro-social resources and lower exposure to harmful elements in the community, such as physical and social disorder, are associated with internal control (Ahlin and Antunes 2015). For example, living in an area of a higher socio-economic level causes children to be more internally controlled (Ahlin 2014). By contrast, people are more likely to believe in external control after experiences of being bullied (Slee 1993) and victimized (Catterson and Hunter 2010; Fredstrom et al. 2011).

Regarding the second conjecture, the stability of adult LOC, Cobb-Clark and Schurer (2013) show robust evidence from Australia that an individual's LOC does not change during the working-age period regardless of their life experiences. Using another panel dataset on Australian households, Elkins et al. (2017) report that non-cognitive skills, including LOC, are stable between the ages of 15 and 24. Similar patterns are

[3] See Ahlin and Antunes (2015) and Carton and Nowicki (1994) for reviews of this.

observed from German data (Infurna et al. 2016). However, many studies also show that adults' LOC changes with changes in employment status and working conditions (Diewald 2007; Gottschalk 2005; Legerski et al. 2006; Preuss and Hennecke 2018; Winefield et al. 1991).

### 2.2. Impact of Weather Shocks in Early Life

Weather conditions play a critical role in socio-economic activities, particularly in developing countries, where many individuals rely on the agricultural sector for their income-earning activities. The literature shows that weather shocks have negative effects on consumption (Fafchamps et al. 1998; Jacoby and Skoufias 1998; Paxson 1992), human capital (Björkman-Nyqvist 2013; Hoddinott and Kindsey 2001; Jacoby and Skoufias 1997; Shah and Steinberg 2017; Stanke et al. 2013), and social capital (Maystadt and Ecker 2014; Mehlum et al. 2006; Miguel et al. 2004; Shoji et al. 2012; Shoji 2018b).

This argument suggests that children who experienced such shocks in early life could believe in external control later in life, through four mechanisms. First, during rainfall shortage, children are exposed to high risk of water-related and vector-borne diseases (Stanke et al. 2013). Furthermore, due to income losses, parents may invest less in their children's health and education. The children with lower health conditions and education level, then, believe in external control if their socio-economic and health status remains poor later in life (Diewald 2007; Gottschalk 2005; Legerski et al. 2006; Preuss and Hennecke 2018; Winefield et al. 1991). In line with this hypothesis, previous studies show that socio-economic circumstances during childhood have a persistent impact on adults' human capital.[4]

[4] In Indonesia, children born in a drought year grew up to suffer from a poor education

Second, it is often documented that in developing countries, those affected by weather shocks smooth consumption by increasing their time allocation to work or migrating to non-affected areas (Kochar 1999; Morduch 1995; Morten 2019; Nguyen et al. 2015; Takasaki et al. 2004). This causes parents to experience mental stress and decreases the time they spend with their children (Haushofer and Fehr 2014; Stanke et al. 2013). The literature suggests that this could trigger the use of bad parenting methods, such as physical/psychological punishment and inconsistent and less kindly enforced discipline (Madianou and Miller 2011; Nobles 2011; Oburu and Palmérus 2003; Pinderhughes et al. 2000).

Third, weather shocks could also affect the socio-economic environment of the community and government. Existing studies show that natural disasters increase the risk of victimization from crime, conflict, and corruption (Maystadt and Ecker 2014; Mehlum et al. 2006; Miguel et al. 2004; Shoji 2018b; Yamamura 2014). Therefore, children who grow up in such a community are exposed to higher risks of victimization and may believe in external control.

Finally, even without the shocks' impact on health conditions, education level,

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level, socio-economic status, and health conditions (Maccini and Yang 2009). In Zimbabwe, the 1994–95 drought worsened children's health status, and the impact lasted up to four years after the shock (Hoddinott and Kindsey 2001). Furthermore, there is evidence that adults' poor socio-economic outcomes can be attributed to disadvantageous circumstances in their early lives, such as disease pandemics (Almond 2006; Banerjee et al. 2010; Bleakley 2007, 2010), civil wars (Akresh et al. 2012; Singhal 2018), natural disasters (Lo Bue 2019), and poor infrastructure (Gould et al. 2011). Other such circumstances include poor access to a safety net (Bharadwaj et al. 2013; Hoynes et al. 2016), parents' poor economic status (Case et al. 2002), and low birth weight (Behrman and Rosenzweig 2004; Currie and Hyson 1999; Royer 2009).

parenting quality, and crime victimization, children could self-learn the power of nature by simply observing their parents and neighbors struggling with the shocks. This could also make them believe in external control.

In line with these hypotheses, previous studies demonstrate a relationship between poverty and belief in external control (Ahlin and Antunes 2015; Conger et al. 2009; Mirowsky and Ross 1986; Moilanen and Shen 2014). Culpin et al. (2015) show that adolescents who experienced socio-economic adversity before age five are more likely to perceive external control and suffer from depression. Stephens and Delys (1973) also find that four-year-old children from economically disadvantaged backgrounds are more likely to believe in external control than children of the same age from wealthy households.

Although weather shocks during childhood may have an impact on LOC, it is theoretically ambiguous how long it persists. On the one hand, Rotter (1954, 1966) and Preuss and Hennecke (2018) claim that an individual's LOC develops through the accumulation of lifetime experiences. This suggests that, as an individual has more experiences, each of them (including those from early life) should have a smaller impact on his/her LOC. In their study on the formation of the belief about returns to financial assets, Malmendier and Nagel (2011) also provide evidence that the belief is characterized by the weighted average of past returns to assets. On the other hand, the impact of weather shocks may persist until later life if it is mediated by the first mechanism, that is, negative impact on human capital and adult socio-economic status.

## 3. Datasets

This study employs three datasets. First, the main dataset of this study is the longitudinal

WVS data. The WVS has been conducted worldwide, with the first wave in 1981–1984 and the sixth one in 2010–2014. The present study employs the following two questions from the survey to elicit individuals' LOC:[5]

1. *Some people feel they have completely free choice and control over their lives, while other people feel that what they do has no real effect on what happens to them. Please use this scale where 1 means "no choice at all" and 10 means "a great deal of choice" to indicate how much freedom of choice and control you feel you have over the way your life turns out (code one number).*[6]
2. *Now I'd like you to tell me your views on various issues. How would you place your views on this scale? 1 means you agree completely with the statement on the left; 10 means you agree completely with the statement on the right; and if your views fall somewhere in between, you can choose any number in between. (Code one number for each issue): (1) In the long run, hard work usually brings a better life, (10) Hard work doesn't generally bring success¬it's more a matter of luck and connections.*

Using these scores, I generate a summary standardized index. Aggregating multiple

[5] The WVS includes further questions, such as "*Why are there people in this country who live in need?*" and "*Some people believe that individuals can decide their own destiny, while others think that it is impossible to escape a predetermined fate. Please tell me which comes closest to your view on this scale, on which 1 means "everything in life is determined by fate" and 10 means that "people shape their fate themselves."*" However, I do not use them as they involve a small sample size.

[6] This question was asked in most countries, in all the waves. Previous studies use this scale as a brief version of the more extensive Rotter scale for LOC (Nikolaev and Bennett 2016; Pitlik et al. 2015).

measures of LOC could improve statistical power (Anderson 2008; Hoynes et al. 2016; Kling et al. 2007). Figure A1 depicts its kernel density.

Second, the climatic data come from Barrios et al. (2010). Their dataset includes the annual rainfall and average temperature for most countries between 1950 and 2006. They use these data to show that 15% to 40% of the GDP gap between Africa and the other developing countries can be explained by rainfall patterns. To define the weather shocks, I first compute the deviations of rainfall and temperature from the national average over the available periods, using the formula $\log W_{ct} - \log \overline{W_c}$, where $W_{ct}$ denotes the rainfall or temperature in country *c* in year *t*, and $\overline{W_c}$ is the national average. Then, I define that a country suffers from rainfall shortage or low rainfall if the annual rainfall of the year deviates by more than one standard deviation (SD=0.21) below the national average over the available periods. High rainfall is defined as a deviation of annual rainfall by more than one standard deviation *above* the national average. I define the shocks of high temperature and low temperature analogously (SD=0.08). Figures A2 and A3 show the kernel densities of rainfall and temperature, respectively.

After matching these two datasets based on the years of birth and countries, I exclude countries, such as the former Soviet Union, whose weather data are available for less than 20 years, because they only result in very young respondents being matched. Migrants are also excluded since their countries of birth are different. Further, respondents whose reported age does not correspond to their year of birth are excluded from the sample. [7] Finally, after excluding respondents with missing information, 44,808 observations from 21 OECD countries and 91,849 observations from 46 non-OECD

[7] The issue of age reporting errors is explored more carefully in Section 6.

countries remain for the analysis.[8] I use the non-OECD samples for the main estimation and the OECD samples for the falsification test.

The third dataset is the Multiple Indicator Cluster Survey (MICS) conducted by UNICEF. The third wave of this survey series includes questions on the quality of parenting, such as the use of physical and psychological punishment. I use this dataset by combining its information with the weather information, to analyze the above-mentioned underlying mechanisms in Section 7. The matched observations include 119,289 parents of children under 14 from 30 countries.[9]

Table 1 presents summary statistics from the WVS. In the non-OECD sample, the average respondent is 34 years old, born in 1972. Regarding the weather shock variables, I divide the early-life period into three parts: during utero, between ages 0 and 5 (pre-school period), and between ages 6 and 10 (schooling period). It appears that 9% of respondents from non-OECD countries experienced rainfall shortage during utero, and 35% of them experienced one between 0 and 5. The probability of experiencing rainfall shortage does not differ between respondents from OECD and those from non-OECD countries. Summary statistics of the MICS data are reported in Table A3.

[Table 1]

## 4. Identification Strategy

This study estimates the impact of weather shocks in early life on adult LOC with the following quantile regression model:

8 The country list is presented in Table A1.

9 The country list is provided in Table A2.

$$LOC_{ibcw} = \alpha Weather_{bc} + \beta X_{ibcw} + \theta_b + \delta_{cw} + \varepsilon_{ibcw}, \quad (1)$$

where $LOC_{ibcw}$ denotes the LOC measure for individual $i$, born in year $b$ in country $c$, and participating in the $w$-th wave of the WVS. $Weather_{bc}$ includes 12 indicators of a weather shock: four weather condition characteristics for each period of early-life—during utero, between ages 0 and 5, and between ages 6 and 10. The weather conditions during utero are included to test the fetal origin hypothesis.[10] $X_{ibcw}$ includes individual $i$'s gender and age. $\theta_b$ and $\delta_{cw}$ represent the year of birth and country-wave fixed effects, respectively. $\delta_{cw}$ controls for the unobserved heterogeneity, such as macro-economic and weather conditions at the time of the survey, and the implementation procedure of the survey. I do not control for respondents' socio-economic status at the time of the survey, because they could be determined by early-life circumstances.

I use a quantile regression model, because, unlike a linear regression model, it is robust to outliers and makes no assumption about the distribution of the residuals. These features are essential for this dataset because, as seen in Figure A2, there are multiple humps in the distribution of LOC for the non-OECD samples.

The use of weather information at the country level rather than the more narrowly defined regional level has advantages and disadvantages. On the one hand, this may cause attenuation bias due to the disparity between the national weather information and actual local weather experienced by the respondents (I address this issue in Section 6). On the

[10] Baker's (1990) fetal origin hypothesis posits that chronic, degenerative conditions in adults can be explained by health status during the utero period. Economists have expanded this hypothesis to explain broader ranges of adult outcomes, such as education and income, in addition to health (Almond and Currie 2011; Currie and Almond 2011).

other hand, the use of local weather information is problematic if the respondents migrate to another region of the same country after experiencing the extreme weather, because the WVS does not contain the information on within-country migration.

There are two potential issues with the model specification: sample selection and measurement errors. These are discussed in Section 6.

## 5. Results

### 5.1. Main Results

It is argued in Subsection 2.2 that weather shocks affect individuals' LOC mainly by lowering their agricultural income. Before showing the main result regarding LOC formation, I test the validity of this assumption. Specifically, using the country-level panel data, I regress the amount of GDP from agriculture on the weather shocks, country fixed effects, and year fixed effects. Table A4 shows that rainfall shortage has a significantly negative impact whereas the other shocks do not. This is consistent with previous studies documenting the severe socio-economic damages from rainfall shortage (Barrios et al. 2010; Hoddinott and Kindsey 2001; Maccini and Yang 2009).

Table 2 presents the estimation results for the model in Equation (1). As expected, early-life weather conditions are not associated with adult LOC in the OECD countries (columns (1) through (3)). Since a smaller proportion of workers engage in agriculture in these countries, the impact of weather shocks should be smaller than that in developing countries. Hence, the results in these columns serve as a falsification test.

By contrast, a significant relationship appears when focusing on non-OECD countries (columns (4) through (6)): those who experienced rainfall shortage between the ages of 0 and 5 are more likely to believe in external control. This result remains unchanged with the inclusion of the other weather shock variables (columns (5) and (6)). The table also reveals that rainfall shortage during utero or the schooling period does not influence adult LOC, countering the fetal origin hypothesis (Baker 1990). In line with the finding in Table A4, the shocks of high rainfall and temperature do not have a negative impact on LOC.[11]

[Table 2]

Table 3 examines the heterogeneous effects of rainfall shortage across gender. It shows that rainfall shortage between ages 0 to 5 has significant effects for females but not for males. This is consistent with the results of previous studies. Nowicki (1978) finds that stressful events during the pre-school period affect women's LOC but not men's. Fisman and O'Neill (2014) find that females are more likely to perceive success as a matter of luck rather than hard work. Other studies also demonstrate that negative shocks in childhood have a larger impact on adult outcomes for females than for males (Gould et al. 2011; Krutikova and Lilleor 2015; Maccini and Yang 2009). Finally, the table shows that even in the model incorporating the gender difference, rainfall shortage during utero and schooling period are uncorrelated with LOC.

[Table 3]

### 5.2. Persistence of the Impact

How long does the impact of early-life rainfall shortage persist? This question is largely unexplored in the literature, presumably because many studies use cross-sectional data;

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[11] Some of the coefficients of temperature shocks are significantly *positive*. However, they are not robust across specifications. The robustness checks are not reported in the paper but available upon request from the author. The unstable result is presumably because the temperature shocks occur less frequently than the rainfall shocks (Table 1).

this does not allow researchers to isolate the age and cohort effects. Exploiting the repeated cross-sectional data of the WVS, this section uncovers how the impact of rainfall shortage changes with age. Specifically, I generate category variables for respondents' age, each spanning a period of 5 years. Subsequently, I estimate a model that includes the interaction terms between the dummy variable for rainfall shortage between ages 0 and 5 and the age category variables.

Figure 1 shows, for the non-OECD countries, the point estimates of the interaction terms' coefficients and the corresponding 90% confidence intervals. Intriguingly, although the impact of rainfall shortage in childhood persists until adulthood, it disappears in the respondents' early 40s. This is consistent with the frameworks of experience-based belief formation and social learning theory (Malmendier and Nagel 2011; 2016; Preuss and Hennecke 2018; Rotter 1954; 1966).

[Figure 1]

### 5.3. Behavioral Impact

This section investigates the behavioral impact of early-life rainfall shortage. The WVS includes some questions on respondents' behavior, such as participation in community work, religious activity, and political activity. Considering the suitability as the proxy for LOC and sample size, I examine the impact on voting behavior. It is hypothesized that those who experienced rainfall shortage in their early lives are less likely to perceive that they can control their life by voting. Table 4 shows a consistent pattern. Columns (2) and (4) suggest that women who experienced rainfall shortage before age 5 are less likely to vote in national elections by 2.9 percentage points and in local elections by 2.5 percentage points. Furthermore, the impact on men is smaller, as expected.

[Table 4]

## 6. Threats to Identification and Robustness Checks

### 6.1. Sample Selection

The first issue in the benchmark specification is sample selection. The risk of stillbirth and child mortality may increase during extreme weather. Further, those who experienced a weather shock in their early lives may be less educated and may not respond to the WVS. To examine the severity of the issue, I conduct three tests. First, I re-estimate Equation (1) by excluding the countries whose infant mortality rate in 1972 (average year of birth among the respondents) was 20% or higher. The results do not change qualitatively (Table A5).

Second, using country-level panel data, I regress child mortality and fertility on the indicators of weather shocks, the year fixed effects, and the country fixed effects (columns (2) through (5) in Table A4). The result shows that rainfall shortage is uncorrelated with these macro indicators.

Third, the sample selection problem implies that children affected by a weather shock are less likely to be included in the sample. Hence, I use country-level panel data again to regress the number of respondents born in year $b$ in country $c$ on the same independent variables as the second test. The sample selection problem predicts significantly negative coefficients of rainfall shortage. However, Table A6 shows that they are statistically insignificant. It appears that the coefficients of *high* rainfall are counter-intuitively negative, and this may suggest some selection. Nonetheless, given the results of three tests overall, the issue of sample selection may not be severe, if any.

These results might seem counter to the previous studies reporting the problems of child health/mortality during natural disasters. However, this study considers that they do not necessarily contradict these studies. Many of the previous studies rely on case studies in the regions severely affected by large-scale disasters. By contrast, the child mortality and fertility variables in Table A4 are country-level indicators. Likewise, the sampling of the WVS respondents covers non-affected areas as well. In addition, the data contain both low- and middle-income countries. The weather shock variables in this study may include moderate disasters. Therefore, it is still plausible that no severe sample selection issue exists in this dataset.

### 6.2. Measurement Errors

First, it is common in poor countries for villagers to not remember their age accurately and report an approximate age. This causes a measurement error in the weather shock variables and, therefore, attenuation bias toward zero. The reporting error may be particularly severe among older respondents. Therefore, for robustness, I estimate Equation (1) after excluding respondents aged over 50. The results do not differ qualitatively (columns (1) and (2) in Table A7).

Second, the country-level weather data might be only imperfectly correlated with the actual weather in the respondent's narrowly defined locality. This also causes attenuation bias, especially in large countries. To address this concern, I estimate Equation (1) after excluding the countries whose land area exceeds 2,000,000 $km^2$. Columns (3) and (4) in Table A7 present the results, which are robust to the exclusion of these countries.

### 6.3. Further Robustness Checks

First, I additionally control for the interaction of weather conditions and the proportion of agricultural employment in the country. Column (2) in Table A8 demonstrates that although the impact of rainfall shortage before age 5 is statistically insignificant in countries where the proportion is zero, in countries where the proportion is at the median level (30%), it becomes significant (p-value=0.012). This is in line with the assumption that rainfall shortage affects the sanitation and agricultural income, and this, in turn, lowers people's non-cognitive skills.

Second, the benchmark specification represents the weather shock variables via binary indicators. In Table A9, I define them by the frequency of experiencing a weather shock. The results are qualitatively the same.

## 7. Discussion: Suggestive Evidence on Underlying Mechanisms

As discussed in Section 2, there are four potential channels through which weather shocks in early life influence adult LOC. First, the shocks negatively affect children's education and health. Subsequently, they suffer from low socio-economic and health status in adulthood, which causes them to believe in external control. Second, weather shocks cause parents to experience mental stress and spend less time with their children. This aggravates the quality of parenting and increases the frequency of physical/psychological punishment. Third, it may also worsen crime incidence, conflict, and corruption. In communities with a high risk of victimization, children do not grow up to believe in internal control. Fourth, even without these mediations, children may believe in external control by self-learning through observing their parents and neighbors struggling with the weather shock.

To test the first channel through low human capital and poor adult outcomes, I additionally control for education level, employment status, and subjective health status at the time of the survey in Equation (1). Table A10 shows that the patterns in the results do not support the hypothesis. The coefficient of rainfall shortage before age 5 is still statistically significant and its magnitude is comparable with Table 2. Furthermore, if the main channel is through health and education, the shocks during utero and the schooling period should also cause negative and possibly even larger effects on adult LOC. Hence, Table 2 also provides evidence against this channel.

I test the second hypothesis by examining how rainfall levels influence parenting quality. Since the WVS does not include retrospective information, such as the respondents' experiences of physical punishment by their parents, I employ the MICS data instead. In the third wave of this survey, the respondents were asked about the use of 11 methods to discipline their children, such as hitting and shouting, during the month prior to the survey. Using this information, I generate composite indices of parenting quality using a summary standardized index. Subsequently, this is regressed on the weather conditions of the survey year and the demographic characteristics of children.

Table 5 presents the estimation results. It is found that, during rainfall shortage, parents are more likely to use severe methods to discipline their children than during the normal period. Intriguingly, the magnitude of the impact, however, does not differ across the age groups and children's gender. One might assume that the result of homogenous impact across age groups and gender contradicts the possibility that parenting quality drives the belief in external control because rainfall shortage has a negative effect on LOC only for pre-school girls. However, older children and boys are considered to be physically and mentally tougher than younger girls and, therefore, it is reasonable to assume that the former can tolerate physical/psychological punishment more than the latter. Furthermore, although the family is the only and most important community for pre-school children, elder children are also part of other communities, such as those at school and in their neighborhood. Hence, parents' influence on LOC should be larger for pre-school children (Carton and Nowicki 1994). These arguments suggest that if their exposure to punishment is of a comparable degree, the impact on LOC would be larger for younger girls. Therefore, the results of Table 5 cannot preclude the possibility that the use of bad parenting methods is an underlying mechanism for the relationship between rainfall and LOC.

[Table 5]

The third and fourth channels are unlikely, given that rainfall shortage during the schooling period has an insignificant effect on LOC. For the third channel to be possible, we have to assume that pre-school children experience victimization by crime, conflict, and corruption, whereas older children do not. Likewise, the fourth channel assumes that pre-school children can self-learn the difficulties in controlling life by simply observing their parents and neighbors, even though elder children cannot. These assumptions are implausible.

## 8. Conclusion

This study uncovered that disadvantageous economic circumstances at the pre-school period are associated with individuals' belief in external control later in life. The impact is particularly larger for females from agricultural countries but diminishes gradually with age and almost disappears by one's early 40s. Furthermore, this study attempted to disentangle the underlying mechanism. It provides evidence against the following potential channels: low socio-economic status in adulthood; high risk of victimization by crime, conflict, and corruption; and, self-learning from parents and neighbors struggling with a hardship. On the other hand, the findings suggest that we cannot preclude the possibility of the channel being the increase in the use of bad parenting methods.

Three policy implications can be derived. First, the literature shows the role of child care and education programs in children's non-cognitive skills (Chetty et al. 2011, Baker et al. 2019). In addition to these interventions, in developing countries it may also be effective to improve the accessibility of irrigation, insurance, and disaster relief programs. Second, existing studies have uncovered that childhood poverty could have persistent effects on adult socio-economic status, mainly through declines in schooling and nutrition intake. This suggests the importance of policy interventions in the education and health sectors during economic shocks. This study, however, shows that there is also the channel through the quality of parenting. It is, therefore, required to provide another type of intervention, such as mental support to the affected parents and children. Third, controlling climate change is one of the main goals of the Sustainable Development Goals (SDGs). This study shows that the negative impact of extreme weather persists and is particularly larger for socio-economically vulnerable individuals, such as females in poor countries. This suggests that climate change is also related to the other goals of SDGs, such as addressing poverty, inequality, and gender issues. To achieve the targets of SDGs, policymakers should not argue these issues independently.

Finally, previous studies assume that adult LOC is exogenous and remain stable. My finding does not necessarily contradict the existing evidence on the stability of adult LOC for a short period (Cobb-Clark and Schurer 2013; Elkins et al. 2017; Infurna et al. 2016) since the impact of early-life experiences emerges before adolescence and gradually diminishes with age. However, this study still confirms that LOC is determined endogenously by life experiences and changes over time. Hence, researchers should be careful when interpreting studies that do not take this endogeneity into account and studies assuming that LOC remains stable for a long period.

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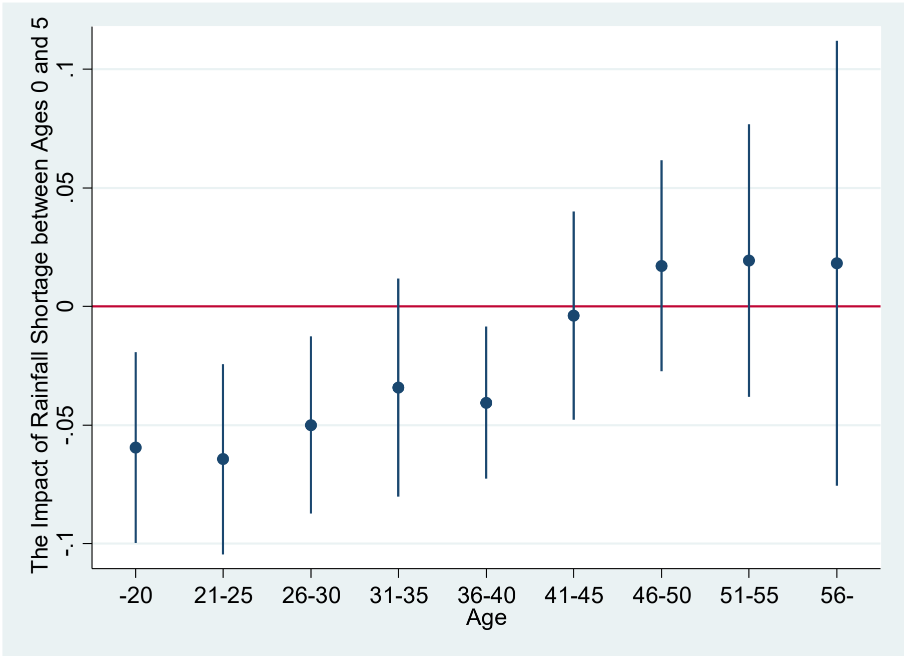


Note: X-axis is the age of respondents. Y-axis is the magnitude of point estimate. The point estimates and 90% confidence intervals are depicted. The sample from non-OECD countries is used.

**Figure 1: Persistence of Early-Life Rainfall Shortage**

**Table 1: Summary Statistics**

| Sample Countries: | OECD | | Non-OECD | |
|---|---|---|---|---|
| | Mean | S.D. | Mean | S.D. |
| Locus of control | -0.07 | 0.96 | 0.03 | 1.02 |
| Low rainfall during utero | 0.07 | 0.26 | 0.09 | 0.29 |
| Low rainfall between 0 and 5 | 0.35 | 0.48 | 0.35 | 0.48 |
| Low rainfall between 6 and 10 | 0.34 | 0.47 | 0.35 | 0.48 |
| High rainfall during utero | 0.09 | 0.28 | 0.08 | 0.27 |
| High rainfall between 0 and 5 | 0.31 | 0.46 | 0.26 | 0.44 |
| High rainfall between 6 and 10 | 0.26 | 0.44 | 0.22 | 0.42 |
| Low temperature during utero | 0.13 | 0.34 | 0.01 | 0.12 |
| Low temperature between 0 and 5 | 0.39 | 0.49 | 0.08 | 0.27 |
| Low temperature between 6 and 10 | 0.32 | 0.47 | 0.06 | 0.25 |
| High temperature during utero | 0.07 | 0.26 | 0.04 | 0.20 |
| High temperature between 0 and 5 | 0.18 | 0.38 | 0.07 | 0.26 |
| High temperature between 6 and 10 | 0.19 | 0.39 | 0.07 | 0.26 |
| Age | 35.9 | 11.4 | 34.3 | 11.3 |
| Male | 0.48 | 0.50 | 0.49 | 0.50 |
| Year of birth | 1967.9 | 11.2 | 1972.3 | 12.0 |
| Completed secondary school | 0.69 | 0.46 | 0.56 | 0.50 |
| Unemployed | 0.07 | 0.26 | 0.12 | 0.32 |
| Full time work | 0.47 | 0.50 | 0.35 | 0.48 |
| Self-employed | 0.08 | 0.28 | 0.15 | 0.36 |
| Self-reported health | 0.75 | 0.43 | 0.74 | 0.44 |
| Vote for national election | 0.89 | 0.31 | 0.78 | 0.41 |
| Vote for local election | 0.87 | 0.34 | 0.78 | 0.42 |
| Number of countries | 21 | | 46 | |
| Number of surveys | 53 | | 82 | |
| Observations | 44,808 | | 91,849 | |

**Table 2: The Impact of Rainfall Shortage in Early Life on Adult Locus of Control**

| | OECD | | | Non-OECD | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Low rainfall during utero | 0.016 | 0.018 | 0.029 | -0.007 | -0.003 | -0.003 |
| | (0.027) | (0.028) | (0.026) | (0.016) | (0.015) | (0.014) |
| Low rainfall between 0 and 5 | 0.008 | 0.009 | 0.017 | -0.033*** | -0.030** | -0.028** |
| | (0.019) | (0.019) | (0.020) | (0.013) | (0.013) | (0.012) |
| Low rainfall between 6 and 10 | 0.015 | 0.009 | 0.005 | -0.026** | -0.022* | -0.019 |
| | (0.018) | (0.019) | (0.018) | (0.013) | (0.012) | (0.012) |
| High rainfall during utero | | 0.037 | 0.032 | | 0.010 | 0.010 |
| | | (0.023) | (0.025) | | (0.020) | (0.019) |
| High rainfall between 0 and 5 | | 0.007 | 0.019 | | 0.005 | 0.001 |
| | | (0.014) | (0.014) | | (0.015) | (0.014) |
| High rainfall between 6 and 10 | | -0.014 | -0.011 | | 0.020 | 0.021 |
| | | (0.017) | (0.017) | | (0.015) | (0.014) |
| Low temperature during utero | | | -0.011 | | | -0.044 |
| | | | (0.020) | | | (0.045) |
| Low temperature between 0 and 5 | | | -0.055** | | | 0.010 |
| | | | (0.022) | | | (0.030) |
| Low temperature between 6 and 10 | | | 0.013 | | | 0.071* |
| | | | (0.020) | | | (0.039) |
| High temperature during utero | | | 0.012 | | | 0.069*** |
| | | | (0.020) | | | (0.025) |
| High temperature between 0 and 5 | | | 0.025 | | | 0.093* |
| | | | (0.021) | | | (0.053) |
| High temperature between 6 and 10 | | | 0.038* | | | -0.012 |
| | | | (0.020) | | | (0.039) |
| Number of countries | 21 | 21 | 21 | 46 | 46 | 46 |
| Number of clusters | 53 | 53 | 53 | 82 | 82 | 82 |
| Observations | 44,808 | 44,808 | 44,808 | 91,849 | 91,849 | 91,849 |

The coefficients of quantile regression are reported. Standard errors clustered at the country and survey wave level are in parentheses. *** p<0.01, ** p<0.05, * p<0.1. The other controls include age, gender, year-of-birth fixed effects, and country-wave fixed effects.

**Table 3: Heterogeneous Impact across Gender**

| | (1) | (2) |
|---|---|---|
| Low rainfall during utero × Female | 0.005 | 0.015 |
| | (0.019) | (0.020) |
| Low rainfall during utero × Male | -0.019 | -0.020 |
| | (0.021) | (0.022) |
| Low rainfall between 0 and 5 × Female | -0.042*** | -0.041*** |
| | (0.016) | (0.015) |
| Low rainfall between 0 and 5 × Male | -0.023 | -0.013 |
| | (0.018) | (0.017) |
| Low rainfall between 6 and 10 × Female | -0.020 | -0.018 |
| | (0.019) | (0.018) |
| Low rainfall between 6 and 10 × Male | -0.028* | -0.020 |
| | (0.015) | (0.015) |
| Other weather variables interacted with gender | No | Yes |
| Number of countries | 46 | 46 |
| Number of clusters | 82 | 82 |
| Observations | 91,849 | 91,849 |

The non-OECD samples are used. The coefficients of quantile regression are reported. Standard errors clustered at the country and survey wave level are in parentheses. *** p<0.01, ** p<0.05, * p<0.1. The other controls include age, gender, year-of-birth fixed effects, and country-wave fixed effects.

**Table 4: The Impact on Voting Behavior**

| | National Election | | Local Election | |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| Low rainfall during utero | 0.011 | | 0.002 | |
| | [0.532] | | [0.876] | |
| Low rainfall during utero × Female | | 0.002 | | -0.009 |
| | | [0.852] | | [0.696] |
| Low rainfall during utero × Male | | 0.019 | | 0.011 |
| | | [0.316] | | [0.528] |
| Low rainfall between 0 and 5 | -0.018 | | -0.014 | |
| | [0.300] | | [0.568] | |
| Low rainfall between 0 and 5 × Female | | -0.029** | | -0.025* |
| | | [0.016] | | [0.084] |
| Low rainfall between 0 and 5 × Male | | -0.008 | | -0.004 |
| | | [0.884] | | [0.936] |
| Low rainfall between 6 and 10 | 0.003 | | -0.002 | |
| | [0.912] | | [0.952] | |
| Low rainfall between 6 and 10 × Female | | 0.002 | | -0.006 |
| | | [0.892] | | [0.824] |
| Low rainfall between 6 and 10 × Male | | 0.005 | | 0.002 |
| | | [0.860] | | [0.944] |
| Other weather variables | Yes | Yes | Yes | Yes |
| Other weather variables interacted with gender | No | Yes | No | Yes |
| Mean of dep. var. | 0.78 | 0.78 | 0.78 | 0.78 |
| Number of countries | 32 | 32 | 31 | 31 |
| Number of clusters | 32 | 32 | 31 | 31 |
| Observations | 38983 | 38983 | 38008 | 38008 |

The non-OECD samples are used. The coefficients of OLS are reported. Wild bootstrap p-values proposed by Cameron et al. (2008) are in brackets (500 bootstrap replications, with imposing the null hypothesis). *** p<0.01, ** p<0.05, * p<0.1. The other controls include age, gender, year-of-birth fixed effects, and country-wave fixed effects.

**Table 5: Test for the channel through parenting quality**

| | (1) | (2) |
|---|---|---|
| Low rainfall between 0 and 5 | 0.410*** | |
| | (0.071) | |
| Low rainfall between 0 and 5 × Female | | 0.407*** |
| | | (0.072) |
| Low rainfall between 0 and 5 × Male | | 0.405*** |
| | | (0.073) |
| Low rainfall between 6 and 10 | 0.442*** | |
| | (0.080) | |
| Low rainfall between 6 and 10 × Female | | 0.437*** |
| | | (0.082) |
| Low rainfall between 6 and 10 × Male | | 0.451*** |
| | | (0.077) |
| Low rainfall between 11 and 14 | 0.428*** | |
| | (0.092) | |
| Low rainfall between 11 and 14 × Female | | 0.421*** |
| | | (0.103) |
| Low rainfall between 11 and 14 × Male | | 0.431*** |
| | | (0.090) |
| Other weather variables | Yes | Yes |
| Other weather variables interacted with gender | No | Yes |
| Number of countries | 30 | 30 |
| Number of clusters | 30 | 30 |
| Observations | 119,289 | 119,289 |

MICS data are used. The coefficients of quantile regression are reported. Standard errors clustered at the country and survey wave level are in parentheses. *** p<0.01, ** p<0.05, * p<0.1. The other controls include age, gender, and survey-year fixed effects. Low temperature shock is not included in the independent variables, since none of the countries suffered in the survey year.

## Appendix

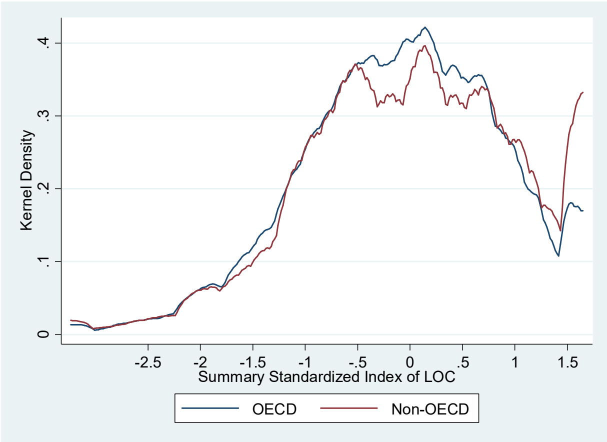


**Figure A1: Kernel Density of Summary Standardized Index of LOC**

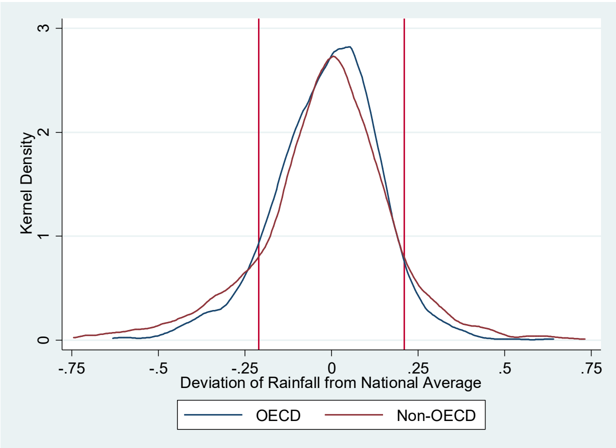


**Figure A2: Kernel Density of Rainfall (Deviation from National Average)**

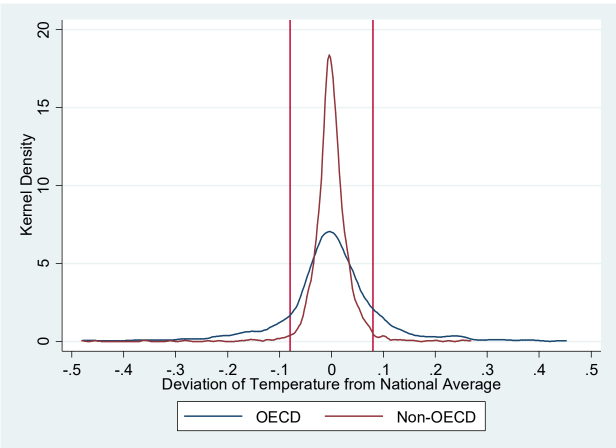


**Figure A3: Kernel Density of Temperature (Deviation from National Average)**

**Table A1: Country List and Sample Size of WVS (67 countries)**

| Name | N | Name | N | Name | N |
|---|---|---|---|---|---|
| OECD (21) | | Non-OECD (46) | | | |
| Australia | 2,765 | Algeria | 1,039 | Malaysia | 2,244 |
| Canada | 1,369 | Argentina | 2,398 | Mali | 1,132 |
| Chile | 3,044 | Bangladesh | 241 | Morocco | 1,859 |
| Finland | 1,238 | Brazil | 3,160 | Nigeria | 4,104 |
| France | 674 | Bulgaria | 1,152 | Pakistan | 903 |
| Germany | 3,740 | Burkina Faso | 1,157 | Peru | 1,864 |
| Hungary | 1,129 | China | 4,637 | Philippines | 1,954 |
| Italy | 667 | Colombia | 1,279 | Qatar | 927 |
| Japan | 2,952 | Cyprus | 1,516 | Romania | 2,943 |
| Mexico | 4,928 | Dominican Rep. | 337 | Russia | 5,041 |
| Netherlands | 1,726 | Ecuador | 993 | Rwanda | 2,695 |
| New Zealand | 1,492 | Egypt | 3,898 | Serbia | 1,597 |
| Norway | 1,368 | El Salvador | 894 | South Africa | 7,570 |
| Poland | 1,385 | Ethiopia | 1,439 | Taiwan | 1,934 |
| South Korea | 2,716 | Ghana | 2,787 | Thailand | 2,198 |
| Spain | 2,836 | India | 7,290 | Trinidad and Tobago | 1,427 |
| Sweden | 1,879 | Indonesia | 1,656 | Tunisia | 993 |
| Switzerland | 1,331 | Iran | 94 | Uruguay | 1,799 |
| Turkey | 3,979 | Iraq | 1,130 | Venezuela | 823 |
| United Kingdom | 691 | Jordan | 1,967 | Vietnam | 1,177 |
| United States | 2,899 | Kuwait | 1,064 | Yemen | 868 |
| | | Lebanon | 1,103 | Zambia | 1,347 |
| | | Libya | 1,868 | Zimbabwe | 1,351 |

**Table A2: Country List and Sample Size of MICS (30 countries)**

| Name | N | Name | N | Name | N |
|---|---|---|---|---|---|
| Albania | 2,478 | Georgia | 4,204 | Macedonia, FYR | 3,555 |
| Belarus | 3,086 | Ghana | 3,835 | Sierra Leone | 6,016 |
| Belize | 1,011 | Guinea | 4,545 | Suriname | 3,010 |
| Bosnia and Herzegovina | 2,891 | Guyana | 2,844 | Syrian Arab Republic | 205 |
| Burkina Faso | 4,236 | Iraq | 12,995 | Tajikistan | 5,176 |
| Cameroon | 5,526 | Jamaica | 2,166 | Togo | 4,570 |
| Central African Republic | 7,740 | Kazakhstan | 6,864 | Trinidad and Tobago | 2,059 |
| Cote d'Ivoire | 6,237 | Kyrgyz Republic | 3,258 | Ukraine | 2,935 |
| Djibouti | 3,070 | Lao PDR | 4,892 | Vietnam | 2,432 |
| Gambia, The | 4,603 | Lebanon | 24 | Yemen, Rep. | 2,826 |

**Table A3: Summary Statistics of MICS Data**

| | Mean | S.D. |
|---|---|---|
| Used methods to discipline children | | |
| Took away privileges, forbade something he/she liked or did not allow him/her to leave house | 0.474 | 0.499 |
| Shook him/her | 0.316 | 0.465 |
| Shouted, yelled at or screamed at him/her. | 0.651 | 0.477 |
| Spanked, hit or slapped him/her on the bottom with bare hand | 0.372 | 0.483 |
| Hit him/her on the bottom or elsewhere on the body with something like a belt, hairbrush, stick or other hard object | 0.221 | 0.415 |
| Called him/her dumb, lazy, or another name, etc | 0.376 | 0.484 |
| Hit or slapped him/her on the face, head or ears | 0.152 | 0.359 |
| Hit or slapped him/her on the hand, arm, or leg | 0.288 | 0.453 |
| Beat him/her up with an implement (hit over and over as hard as one could) | 0.057 | 0.232 |
| Parenting quality index (summary standardized index) | 0.000 | 1.000 |
| Low rainfall | 0.136 | 0.343 |
| High rainfall | 0.127 | 0.333 |
| Low temperature | 0.000 | 0.000 |
| High temperature | 0.009 | 0.094 |
| Number of countries | 30 | |
| Observations | 119,289 | |

**Table A4: The Impact of Weather Shocks on Macro Indicators**

| | Log (GDP from Agriculture) | Mortality rate before the age of | | | Crude birth |
|---|---|---|---|---|---|
| | | 28 days | 1 year | 5 years | |
| | (1) | (2) | (3) | (4) | (5) |
| Low rainfall | -0.066*** | 0.857 | 1.905 | 2.584 | -0.025 |
| | (0.024) | (0.627) | (1.767) | (2.948) | (0.309) |
| High rainfall | -0.008 | 0.769 | 2.126 | 2.819 | -0.096 |
| | (0.032) | (0.766) | (2.528) | (4.059) | (0.370) |
| Low temperature | 0.055 | -0.728 | 1.487 | 3.840 | 0.345 |
| | (0.041) | (0.813) | (1.907) | (2.641) | (0.303) |
| High temperature | -0.005 | -1.050 | 0.747 | 1.409 | 0.484 |
| | (0.115) | (1.716) | (2.702) | (5.176) | (0.680) |
| Year fixed effects | Yes | Yes | Yes | Yes | Yes |
| Country fixed effects | Yes | Yes | Yes | Yes | Yes |
| Number of countries | 39 | 43 | 43 | 43 | 43 |
| Mean of dep. var. | 24.3 | 39.2 | 80.0 | 119.3 | 36.9 |
| Observations | 867 | 884 | 1,204 | 1,204 | 1,311 |

The non-OECD samples are used. The coefficients of OLS are reported. Standard errors clustered at the country level are in parentheses. The observations after 1991 are not included because most respondents were born before 1990. *** p<0.01, ** p<0.05, * p<0.1.

**Table A5: Robustness to Sample Selection by Infant Mortality**

| | (1) | (2) |
|---|---|---|
| Low rainfall during utero | 0.010 | |
| | (0.018) | |
| Low rainfall during utero | | 0.027 |
| × Female | | (0.026) |
| Low rainfall during utero | | -0.004 |
| × Male | | (0.023) |
| Low rainfall between 0 and 5 | -0.030** | |
| | (0.015) | |
| Low rainfall between 0 and 5 | | -0.035* |
| × Female | | (0.019) |
| Low rainfall between 0 and 5 | | -0.020 |
| × Male | | (0.019) |
| Low rainfall between 6 and 10 | -0.001 | |
| | (0.015) | |
| Low rainfall between 6 and 10 | | 0.005 |
| × Female | | (0.024) |
| Low rainfall between 6 and 10 | | -0.011 |
| × Male | | (0.016) |
| Number of countries | 32 | 32 |
| Number of clusters | 56 | 56 |
| Observations | 55,369 | 55,369 |

The sample includes the non-OECD countries whose infant mortality in 1972 was 200 or lower. The coefficients of quantile regression are reported. Standard errors clustered at the country and survey wave level are in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.1$. The other controls include age, gender, year-of-birth fixed effects, and country-wave fixed effects.

**Table A6: Test for Sample Selection**
**Dependent Variable: Log(the number of respondents)**

| | (1) |
|---|---|
| Low rainfall during utero | -0.041 |
| | (0.053) |
| Low rainfall between 0 and 5 | 0.042 |
| | (0.073) |
| Low rainfall between 6 and 10 | -0.031 |
| | (0.063) |
| High rainfall during utero | -0.088* |
| | (0.049) |
| High rainfall between 0 and 5 | -0.164** |
| | (0.067) |
| High rainfall between 6 and 10 | -0.137*** |
| | (0.051) |
| Low temperature during utero | -0.008 |
| | (0.116) |
| Low temperature between 0 and 5 | 0.194* |
| | (0.106) |
| Low temperature between 6 and 10 | 0.046 |
| | (0.124) |
| High temperature during utero | -0.116 |
| | (0.163) |
| High temperature between 0 and 5 | -0.129 |
| | (0.188) |
| High temperature between 6 and 10 | -0.050 |
| | (0.260) |
| Year fixed effects | Yes |
| Country fixed effects | Yes |
| Mean of dep. var. | 3.50 |
| P-values of F-test for joint significance: | |
| Low rainfall | 0.4395 |
| High rainfall | 0.0295 |
| Low temperature | 0.1130 |
| High temperature | 0.7694 |
| Observations | 1937 |

The non-OECD samples are used. The coefficients of OLS are reported. Standard errors clustered at the country level are in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

**Table A7: Robustness to the Measurement Errors**

| | Reporting error in age | | Measurement error in weather | |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| Low rainfall during utero | 0.009 | | 0.002 | |
| | (0.017) | | (0.016) | |
| Low rainfall during utero × Female | | 0.027 | | 0.007 |
| | | (0.022) | | (0.021) |
| Low rainfall during utero × Male | | -0.013 | | 0.003 |
| | | (0.026) | | (0.021) |
| Low rainfall between 0 and 5 | -0.024* | | -0.037** | |
| | (0.013) | | (0.015) | |
| Low rainfall between 0 and 5 × Female | | -0.037** | | -0.048*** |
| | | (0.017) | | (0.018) |
| Low rainfall between 0 and 5 × Male | | -0.008 | | -0.019 |
| | | (0.018) | | (0.020) |
| Low rainfall between 6 and 10 | -0.020 | | -0.001 | |
| | (0.013) | | (0.012) | |
| Low rainfall between 6 and 10 × Female | | -0.018 | | -0.010 |
| | | (0.019) | | (0.020) |
| Low rainfall between 6 and 10 × Male | | -0.024 | | 0.008 |
| | | (0.015) | | (0.015) |
| Number of countries | 46 | 46 | 37 | 37 |
| Number of clusters | 82 | 82 | 57 | 57 |
| Observations | 70,244 | 70,244 | 63,621 | 63,621 |

The non-OECD samples are used. The sample for Columns (1) and (2) includes the respondents aged 50 or under. The sample for Columns (3) and (4) includes the countries with the size being 2,000,000km$^2$ or smaller. The coefficients of quantile regression are reported. Standard errors clustered at the country and survey wave level are in parentheses. *** p<0.01, ** p<0.05, * p<0.1. The other controls include age, gender, year-of-birth fixed effects, and country-wave fixed effects.

**Table A8: Heterogeneous Impact by the Share of Agricultural Employment**

| | (1) | (2) |
|---|---|---|
| Low rainfall during utero | -0.011 | 0.006 |
| | (0.023) | (0.021) |
| × Proportion of agricultural employment | 0.024 | -0.008 |
| | (0.090) | (0.091) |
| Low rainfall between 0 and 5 | -0.015 | -0.008 |
| | (0.021) | (0.022) |
| × Proportion of agricultural employment | -0.061 | -0.076 |
| | (0.060) | (0.062) |
| Low rainfall between 6 and 10 | -0.030 | -0.025 |
| | (0.022) | (0.023) |
| × Proportion of agricultural employment | 0.022 | 0.010 |
| | (0.053) | (0.056) |
| Other weather variables interacted with agricultural employment | No | Yes |
| Number of countries | 43 | 43 |
| Number of clusters | 77 | 77 |
| Observations | 87,186 | 87,186 |

The non-OECD samples are used. The coefficients of quantile regression are reported. Standard errors clustered at the country and survey wave level are in parentheses. *** p<0.01, ** p<0.05, * p<0.1. The other controls include age, gender, year-of-birth fixed effects, and country-wave fixed effects. The data on agricultural employment comes from the World Development Indicators.

**Table A9: Robustness to the Definition of Extreme Weather Variables**

| | (1) | (2) |
|---|---|---|
| Low rainfall during utero | 0.005 | |
| | (0.015) | |
| Low rainfall during utero | | 0.010 |
| × Female | | (0.018) |
| Low rainfall during utero | | -0.019 |
| × Male | | (0.021) |
| Low rainfall between 0 and 5 | -0.013** | |
| | (0.005) | |
| Low rainfall between 0 and 5 | | -0.018*** |
| × Female | | (0.007) |
| Low rainfall between 0 and 5 | | -0.009 |
| × Male | | (0.008) |
| Low rainfall between 6 and 10 | -0.012** | |
| | (0.005) | |
| Low rainfall between 6 and 10 | | -0.009 |
| × Female | | (0.007) |
| Low rainfall between 6 and 10 | | -0.014* |
| × Male | | (0.008) |
| Number of countries | 46 | 46 |
| Number of clusters | 82 | 82 |
| Observations | 91,849 | 91,849 |

The non-OECD samples are used. The coefficients of quantile regression are reported. Standard errors clustered at the country and survey wave level are in parentheses. *** p<0.01, ** p<0.05, * p<0.1. The other controls include age, gender, year-of-birth fixed effects, and country-wave fixed effects. The extreme weather is measured by the frequency that the rainfall/temperature deviates by more than 1 SD from national mean.

**Table A10: Test for the channel through socio-economic and health status**

| | (1) | (2) |
|---|---|---|
| Low rainfall during utero | 0.006 | |
| | (0.018) | |
| Low rainfall during utero | | 0.018 |
| × Female | | (0.021) |
| Low rainfall during utero | | -0.010 |
| × Male | | (0.024) |
| Low rainfall between 0 and 5 | -0.026* | |
| | (0.013) | |
| Low rainfall between 0 and 5 | | -0.041** |
| × Female | | (0.017) |
| Low rainfall between 0 and 5 | | -0.006 |
| × Male | | (0.018) |
| Low rainfall between 6 and 10 | -0.014 | |
| | (0.015) | |
| Low rainfall between 6 and 10 | | -0.014 |
| × Female | | (0.020) |
| Low rainfall between 6 and 10 | | -0.018 |
| × Male | | (0.018) |
| Completed secondary school | 0.119*** | 0.119*** |
| | (0.019) | (0.019) |
| Unemployed | -0.046* | -0.045* |
| | (0.025) | (0.025) |
| Full time work | 0.068*** | 0.071*** |
| | (0.016) | (0.015) |
| Self-employed | 0.038** | 0.041** |
| | (0.019) | (0.019) |
| Self-reported health | 0.190*** | 0.187*** |
| | (0.019) | (0.019) |
| Other weather variables interacted with gender | Yes | Yes |
| Number of countries | 46 | 46 |
| Number of clusters | 77 | 77 |
| Observations | 87,026 | 87,026 |

The non-OECD samples are used. The coefficients of quantile regression are reported. Standard errors clustered at the country and survey wave level are in parentheses. *** p<0.01, ** p<0.05, * p<0.1. The other controls include age, gender, year-of-birth fixed effects, and country-wave fixed effects.