3-19-2021

The Effects of Negative Economic Shocks at Birth on Adolescents' Cognitive Health and Educational Attainment in Malawi

Fabrice Kämpfen

Fatima Zahra

Hans-Peter Kohler

Rachel Kidman

The Effects of Negative Economic Shocks at Birth on Adolescents' Cognitive Health and Educational Attainment in Malawi

Abstract

We provide new evidence of the effects of moderate negative economic shocks in utero or shortly after birth on adolescents' cognitive outcomes and educational attainment in Malawi. This is the first study in a sub-Saharan African (SSA) low-income country (LIC) to analyze the effect of not one, but multiple moderate negative economic shocks. This focus is important as multiple economic shocks in early life are more representative of the experiences of adolescents in LICs. Combining data on adolescents aged 10-16 from the Adverse Childhood Experiences (ACE) project of the Malawi Longitudinal Study on Families and Health (MLSFH) (N = 1, 559), we use linear and probit regression models to show that girls whose households experienced two or more economic shocks in their year of birth have lower cognitive skills as measured by working memory, reading, and mathematical skills. Girls also have lower educational attainment, conditional on age. These effects are very gendered, and we do not observe similar effects among boys. Overall, our results point to lasting effects of early-life adversity on adolescents, and they highlight that, even in a LIC context where early-life adversity is common, policymakers need to intervene early to alleviate the long-term educational impacts of in utero or early life shocks among girls.

Keywords

economic shock, early life adversity, cognitive health, schooling, investments in education, adolescents, Malawi

Disciplines

Demography, Population, and Ecology | Education | Family, Life Course, and Society | Gender and Sexuality | Inequality and Stratification | Social and Behavioral Sciences | Sociology

The Effects of Negative Economic Shocks at Birth on Adolescents' Cognitive Health and Educational Attainment in Malawi

Fabrice Kämpfen[a*] Fatima Zahra[b] Hans-Peter Kohler[a]
Rachel Kidman[c]

[a]Population Studies Center, University of Pennsylvania, Philadelphia, PA, USA
[b]GIRL Center, Population Council, Washington, D.C., USA
[c]Department of Family, Population and Preventive Medicine, Stony Brook, NY, USA

March 19, 2021

Abstract

We provide new evidence of the effects of moderate negative economic shocks in utero or shortly after birth on adolescents' cognitive outcomes and educational attainment in Malawi. This is the first study in a sub-Saharan African (SSA) low-income country (LIC) to analyze the effect of not one, but multiple moderate negative economic shocks. This focus is important as multiple economic shocks in early life are more representative of the experiences of adolescents in LICs. Combining data on adolescents aged 10-16 from the Adverse Childhood Experiences (ACE) project of the Malawi Longitudinal Study on Families and Health (MLSFH) ($N = 1,559$), we use linear and probit regression models to show that girls whose households experienced two or more economic shocks in their year of birth have lower cognitive skills as measured by working memory, reading, and mathematical skills. Girls also have lower educational attainment, conditional on age. These effects are very gendered, and we do not observe similar effects among boys. Overall, our results point to lasting effects of early-life adversity on adolescents, and they highlight that, even in a LIC context where early-life adversity is common, policymakers need to intervene early to alleviate the long-term educational impacts of in utero or early life shocks among girls.

Keywords: *Economic shock, Early life adversity, Cognitive health, Schooling, Investments in education, Adolescents, Malawi*
JEL: *I15, I25, J13, C21*

*E-mail address: kampfenf@sas.upenn.edu, Tel.: +1215-898-6441.

1 Introduction

Prenatal and early childhood conditions are critical for long-term human capital development (Almond and Currie 2011; Georgiadis *et al.* 2017). Prior studies have identified the human capital effects of these conditions, showing that both extreme and subtle shocks in utero and during early childhood can have lasting effects on later educational attainment, test scores, and child health (Almond *et al.* 2018; Brown 2018; Cook *et al.* 2019; Lee 2014). These negative shocks can affect children through both biological and social pathways that determine educational and cognitive outcomes. For instance, prenatal and postnatal malnutrition can damage brain development (Levitsky and Strupp 1995). In addition, parental investments in maternal or child nutrition may determine children's long-term cognitive outcomes (Almond *et al.* 2018; Wolf and McCoy 2019). Together, these pathways help form the environment within which the cognitive development of the fetus and young children takes place, and set a foundation for later educational achievement.

Most research from low-income countries (LICs) has examined extreme climate shocks, famine, and violence, showing detrimental effects on test scores and educational attainment (Ampaabeng and Tan 2013; Millett and Shah 2012; Rosales 2013). There is scarce evidence on how multiple, moderate to severe, frequently occurring negative shocks—which are far more common to households in these contexts—affect these outcomes. Few studies in sub-Saharan Africa have shown how moderate shocks in utero and early childhood influence adolescents' educational outcomes (Beshir and Maystadt 2020), despite the fact that frequent and often repeated exposure to moderate shocks is a much more common early-life experience in LICs than exposure to severe shocks.

Using a rare LIC dataset that links shocks and household conditions in the year of birth with Malawian adolescents' cognitive and educational outcomes, we contribute to literature on the relationship between shocks in the year of birth and adolescent educational outcomes (reading, Math, and working memory scores; age for grade progression; educational attainment) by focusing on four research questions that, to date, have received scant attention in LICs: 1. Do multiple negative shocks experienced in the year of birth impact adolescent educational attainment; age for grade progression; and reading, Math, and working memory test scores? 2. Do we observe differences in coefficient size for adolescents' educational outcomes when shocks are defined and restricted to those that affect the entire community? 3. Do the effects of these shocks on adolescent outcomes differ by gender? 4. Do anthropometric measures (a proxy for

nutritional investments) and investments in education mediate the relationship between economic shocks and adolescents' cognitive outcomes?

Overall, our analyses show that multiple shocks in the year of birth adversely affect girls' educational outcomes. Specifically, girls who experience two or more economic shocks are more likely to be unable to read sentences in Chichewa, unable to recall numbers (working memory), and have lower overall Math scores and educational attainment compared to girls who experienced no shock in their year of birth. We find similar results for economic shocks that affect the entire community. Importantly, our results reveal gendered effects of early-life adversity on adolescent cognition and educational outcomes, given that we do not find similarly strong effects among boys. In addition, shocks experienced two years after birth are not associated with adolescents' educational and cognitive outcomes. Notably, we find evidence of greater household investment in boys' education in response to shocks.

2 Background: Limited Evidence on the Long-term Effects of Early-life Adversity on Adolescents in LICs

The fetal origins hypothesis states that the prenatal environment can affect the fetus, with both short and long-term consequences for health outcomes (Barker 1990). Prior studies have expanded on this, hypothesizing the effects of both prenatal and postnatal investments on long-term human capital development (Almond *et al.* 2018; Heckman 2007). This is predicated on the assumption that the development of human capital is linked across the life-course. A dearth of investment during this critical period, for instance as a result of negative shocks that adversely affect a household, can be harmful for outcomes measured a decade or more later in life. Thus, children with unfavorable prenatal or early childhood conditions may not only suffer worse outcomes in later periods, they may also have lower returns on the investments made in them due to early disadvantages (Almond and Currie 2011; Heckman 2007).

Shocks in the gestation period (prenatal) and early childhood (postnatal) can affect children through both biological and social pathways (Almond *et al.* 2018), but disentangling these pathways is often difficult. Biologically, prenatal malnutrition can alter brain neural receptor pathways through permanent effects on the hippocampus and cerebellum (Levitsky and Strupp 1995). In addition, negative

prenatal shocks can result in adverse birth outcomes like low birth weight, which has been linked to low educational attainment and poor test scores in childhood and adulthood (Almond and Currie 2011; Almond *et al.* 2018). Postnatal malnutrition can also inflict damage on brain development (Levitsky and Strupp 1995; Uauy and Dangour 2006). However, biological effects on cognitive health may not manifest until a later period, suggesting that the effects of prenatal and postnatal shocks may be irregular over age (Heckman 2007). Shocks may also affect educational outcomes through social pathways, with long-term implications for educational outcomes and test scores. For instance, parental preferences may determine investments in child health and education in response to a shock, affecting the timing of school enrollment and the likelihood of remaining enrolled and on track in school. Recent additions to these hypotheses pay particular attention to the role of parental investments. Linking postnatal investments in response to shocks in utero, Almond *et al.* (2018) hypothesize that postnatal investments in children depend on parents' preferences, budget constraints, and constraints in production technology. In turn, these preferences, which can include gender preferences, may mitigate or worsen the long term cognitive impact of negative shocks experienced in the prenatal and early childhood periods (Becker and Tomes 1976; Behrman *et al.* 1982).

Despite the reality that experiences of early-life adversity are common in LICs, the literature documenting the relationship between negative prenatal and postnatal shocks and long-term educational outcomes has several limitations. First, the majority of existing studies focus on high income countries (HICs) (Aizer *et al.* 2016; Almond *et al.* 2015; Greve *et al.* 2017; von Hinke Kessler Scholder *et al.* 2014), with a small but growing literature on middle-income countries (MICs) (Almond *et al.* 2018). Often these studies in HICs or MICs investigate shocks that are more relevant to HIC or MIC contexts rather than LIC contexts (e.g, alcohol consumption). Related research in LICs, and in particular SSA LICs, remains scarce.

Second, the few LIC studies on early-life adversity have often investigated extreme negative shocks, which are important, but by their very definition, are relatively rare. Examples include: El-Nino floods in Ecuador (Rosales 2013), famine in Ghana (Ampaabeng and Tan 2013), genocide and war in Rwanda and Zimbabwe (Alderman *et al.* 2006; Bundervoet and Fransen 2018), drought in India, Burkina Faso, and Zimbabwe (Akresh *et al.* 2012; Alderman *et al.* 2006; Hoddinott and Kinsey 2001; Millett and Shah 2012). Across all of these studies, the key finding is that children exposed to shocks in utero and early childhood have lower test scores and educational attainment. These effects can also persist

across generations. For instance, Tafere (2016) finds intergenerational effects of famine and shows that the children of Ethiopian mothers who were exposed to famine between ages 0-3 are more likely to have lower test scores, educational attainment, and poorer health. A rare example of a study that has focused on moderate shocks is from Ethiopia (Beshir and Maystadt 2020) and shows that exposure to seasonal food insecurity experienced in utero results in lower Math scores at age 8 and 12.

Third, besides a focus on middle- and high-income contexts, a further limitation of the existing literature is its emphasis on a single positive or negative shock in utero. Studies that examine more than one shock typically analyze whether a negative shock can be compensated by a positive shock, usually a conditional cash transfer (Adhvaryu *et al.* 2018; Aguilar and Vicarelli 2011; Duque *et al.* 2018). To our knowledge, no previous studies examine the impact of multiple, moderate negative shocks experienced in utero and early childhood on adolescents' educational and cognitive outcomes. This is important to investigate in sub-Saharan African low-income countries, such as Malawi, where households are likely to experience multiple shocks related not only to income, but also excess adult mortality due to epidemics like HIV. Furthermore, previous studies that have distinguished between the effects of shocks to the household and shocks to the entire community have focused on school enrollment (Hyder *et al.* 2015), and not the long-term educational and cognitive outcomes of children who experience these shocks in the year of birth. Community level shocks might make it difficult for households to buffer a shock through the support of their neighbors or social network, thus causing greater severity in detrimental impacts on children's outcomes.

Fourth, there has been limited attention throughout the literature on gendered or heterogeneous effects. Some studies from LMICs that examine the relationship between exposure to in utero and early childhood shocks and educational outcomes find some heterogeneity in effects based on the timing of the shock and the gender of the child. Specifically, studies that distinguish between shocks in utero, early and middle childhood, generally find that earlier shocks have greater impact on educational outcomes. For instance, in both India and Ghana, the severity of the impact of exposure to drought is highest when experienced in utero, and fades after age two (Akresh *et al.* 2012; Millett and Shah 2012). Ampaabeng and Tan (2013) find that Ghanaian children exposed to famine between age 0-2, but not 3-8, have lower educational attainment, and lower reading and Math test scores 20 years later. With regard to gender differences, evidence from both Ethiopia and India suggests that extreme

and subtle shocks in utero impact boys' Math scores more severely compared to girls (Beshir and Maystadt 2020; Millett and Shah 2012). Parents' gender preferences may influence the investment choices they make for their sons and daughters, and these preferences may be reinforced when making investment decisions after experiencing negative shocks. Related evidence from sub-Saharan Africa is particularly scarce. Most evidence of general gender bias in parental educational investment comes from South Asia (Azam and Kingdon 2013; Kaul 2018). In sub-Saharan Africa, there is mixed evidence of gender bias in intra-household allocation of resources towards health and education (Haddad and Reardon 1993; Hadley *et al.* 2008; Sauerborn *et al.* 1996). A recent study from Ethiopia finds that boys exposed to seasonal food insecurity in utero are more likely to have low Math scores at age 12, compared to girls. However, these differences cannot be explained by parental education and health investments (Beshir and Maystadt 2020). Previous studies have not examined parental gender preferences in household educational expenditures before children exposed to prenatal/early childhood shocks enter school. Parents may continue to reinforce previous patterns of gender preferences when making investment decisions for children exposed to shocks, and may thus exacerbate the impact of early shocks. In addition, these studies do not consider how parents' informal social networks, which may be an important resource when households face budget constraints, reinforce or mitigate gender bias when providing support.

Fifth, few studies in LICs have investigated the role of parental or household responses to early-life adversity in mediating the consequences of early-life shocks on later-life adolescent outcomes such as schooling. (Almond *et al.* 2018). In general, parents' response to shocks can either mitigate or exacerbate the severity of the impact of the shock on children's long-term educational outcomes (Almond *et al.* 2018). For instance, Chinese parents whose children suffer from serious illness in early childhood have been shown to increase health expenditures on sick children, but later offset this by reducing educational expenditures (Yi *et al.* 2015). To our knowledge, there is one study that comprehensively evaluates parental investments as a mediating mechanism between in utero shocks and educational outcomes in a low-income context. Beshir and Maystadt (2020) examine a range of parental health and education investment indicators for older children, including the timing of school enrollment, public vs. private school attendance, nutrition, whether parents paid for recent school and medical expenditures, and the number of hours a child spends studying at home. The authors find that none of these mechanisms explain the relationship between exposure to seasonal food insecurity in utero and Ethiopian boys' lower Math scores. However, these

studies do not examine responses to multiple prenatal/early childhood shocks, and do not include household gender preferences.

3 Data and Measures

Our analyses are based on the Adverse Childhood Experiences (ACE) project (Kidman *et al.* 2020) of the Malawi Longitudinal Study of Families and Health (MLSFH) (Kohler *et al.* 2015). This MLSFH ACE project focuses on adverse childhood environments and transitions to adulthood, collecting data in rural areas in three districts in Malawi (Mchinji, Rumphi and Balaka) in 2017 and 2018 (and forthcoming in 2021). MLSFH ACE data are integrated with the MLSFH, and specically, data on MLSFH ACE adolescents is linked to prior MLSFH data for the adolescents' parents dating back to 1998. While the MLSFH ACE project is designed as a longitudinal cohort study, this study draws on the currently available initial wave of adolescent surveys collected in 2017–18 when respondents were 10–16 years old.[1] Importantly, the MLSFH ACE data provide comprehensive measures on a range of cognitive outcomes among adolescents, which we use as the main dependent variables in our study. The data also has measures on a number of other adolescent experiences including health, violence, and relationships with caregivers.

At least one parent (or household member)[2] of the 2017–18 ACE adolescent respondent was previously surveyed by the MLSFH in 2008 or 2010 when they were asked to report economic shocks that they or their household experienced over previous years.[3] We match adolescent's year of birth as reported in the ACE study to their household's information collected in 2008 and 2010, which includes economic shocks reported between 2003 and 2008.[4]

We only have information about economic shocks for the period between 2003 and 2010. Thus, out of the 2,089 adolescents that were interviewed as part of the ACE study, 273 adolescents were excluded from the analysis because they

[1] These adolescents were selected from the 2008 and 2010 Household Rosters of the MLSFH.

[2] Parents, grandparents and aunts/uncles represent 77%, 16% 3.4% of these individuals, respectively.

[3] The 2008 questionnaire asked about shocks that occurred in the past five years, from 2003 to 2008, and the 2010 questionnaire asked about shocks that happened over the past two years, covering the period from 2008 to 2010.

[4] Note that all adolescents in our sample were born between 2003 and 2008. We use shocks reported in the 2010 survey for the year 2008 so that we include economic shocks that occurred after the 2008 study.

were born in 2001 or 2002. Moreover, we exclude a further 257 adolescents who were born between 2003 and 2007, and whose households were surveyed only in 2010 and thus had no shock data for the year of their birth. Our final sample includes 1,559 adolescents, for whom we have information about whether their household experienced economic shocks in the year that they were born.

Cognitive measures: The MLSFH ACE data provide several measures of cognitive abilities that encompass three different domains: literacy, mathematical skills, and working memory. Our initial outcome variable is "reading score", which ranges from 0 to 8. Adolescents were presented with four different sentences, two in Chichewa and two in English, that they were asked to read. For each of these sentences, they received a score of 0 if they were not able to read any part of the sentence, 1 point if they were able to read only part of the sentence, and 2 points if they were able to read the whole sentence. For our measure, we added scores for all four sentences. To explore the effects of economic shocks at birth at the lower end of the reading score distribution, we also created a dichotomous variable that takes the value 1 if adolescents were not able to read any part of the two Chichewa sentences, and 0 otherwise.[5]

We created a measure for mathematical skills based on 12 questions that assess different analytical abilities. The first two questions asked adolescents to fill in missing numbers in a short sequence of numbers, and order five numbers in descending order. The next eight questions tested adolescents' ability to perform simple additions, subtractions, multiplications and divisions (two questions for each domain). The last two questions were two short word problems that adolescents were asked to solve. As an example, one of the word problems asked, "You have 75 tambala and you want to buy a pencil that cost 67 tambala. How much change would you get?". Adolescents were given one point for correctly answering each question. For our measure, we added their scores on each question. Therefore, the Math score ranges from 0 to 12. Similar to our measure for reading ability, we also created a dichotomous variable for Math that takes the value 1 if adolescents were not able to answer to any of the math questions correctly, and 0 otherwise.

Our third cognitive measure is working memory. Adolescents were asked to repeat a list of numbers backwards. A series of only two numbers was asked first, and became progressively larger, reaching a list of eight digits.[6] We created a

[5]We created a corresponding measure using the two English sentences and present related results in the Appendix.

[6]This measure was added to the survey between rounds of data collection, and thus is only available for those respondents in the 2018 round.

measure of working memory that ranges from 0 to 7, where a score of 0 is given to an adolescent who is not able to repeat a list of two numbers and a score of 7 to someone who is able to repeat the list of eight numbers. An adolescent is given a point for each additional number he or she is able to recall.

For other measures of education, we also included schooling attainment and on-time progression in school. For schooling attainment, we measure highest grade attained. For on-time progression in school, we used a dummy variable that takes the value 1 if adolescents are at least 3 years behind the expected grade for their age, and 0 otherwise.[7]

Economic shocks: In the 2008 and 2010 MLSFH surveys, respondents were asked to report economic shocks experienced by their households that ***negatively*** affected their income and/or assets. In 2008, respondents were asked whether their household experienced the following economic shocks: 1) "Death or serious illness of an adult member or someone who provides support for yourself or your family", 2) "Poor crop yields, loss of crops due to disease or pests, or loss of livestock due to theft or disease, or loss of coupon", 3) "Loss of source of income—such as loss of employment, business failure, someone who had been assisting the household stopped their support", 4) "Big change in price of grain (either increase or decrease)", 5) "Breakup of household, such as a divorce", 6) "Damage to house due to fire, flood, or other unexpected event" or 7) any other economic shocks they could specify over the 5 years preceding the interview. The 2010 questionnaire asked questions about the same shocks experienced within 2 year prior to the survey, but also included "Changes in crop yields" as a shock, and replaced "Big change in price of grain (either increase or decrease)" with "Fertilizer subsidy".[8] The 2010 questionnaire also excluded the "other" option where respondents could report shocks not listed in the response options. In both survey years, respondents were asked to report the shocks they experienced, along with the year when the three most "significant" shocks occurred. In addition to the years of occurrence, they were asked whether the shock they reported affected their "own household only", "other households as well", "most households in the community" or "all households in the community". We match the years of occurrence of these economic shocks to the years of birth of the ACE adolescents

[7] "Age for grade" is a measure of delayed entry and/or grade repetition based on the adolescents' age and the grade in which they should be as per the expected school schedule.

[8] "Big change in price of grain" and "change in crop yields" can potentially represent positive or negative shocks depending on whether the household is a net consumer or producer of crops. However, the survey asks respondents whether the economic shocks they report resulted in "income loss", "asset loss", "loss of both" or "neither". Our analysis is restricted to shocks that resulted in income loss, asset loss or both, i.e., negative economic shocks.

in our sample.

Descriptive statistics of study population:

Table 1 presents the descriptive statistics of the 1,559 adolescents that constitute our study sample. Panel A shows basic descriptive statistics of the outcome variables we consider in our analysis. The average reading score in our sample was about 4.4, on a scale from 0 to 8. About 32% of the adolescents couldn't read, even partially, the two sentences in Chichewa that were presented to them. On a scale ranging from 0 to 7, the average working memory score of the adolescents in our sample was about 2.5 and about 7.5% of them had a score of 0. The average math score was about 6.9, out of 12 points, and a bit more than 6% of the sample had a score of 0.

Panel B of Table 1 shows the distribution of the economic shocks experienced by the adolescents the year of the birth. About three quarters of the adolescents in our sample experienced no economic shocks at birth, whereas about 19% and 5.4% of them experienced one and two shocks or more the year of their birth, respectively.

Table 2 reports the types of shocks that the adolescents experienced during their year of birth. The most prevalent negative shocks, which represent about 41% of the economic shocks encountered, correspond to shocks that have resulted in poor crop yields "due to disease or pests, or loss of livestock due to theft or disease, or loss of coupon". Second after poor crop yields comes "big change in price of grain (either increase or decrease)", that represents about 30% of the shocks reported. These two shocks, which account for about 71% of the shocks, are plausibly more exogenous than others as they are more likely to be independent to the respondent's or household's characteristics. They can be used to reinforce the causal interpretation of our effects, as we will discussed below. In order, "death or serious illness", "loss of income", "breakup of household", "damage to house" and loss of "fertilizer subsidy" represent 24.1%, 16.3%, 6.2%, 4.9% and 0.5% of the experienced economic shocks, respectively.

Finally, Panel C of Table 1 shows basic descriptive statistics of the adolescents in our sample. A bit less than half (49.1%) of the adolescents were girls and the average age was about 12.8 years old. Adolescents were fairly well spread out across our three study region with about 31%, 37% and 33% of our adolescents coming from the Central, the Southern and the Northern region, respectively.

Table 1: Descriptive statistics of the benchmark sample ($N = 1,559$)

	Mean	Std. dev.	25^{th}	75^{th}	Obs.
A. Outcome variables					
Reading score (sentences)	4.424	3.371	0	8	1544
Can't read Chichewa sentences	0.315	0.465	0	1	1546
Working memory score	2.477	1.623	1	3	1278
Working memory score of 0	0.075	0.264	0	0	1278
Math score	6.853	3.505	5	10	1513
No correct Math answers	0.062	0.241	0	0	1513
School attainment (years)	4.658	1.890	3	6	1557
Age for grade $\geqslant 3$	0.617	0.486	0	1	1450
B. Economic shock					
Shock at birth	0.248	0.432	0	0	1559
0 shock at birth	0.752	0.432	1	1	1559
1 shock at birth	0.194	0.395	0	0	1559
2 shocks or more at birth	0.054	0.226	0	0	1559
C. Control variables					
Girl	0.491	0.500	0	1	1559
Age	12.831	1.464	12	14	1559
Central region	0.305	0.460	0	1	1559
South region	0.371	0.483	0	1	1559
North region	0.325	0.468	0	1	1559
Age of the caregiver at birth	31.984	13.334	22	38	1558
Caregiver married at birth	0.872	0.335	1	1	1559
No formal education - caregiver	0.262	0.440	0	1	1559
Primary level education - caregiver	0.654	0.476	0	1	1559
Secondar level education or higher - caregiver	0.084	0.278	0	0	1559
Wealth score	-0.081	1.868	-1.318	0.800	1557

Note: The sample is derived from the ACE sample collected in 2017 and 2018. Economic shocks are reported by adolescent's household as part of the MLSFH collected in 2008 and 2010. Reading score is the sum of the points obtained when reading two sentences in Chichewa and two sentences in English, in which adolescents were given 2 points if they were able to read the whole sentence and one point if they were able to read only part of it. Working memory score is derived from a list of numbers that adolescents had to repeat backwards (modeled on the WISC digit sequence test). Math score is derived from a list of 12 questions, two questions in which adolescents had to fill in a missing number in a sequence, two questions on additions, subtractions, multiplications, divisions and questions in which they had to solve a simple math problem. "Std. dev." stands for standard deviation. 25^{th} and 75^{th} represent the 25^{th} and 75^{th} percentiles of the distributions, respectively.

4 Analytic Approach

We match ACE adolescents surveyed in 2017 and 2018 to shocks reported by their parents (or caregivers) in 2008 and 2010, to create a sample of ACE ado-

Table 2: Descriptive statistics of the economic shocks reported

	Count	Prevalence
All shocks	383	0.248
Death or serious illness	93	0.241
Poor crop yields	159	0.412
Loss income	63	0.163
Big change in price of grain	116	0.301
Fertilizer subsidy	2	0.005
Breakup of household	24	0.062
Damage to house	19	0.049
Other	2	0.005

Note: These shocks are reported by adolescents' households as part of the MLSFH collected in 2008 and 2010. "Death or serious illness" is phrased as "Death or serious illness of an adult member or someone who provides support for yourself or your family". "Poor crop yields" corresponds to "Poor crop yields, loss of crops due to disease or pests, or loss of livestock due to theft or disease, or loss of coupon". "Loss income" is "Loss of source of income-such as loss of employment, business failure, someone who had been assisting the household stopped their support". "Big change in price of grain" was collected only in 2008 and was phrased as "Big change in price of grain (either increase or decrease)". "Fertilizer subsidy" was asked only in 2010. "Breakup of household" is "Breakup of household, such as a divorce". "Damage to house" corresponds to "Damage to house due to fire, flood, or other unexpected event".

lescents who experienced economic shocks during the year of birth. We then regress our cognitive and education measures on our main independent variable: economic shocks. We had two dichotomous measures of economic shocks. The first was coded 1 if the adolescent experienced one economic shock at birth, and 0 otherwise. The second was coded 1 if they experienced two or more economic shocks at birth, and zero otherwise.[9]

We conduct linear regressions for all continuous dependent variables, including reading, math, and working memory scores, and schooling attainment (mea-

[9]Note that adolescents can experience up to three economic shocks at birth, but given very low occurrence of experiencing three shocks –only 10 adolescents experienced three economic shocks at birth (0.64% of our sample)– we combine those who experienced three shocks with those who experienced two economic shocks at birth.

sured as highest grade attained). We use probit regressions for all dichotomous dependent variables.

Our econometric specification includes the age of the adolescent (dummy variables for each age in years), characteristics of the caregivers including age, marital status, educational level (no school, primary level of education, secondary level of education and higher of education), and a continuous wealth index based on a set of 20 dwelling characteristics and ownership of household durable assets, constructed using first principal component analysis (Chin 2010; Filmer and Pritchett 1998; Hyder *et al.* 2015; Vyas and Kumaranayake 2006). Wealth measures based on household asset ownership are usually used to control for *stable* household wealth characteristics (Behrman and Knowles 1999; Thomas and Strauss 1992). We use the most up-to-date information available at the year of birth to define these variables. In other words, information collected in wave 5 (2008), wave 4 (2006) and wave 3 (2004) was used to define these variables for children born in 2007-2008, 2005-2006 and 2003-2004 respectively. For missing cases, we use the most recent information available.[10] In addition to these variables, all regressions include region dummy variables to control for any systematic differences in the three regions where fieldwork took place (Rumphi in the North, Balaka in the South and Mchinji in the central region of Malawi). Finally, because some adolescents were interviewed in 2017 and others in 2018, all our specifications include a binary variable coded 1 if the survey was conducted in 2017 vs. 2018. This year dummy captures any systematic differences and changes that might have occurred in 2018. For all our analyses, standard errors are clustered at the household level.

5 Results

Our results show that experiencing two or more ("two^{+}") negative economic shocks at birth have a substantively large and statistically significant detrimental effects on girls' cognitive and educational outcomes, while there is no strong evidence for corresponding detrimental effects for boys. Specifically, Table 3 presents the effects of economic shocks at birth on our set of outcome variables. Panel A shows the results of the effects of economic shocks on adolescents' reading ability.

[10] Because the wealth index can potentially be directly related to the (previous) experience of economic shocks, as a robustness check we use values of this variables prior to adolescent birth instead of the "current one". Despite a notable decrease in the sample size, we show that results are qualitatively similar to those estimated in the specification with the full sample.

The first three columns show that, on average, adolescents who experience two$^+$ economic shocks at birth have a reading score that is approximately 0.4 points lower than those who did not experience any shocks. This negative effect is observed only among girls, for whom the effect is twice as large, and is statistically significant at the 10% level (Column 3).[11] Experiencing only one economic shock at birth does not have any impact on adolescents' reading scores, irrespective of the sex of the adolescent. The last three columns show that experiencing two$^+$ economic shocks at birth increases the probability of not being able to read any sentences in Chichewa; an effect that is also observed mainly among girls (Column 6). The probit coefficient of experiencing two$^+$ economic shocks at birth on the ability to read sentences in Chichewa is 0.435 (p-value=0.064), which corresponds to an increase of about 12.6 percentage points in the probability of not being able to read sentences in Chichewa.

Panel B of Table 3 shows similar results for working memory. While experiencing two$^+$ economic shocks does have a negative effect on working memory scores and is stronger among girls (Columns 1-3), it is not statistically significant. However, the effect is significant for the lower end of the outcome distribution: experiencing two$^+$ economic shocks at birth corresponds to a probit coefficient of 0.670 (p-value=0.046), which implies an 11.8 percentage point marginal increase in the probability of having a working memory score of 0. This affect is stronger among girls, but not among boys.

Panel C presents results on math skills. Similar to findings for working memory, experiencing two$^+$ economic shocks at birth is particularly detrimental for girls, whereas no negative effects are observed for boys. Notably, we observe large effects on girls' probability of having a math score of 0 for girls who experience two$^+$ economic shocks at birth.

Finally, Panel D of Table 3 shows differences in educational attainment for those who experience one or two$^+$ economic shocks during the year of their birth, relative to those who do not experience any economic shocks at birth. Girls who experience two$^+$ shocks at birth have, on average, 0.4 fewer years of schooling compared to girls who experience no economic shocks at birth. We observe no significant effects among boys (Columns 2 and 3). Experiencing two$^+$ shocks at birth also seems to increase the probability of girls being behind their school schedule, although this effect is not precisely estimated (Column 6).

Overall, experiencing a single economic shock during the year of birth does

[11] We report 10% significance level ("+") given the small sample size and measurement error that tend to reduce overall power. We consider systematic and consistent findings at 10% across multiple outcomes and specifications as relevant results.

Table 3: Effects of economic shocks at birth on cognitive and educational attainment outcomes

	All (1)	Boys (2)	Girls (3)	All (4)	Boys (5)	Girls (6)
			A. Reading skills			
	Reading score			Can't read Chichewa		
1 shock at birth	0.123	0.217	-0.047	-0.014	-0.037	0.035
	(0.204)	(0.288)	(0.300)	(0.092)	(0.124)	(0.149)
2 shocks or more at birth	-0.439	0.004	-0.925^{+}	0.280^{+}	0.164	0.435^{+}
	(0.366)	(0.494)	(0.530)	(0.165)	(0.233)	(0.234)
Observations	1541	786	755	1543	787	756
			B Working memory			
	Working memory score			Score of 0		
1 shock at birth	0.025	0.113	-0.063	0.010	-0.299	0.354
	(0.114)	(0.149)	(0.180)	(0.145)	(0.212)	(0.223)
2 shocks or more at birth	-0.295	-0.112	-0.488	0.477*	0.385	0.670*
	(0.204)	(0.246)	(0.309)	(0.218)	(0.306)	(0.336)
Observations	1276	644	632	1276	644	545
			C. Mathematical skills			
	Math score			Score of 0		
1 shock at birth	-0.042	-0.036	-0.108	0.143	0.054	0.320
	(0.215)	(0.301)	(0.319)	(0.137)	(0.171)	(0.228)
2 shocks or more at birth	-0.563	-0.433	-0.783	0.207	-0.158	0.748*
	(0.377)	(0.527)	(0.536)	(0.214)	(0.308)	(0.311)
Observations	1510	770	740	1510	770	678
			D. Schooling			
	Educational attainment			Age for grade $\geqslant 3$		
1 shock at birth	0.017	0.109	-0.120	-0.024	-0.027	-0.008
	(0.087)	(0.113)	(0.134)	(0.096)	(0.129)	(0.147)
2 shocks or more at birth	-0.114	0.200	-0.413^{+}	0.100	0.007	0.260
	(0.161)	(0.205)	(0.246)	(0.177)	(0.255)	(0.258)
Observations	1554	792	762	1447	738	709

Note: Standard errors in parentheses clustered at the household level ($^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$). The sample is derived from the ACE sample collected in 2017 and 2018. Economic shocks are reported by adolescent's households as part of the MLSFH collected in 2008 and 2010. All regressions control for age (in years) and region fixed effects, age and marital status of the caregiver at birth, educational level of the caregiver (no school, primary level of education, secondary level of education and higher of education), a continuous wealth index of the household and sex of the adolescent.

not seem to affect the cognitive outcomes of adolescents in our sample. However, experiencing two^{+} economic shocks at birth does seem to affect adolescents' cognitive outcomes, but effects are statistically significant only among girls.

Table A1 in the Appendix shows that such patterns are not limited to the cognitive outcomes presented in Table 3. Table A1 shows that girls who experience two$^+$ economic shocks at birth are less likely to be able to read sentences in English, answer basic mathematical questions and have lower math index scores.[12] We do not observe similar effects among boys. These additional results show that the negative effects of economic shocks at birth are not limited to the math and reading skills we focus on in our main analyses, but that they seem to affect English reading skills and other measures of mathematical skills as well.

Economic shocks can be particularly detrimental when they affect entire communities, since this limits households' ability to buffer the impact of shocks by seeking social support from their neighbors. Among the economic shocks reported by respondents in 2008 and 2010, two are "plausibly exogenous" in the sense that they are more likely to be not related to individual and household characteristics or behaviors. "Poor crop yields" and "big change in price of grain" are likely to be beyond an individual household's control and hence largely exogenous. We therefore restrict our economic shock variable to these two "plausibly exogenous" shocks to strengthen the causal interpretation of our estimates. As an additional check for exogeneity, respondents are asked whether the shocks they report affected other households in their community. We are therefore able to restrict these two shocks to those that affected other households in the community in order to further reinforce the causal interpretation of our estimates (because these restrictions reduce the number of shocks reported by the respondents, we are not able to differentiate between adolescents who experienced one or two$^+$ exogenous shocks at birth and hence present results in which we combine adolescents who experience one or more exogenous shocks in the same category). Table 4 presents the results for these plausibly exogenous shocks on our dependent variables.

Overall, the effects appear to be more precisely estimated and similar in magnitude to those obtained in our benchmark analysis for adolescents who experienced two$^+$ shocks at birth. Specifically, girls who experience an exogenous shock at birth have a reading score that is 0.9 points lower than girls who do not experience an exogenous shock at birth. The probit coefficient for the probability of not being able to read any sentences in Chichewa equals 0.436 (p-value=0.009), which implies a 12.5 percentage point marginal increase in the probability of not being able to read any sentences in Chichewa. Similar effects are not observed among boys. While the large effects on the probability of having a working

[12]This index is a composite score derived from factor analysis that combines adolescents' answers on addition, subtraction, multiplication, division and problem solving questions.

Table 4: Effects of economic shocks at birth on cognitive and educational attainment outcomes using plausible exogenous shocks

	All	Boys	Girls	All	Boys	Girls
	(1)	(2)	(3)	(4)	(5)	(6)
			A. Reading skills			
	Reading score			Can't read Chichewa		
Exogenous shock at birth	-0.345	-0.032	-0.856*	0.240*	0.125	0.436**
	(0.244)	(0.328)	(0.367)	(0.106)	(0.139)	(0.168)
Observations	1541	786	755	1543	787	756
			B. Working memory			
	Working memory score			Score of 0		
Exogenous shock at birth	-0.107	0.143	-0.358	0.171	-0.038	0.456+
	(0.135)	(0.161)	(0.220)	(0.149)	(0.204)	(0.247)
Observations	1276	644	632	1276	644	632
			C. Mathematical skills			
	Math score			Score of 0		
Exogenous shock at birth	-0.790**	-0.493	-1.218**	0.239	-0.014	0.628**
	(0.249)	(0.350)	(0.367)	(0.152)	(0.206)	(0.239)
Observations	1510	770	740	1510	770	740
			D. Schooling			
	Educational attainment			Age for grade $\geqslant 3$		
Exogenous shock at birth	-0.103	0.055	-0.325*	0.095	0.021	0.244
	(0.101)	(0.132)	(0.159)	(0.113)	(0.150)	(0.178)
Observations	1554	792	762	1447	738	709

Note: Standard errors in parentheses clustered at the household level ($^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$). The sample is derived from the ACE sample collected in 2017 and 2018. Economic shocks are reported by adolescent's household as part of the MLSFH collected in 2008 and 2010. All regressions control for age (in years) and region fixed effects, age and marital status of the caregiver at birth, educational level of the caregiver (no school, primary level of education, secondary level of education and higher of education), a continuous wealth index of the household and sex of the adolescent. "Exogenous shock at birth" is a dichotomous variable that takes the value 1 if the adolescent experienced a "poor crop yields" or a "big change in price of grain" economic shock at birth that affected other households in the community.

memory score of 0 becomes smaller and less precisely estimated when considering exogenous shocks, effects on mathematical skills become larger and are more precisely estimated. Girls who experience an exogenous shock at birth have, on average, a math score about 1.2 points lower than girls who do not experience an exogenous shock. The probit coefficient for the probability of having a math score of 0 equals 0.628 (p-value=0.009); a 7.5 percentage point increase. Similar to

other outcomes, these effects are only observed among girls and not boys. Finally, effects on schooling are similar to those in the benchmark analysis; we find that girls who experience an exogenous shock have 0.3 fewer grades of schooling than those who do not (p-value=0.042).

6 Robustness checks

We test other specifications to check the robustness of our findings. First, Table A2 in the Appendix presents corresponding analysis but this time interacting economic shocks during the year of birth with sex, instead of running separate regressions by sex. This new specification is not as flexible as our benchmark specification as it has the undesirable property to "force" coefficients—other than economic shocks—to be similar across sex. Because processes and characteristics that govern cognitive and educational outcomes can vary across gender in this context (UNICEF 2020), such a specification is probably too restrictive and unlikely to fit the data well. We allow not only shocks but also age effects to depend on sex, in an attempt to resolve a part of this restriction. Similar to our benchmark analysis, no clear relationship between the occurrence of economic shocks during the year of birth and cognitive outcomes can be observed for boys. Although not always precisely estimated, a clear negative relationship can be seen for girls, for whom the detrimental effects become larger as the number of economic shocks occurring during the year of birth increases.

One concern in our analysis is that the effects estimated thus far could be due to serially correlated shocks that happened prior or after the year of birth, and may not be the result of shocks happening during the year of birth. To rule out this possibility, we include in the same econometric specification both economic shocks occurring during the year of birth and those occurring two years after the year of birth.[13] Table A3 shows that including economic shocks two years after birth does not alter the effects of economic shocks occurring in the year at birth, which underscores the importance of the long-term cognitive impact of shocks during the year of birth.[14]

[13]We include in the econometric specification economic shocks occurring two years after the year of birth to make sure these shocks do not happen right after birth, for instance for those born in December of a given year.

[14]Note also that including only economic shocks occurring two years after birth does not explain any of our outcome variables (see Appendix Table A4), which supports the fact that the effects of economic shocks at birth estimated thus far does indeed capture distress and shocks in the year of birth and not just heterogeneity in some latent and uncontrolled socioeconomic

An additional concern is that the wealth score we include as a control variable in our benchmark specification could also be an outcome variable, given that economic shocks could affect households' wealth and become a pathway to impacting children's cognitive health and outcomes. Although our wealth measure is constructed from durable household assets that may be relatively stable over time, including such an independent variable in our model could capture some of the effects of the economic shocks on cognitive and educational outcomes. However, we show that our results are robust to other versions of wealth measures. First, instead of a wealth score, we include in our model household land ownership as a proxy for socioeconomic status. Table A5 shows that controlling for land ownership does not alter our previous findings.[15] In addition, the only assets for which we have information about whether respondents owned them in 1998, 2001, 2004, 2006, 2008 and 2010 were mattress, radio, bicycle, pit latrine and lamp. Using this subset of assets, we created an indicator variable that takes the value 1 if a respondent owned a particular asset, and summed these indicator variables over the five different assets. We did that for survey years 1998, 2001, 2004, 2006, 2008 and 2010, and took the average of these asset scores, conditioning again on having at least two observations. Table A6 in the Appendix shows that our results are robust to including this measure of socioeconomic status. Table A7 in the Appendix also presents results controlling for wealth score measured in 2004, which predates most of the births of adolescents in our sample. Despite the large decrease in the sample size since not all adolescents had caregivers that were interviewed in 2004, Table A7 shows that the effects of the shocks on cognitive and educational outcomes are similar to those estimated in our benchmark specification, but less precisely estimated due to smaller sample size. We also present results from a specification in which wealth score is not controlled for. In that case, under the assumption that economic shocks and wealth score are negatively correlated, we would expect economic shocks to have larger effects on cognitive and educational outcomes than when wealth score is controlled for.[16] This is indeed what we see in our results (Table A8 in Appendix). Overall, our results are robust to various specifications of wealth measures, including wealth measures that preceded the birth of the adolescents in our sample.

characteristics of the households.

[15] To construct our measure of land ownership, we compute the percentile rank of respondent's land ownership in each wave 1998, 2001, 2004, 2006, 2008 and 2010, and take the average of these percentile ranks, conditioning on having at least two observations for each respondents.

[16] Not including wealth index in the analysis therefore helps to identify the *total effects* of the shocks on cognitive outcome, but weakens the plausibility of the exogeneity of the shocks.

7 Schooling as a Possible Mediating Mechanisms

Our analysis thus far has established that economic shocks in the year of birth have negative effects on girls' cognitive and educational outcomes but such effects are not observed among boys. In this section, we investigate possible mechanisms that might explain this difference.

Early-life physical development is an important determinant of later-life cognitive outcomes. The gender differences we find could therefore stem from the fact that economic shocks at birth impact the physical development of girls differently from that of boys in the early years of life, leading to differences in cognitive and educational outcomes in adolescence. However, Table A9 in the Appendix shows that adolescents who experience economic shocks during the year of their birth do not appear to have different anthropometric characteristics as measured by height and height z-scores[17], where height is generally used as a proxy for stress exposure and deprivation experienced in utero and early in life (Beach *et al.* 2018; Currie and Vogl 2013; Parman 2015; Thomas *et al.* 1990; WHO 1995). Note that this holds true for both girls and boys. For a sub-sample of adolescents, we also have measures for their height in early childhood, as part of data collected for the 2008 MLSFH survey. We do not find any statistically significant effects of economic shocks during the year of birth on adolescent's height and height z-scores[18] measured during early childhood in 2008 (Appendix Table A10). Our results indicate that adolescent's height and height z-score are not affected by economic shocks experienced at birth. We therefore find no evidence for a biological impact using height. This is however a rough marker for biological development and may not be adequate to capture more subtle physiological changes.

Another possible mechanism could be that households that experience economic shocks adopt more extreme gender attitudes, favoring investment in boys' education over girls. As described in the introduction, in the face of adversity and tightening budget constraints, households may have to make difficult choices and may favor boys, or buffer boys from the consequences of shocks, over girls. The effects of economic shocks on cognitive outcomes could therefore be moderated by gender attitudes and difference in investment in education, wherein

[17]The z-score is derived using the characteristics of the height distribution in our sample of adolescents. It is sex and age (in years) specific. We cannot use the WHO growth standards to compute the z-score because these standards exist only for children up to 5 years of age.

[18]The z-score is derived using the WHO standard height characteristics, which are available only for children up to 5 years old.

girls living in more equitable households may be better protected against shocks than those in less equitable households. We therefore test whether differences in cognitive outcomes and educational attainment can be explained by differences in educational experiences and investments in education.

We start our analysis by looking closely at the importance of early investment in education. Adolescents who live in households that experience economic shocks during the year of birth might receive lower investment in education, which could result in lower cognitive and educational outcomes later in life, including lower probability of being enrolled in school at the time of interview. The 2010 MLSFH survey contains a module on investment in education in which respondents were asked how much they have invested in the investment of children in their household who were between 5 and 25 years of age. We merge this information to adolescents in our sample to assess to what extent their experience of a negative economic shock at birth affected the investment in education of their caregiver in 2010. Note that the following analysis is restricted to adolescents who were born in 2005 and before, which results in a substantial reduction in the size of our sample.

As detailed below, we find suggestive evidence that investment in education could be the reason why we observe negative effects of economic shocks at birth on cognitive outcomes and educational attainment for girls but not for boys. We find evidence that these gender differences possibly stem from changes in investment in education, where boys appear to be relatively protected from cuts in investment whereas girls suffer from investment cuts following negative economic shocks that occur during the year of their birth.

Table 5 presents the results of the effects of experiencing an economic shock at birth on educational investment.[19] Because of the nature of our dependent variable, we estimate two-part models to account for the large number of 0's and the substantial skewness in the distribution, which are typical in expenditure data. We specify our two-part model by choosing a probit specification for the extensive margin analysis, a log transform for the link function[20] and a gamma distribution to define the variance as being proportional to the square of the mean of our outcome variable.[21] The results of the effects of economic shocks

[19] Again, because of the small sample size, we are unable to differentiate between adolescents who experienced one or more shocks at birth and hence present results in which these two categories are combined.

[20] In our benchmark specification, the θ coefficient of a Box-Cox approach test is equal to 0.131, which is close to 0 and hence corresponds to the natural log transform (Deb and Norton 2018). The result is very similar when we do not control for any covariates in the specification.

[21] We follow Deb and Norton (2018) and proceed to a modified Park test (Park 1966) that

on investment in education, both at the extensive (probit) and intensive margin (GLM) are presented in Table 5. The outcome variable in the first three columns corresponds to the total amount that that was invested in education in 2010 for a particular adolescent in the ACE sample. Columns 4 to 6 and 7 to 9 break this total down by whether the amount is coming from the household or by someone else outside the household. Note that in this specification we control for the total number of children present in the household, the total number of girls, the age order and the number of children that are reported in the educational investment module of the 2010 MLSFH survey. Column 3 of Table 5 shows that girls who experienced a negative economic shock during the year of birth received lower educational investment from their households compared to girls who did not experience any shocks at birth. The lower investment is coming from the intensive margin, meaning that girls who experienced a shock at birth were not more or less likely to receive a positive amount, but the amount they were receiving was lower than others. We do not observe corresponding effects for boys (Column 2). When examining where the money is coming from, we observe that it is mostly the investment in education coming from persons outside the household that reduce the investment on girls—both at the intensive and extensive margins—whereas the household itself does not seem to change its investment in education behavior after an economic shock.

Tables A11 and A12 in the Appendix show that it is economic shocks at birth that affect investment in education later in life, and that economic shocks that occur two years after the year of birth do not have similar effects. This is surprising given that shocks that occur two years after the year of birth are temporally closer to when decisions about investment in schooling are made.

consists in estimating a GLM (with log link and gamma distribution) from which we derive the conditional expected mean and squared error term for each observation. We then regress the squared error term on conditional expected mean and look at the value of that coefficient to determine the most appropriate distribution to use. In our benchmark specification, the coefficient associated with that regression equals 2.220, and we cannot reject the hypothesis that the coefficient is equal to 2 (p-value=0.680), which suggests the use of a gamma distribution (Deb and Norton 2018).

Table 5: Effects of economic shocks on investment in education

	Total			Household			Others		
	All	Boys	Girls	All	Boys	Girls	All	Boys	Girls
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Extensive margin (Probit)									
Shock at birth	0.020	-0.061	0.138	-0.009	-0.101	0.114	-0.179	0.090	-0.615^{+}
	(0.182)	(0.235)	(0.265)	(0.181)	(0.233)	(0.265)	(0.206)	(0.271)	(0.340)
Intensive margin (GLM)									
Shock at birth	-0.144	0.328	-0.417^{+}	-0.037	0.212	-0.196	-0.618	0.500	-1.436*
	(0.170)	(0.249)	(0.224)	(0.172)	(0.263)	(0.218)	(0.467)	(0.744)	(0.578)
Observations	692	333	359	694	334	360	694	333	361

Note: The sample is derived from the ACE sample collected in 2017 and 2018 for which we have information about the amount that were spent for their schooling. Economic shocks are reported by adolescent's household as part of the MLSFH collected in 2008 and 2010. All regressions control for age (in years) and region fixed effects, age and marital status of the caregiver at birth, educational level of the caregiver (no school, primary level of education, secondary level of education and higher of education), a continuous wealth index of the household, sex of the adolescent, total number of children present in the household, the total number of girls, the age order and the number of children that are reported in the educational investment module of the 2010 MLSFH survey. Standard errors are clustered at the household level ($^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$).

Moreover, our analysis suggests the presence of some compensatory behaviors in terms of investment in education for boys. Table A13 in the Appendix shows that economic shocks that occur during the year of birth of a boy not only increase mean investment in education for boys within the household, but that economic shocks during the year of birth of girls increase mean investment on boys as well.

Finally, we show that investment in education at the household level predicts the cognitive and educational outcomes of the adolescents in our sample. Table 6 analyzes the effects of investment on schooling (at the household level) on cognitive outcomes, when considering investment in education as a continuous measure using a inverse hyperbolic sine transformation.[22] This table suggests that higher investment in education at the household level appears to be particularly beneficial for girls and less so for boys. This is consistent with the results from the previous table: girls outcomes are more sensitive to investment in education, and economic shocks decrease the amount of investment that is spent on their own education.[23]

[22] This transformation is roughly similar to the natural logarithm but allows for 0 (specifically, the transformation approaches $\ln(x+1)$ for small values of X, and $\ln(x)$ for large values of x).

[23] Ideally, one would want to assess the effects of economic shocks at birth on investment in education for a particular child and consequently their effects on cognitive and educational attainment. It is however not possible to do so in our sample given that we have information

Table 6: Associations between investment in education and cognitive and educational attainment outcomes

	All (1)	Boys (2)	Girls (3)	All (4)	Boys (5)	Girls (6)
			A. Reading skills			
	Reading score			Can't read Chichewa		
Investment in education (ihst)	0.093**	0.069	0.113*	-0.034*	-0.017	-0.054**
	(0.036)	(0.049)	(0.045)	(0.016)	(0.021)	(0.021)
Observations	1616	812	804	1612	809	803
			B Working memory			
	Working memory score			Score of 0		
Investment in education (ihst)	-0.005	0.001	-0.011	-0.004	0.017	-0.028
	(0.022)	(0.028)	(0.028)	(0.024)	(0.032)	(0.032)
Observations	1317	654	663	1310	650	660
			C. Mathematical skills			
	Math score			Score of 0		
Investment in education (ihst)	0.095*	0.070	0.121*	-0.023	-0.022	-0.033
	(0.038)	(0.053)	(0.047)	(0.020)	(0.026)	(0.027)
Observations	1590	797	793	1583	793	715
			D. Schooling			
	Educational attainment			Age for grade $\geqslant 3$		
Investment in education (ihst)	0.080**	0.071**	0.090**	-0.043*	-0.027	-0.062**
	(0.016)	(0.022)	(0.020)	(0.018)	(0.025)	(0.023)
Observations	1632	819	813	1494	760	734

Note: The sample is derived from the ACE sample collected in 2017 and 2018 for which we have information about the amount spent on education by their household. All regressions control for age (in years) and region fixed effects, age and marital status of the caregiver at birth, educational level of the caregiver (no school, primary level of education, secondary level of education and higher of education), a continuous wealth index of the household and sex of the adolescent. We also control for the number of children living in the household. "ihst" stands for inverse hyperbolic sine transformation. Standard errors are clustered at the household level ($^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$).

One measure of schooling experiences or continued investment in education that could explain the relationship between economic shocks and cognitive/educational outcomes later in life is whether an adolescent is currently in school at the time of the interview.[24] Such mediator can proxy for the importance that

about investment in education only for adolescents who are born prior to 2005.

[24]Unfortunately, we cannot assess the effects of economic shocks at birth on school entry age to examine whether the shocks had any effects on delayed school entry because information about school entry age was asked only to adolescents who were currently enrolled in school at the time of the interview.

households give to education, especially for those children who were affected by an economic shock during their year of birth. Table A14 in the Appendix shows that boys who experienced economic shocks during their year of birth had a higher probability of being enrolled in school at the time of the interview, compared to boys who did not experience such shocks. However, girls who experienced an economic shock during the year of birth had a lower probability of being enrolled in school, possibly because they have dropped out. This could indicate the presence of compensatory behaviors in the form of higher investment in education for boys affected by economic shocks at birth but not for girls. Table 7 presents the results of our mediation analysis in which we assess whether controlling for adolescents' current enrollment in school attenuates the direct effects of economic shocks at birth on cognitive outcomes and educational attainment. Specifically, Columns 1-3 present the results of the total effects of the shocks on the outcome variables of interest, while Columns 4-6 control for "currently in school" in the econometric specification. We observe that current enrollment at school has positive effects on all cognitive outcomes, especially for girls (Column 6). In addition, we also observe that including current enrollment status in the model attenuates the negative effects of economic shocks on all our dependent variables for girls, making almost all of them statistically insignificant, while at the same time keeping the effects among boys relatively stable. This results in a convergence in the effects of the economic shocks on cognitive outcomes and educational attainment between boys and girls, which indicates that current enrollment in school could be a mediator that explains the *gender differences* in the effects of the shocks on our dependent variables. The only exception is the effects on the probability of having a math score of 0, which remains large and statistically significant for girls even after controlling for whether they are currently in school.

Table 7: Mediation analysis between economic shocks at birth and cognitive and educational attainment outcomes - currently in school

	All (1)	Boys (2)	Girls (3)	All (4)	Boys (5)	Girls (6)
			Reading score			
1 shock at birth	0.123	0.217	-0.047	0.078	0.109	0.049
	(0.204)	(0.288)	(0.300)	(0.197)	(0.284)	(0.276)
2 shocks or more at birth	-0.439	0.004	-0.925^{+}	-0.457	-0.147	-0.699
	(0.366)	(0.494)	(0.530)	(0.351)	(0.492)	(0.506)
Currently in school				3.383**	2.392**	4.327**
				(0.270)	(0.411)	(0.331)
			Can't read Chichewa			
1 shock at birth	-0.014	-0.037	0.035	-0.001	0.010	-0.008
	(0.092)	(0.124)	(0.149)	(0.093)	(0.124)	(0.152)
2 shocks or more at birth	0.280^{+}	0.164	0.435^{+}	0.289^{+}	0.228	0.361
	(0.165)	(0.233)	(0.234)	(0.163)	(0.235)	(0.238)
Currently in school				-1.603**	-1.208**	-2.024**
				(0.166)	(0.230)	(0.220)
			Cognitive score			
1 shock at birth	0.025	0.113	-0.063	0.012	0.086	-0.021
	(0.114)	(0.149)	(0.180)	(0.113)	(0.149)	(0.178)
2 shocks or more at birth	-0.295	-0.112	-0.488	-0.300	-0.151	-0.397
	(0.204)	(0.246)	(0.309)	(0.197)	(0.244)	(0.292)
Currently in school				0.923**	0.516*	1.368**
				(0.157)	(0.246)	(0.181)
			Cognitive score of 0			
1 shock at birth	0.010	-0.299	0.354	0.023	-0.280	0.303
	(0.145)	(0.212)	(0.223)	(0.147)	(0.211)	(0.231)
2 shocks or more at birth	0.477*	0.385	0.670*	0.475*	0.426	0.481
	(0.218)	(0.306)	(0.336)	(0.212)	(0.308)	(0.309)
Currently in school				-0.779**	-0.366	-1.191**
				(0.170)	(0.258)	(0.236)
			Math score			
1 shock at birth	-0.042	-0.036	-0.108	-0.087	-0.190	-0.000
	(0.215)	(0.301)	(0.319)	(0.208)	(0.293)	(0.304)
2 shocks or more at birth	-0.563	-0.433	-0.783	-0.574	-0.648	-0.538
	(0.377)	(0.527)	(0.536)	(0.354)	(0.524)	(0.480)
Currently in school				4.011**	3.521**	4.558**
				(0.288)	(0.413)	(0.400)
			Math score of 0			
1 shock at birth	0.143	0.054	0.320	0.188	0.162	0.270
	(0.137)	(0.171)	(0.228)	(0.142)	(0.177)	(0.238)
2 shocks or more at birth	0.207	-0.158	0.748*	0.243	-0.042	0.656*
	(0.214)	(0.308)	(0.311)	(0.205)	(0.311)	(0.304)
Currently in school				-1.185**	-1.138**	-1.376**
				(0.162)	(0.218)	(0.242)
			Educational attainment			
1 shock at birth	0.017	0.109	-0.120	-0.004	0.050	-0.083
	(0.087)	(0.113)	(0.134)	(0.083)	(0.110)	(0.125)
2 shocks or more at birth	-0.114	0.200	-0.413^{+}	-0.123	0.118	-0.323
	(0.161)	(0.205)	(0.246)	(0.148)	(0.198)	(0.220)
Currently in school				1.523**	1.304**	1.743**
				(0.157)	(0.225)	(0.237)
Observations	1554	792	762	1554	792	762

Note: Standard errors in parentheses clustered at the household level ($^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$). The sample is derived from the ACE sample collected in 2017 and 2018. Economic shocks are reported by adolescent's household as part of the MLSFH collected in 2008 and 2010. All regressions control for age (in years) and region fixed effects, age and marital status of the caregiver at birth, educational level of the caregiver (no school, primary level of education, secondary level of education and higher of education), a continuous wealth index of the household and sex of the adolescent.

8 Discussion

Our study is among the first to examine the effect of moderately-severe frequently-occurring shocks in early life on adolescent cognition and schooling attainment in a LIC. We contribute to the literature by focusing on Malawi, a LIC, and by estimating the effects of moderately-severe early-life shocks, rather than the severe and relatively rare shocks (e.g, famine, civil war) that have been investigated to date (Bundervoet and Fransen 2018; Millett and Shah 2012; Tafere 2016). We find that two or more moderate economic shocks in the year of birth adversely affect adolescent girls' educational and cognitive outcomes, though we do not observe the same pattern for boys, unlike previous studies (Beshir and Maystadt 2020). We also find that effects on girls' educational and cognitive outcomes are larger for shocks that affect the entire community, potentially making it difficult for households to buffer their impact by seeking help from neighbors. We also find suggestive evidence for educational investment as a possible pathway that might explain gender differences in the long-term impact of shocks. While we cannot formally test educational investment as a mediating mechanism due to data limitations, our results indicate that households compensate boys' but not girls' education in response to shocks in the year of birth. This is consistent with our expectation that lower educational investment in early childhood may be a possible pathway to girls' disadvantage in educational and cognitive outcomes during adolescence.

As a possible biological pathway (based on limited sample size), we find no evidence that height mediate the relationship between shocks in the year of birth and adolescent educational outcomes. However, this measure may be too crude for capturing the cognitive impact of experiencing economic shocks in utero. Notably, we do not find that shocks experienced two years after birth affect either adolescent girls' or boys' educational and cognitive outcomes. Given that more recent shocks to household resources are expected to affect educational investments in children (Hyder *et al.* 2015), this finding hints at the possibility of biological mechanisms driving long-term gender differences in educational outcomes.

Overall, similar to evidence on pathways from Ethiopia (Beshir and Maystadt 2020), our study encourages future investigation of both biological and social pathways that might help explain why in utero or early life shocks result in gender differences in adolescent's educational and cognitive outcomes in low income countries. Our findings lend support to policies aimed at alleviating educational inequalities in Malawi (Psaki *et al.* 2018), and sub-Saharan Africa more broadly.

Although the gender gap in primary school completion rates in Malawi has narrowed in recent years (Brossard *et al.* 2010; Psaki *et al.* 2018), overall primary school completion remain low. Despite seeming gender equality in low educational attainment among all adolescents, the pathways to school dropout may still be gendered. For instance, girls may experience drop out (and thus low educational attainment) due to pregnancy, whereas boys may dropout of school to participate in paid work (Psaki *et al.* 2018). Differential pathways to school dropout require different interventions. Our results also highlight that economic shocks in the year of birth may be an additional gendered pathway that puts girls at an educational disadvantage. Therefore, policymakers should intervene early to alleviate the long-term educational impact of these shocks for girls. Refining the nature and design of such interventions may hinge on further evidence on what role biological and social pathways play in generating gender differences in educational outcomes. Evidence of detrimental impact on cognitive development in utero may imply greater investment in the health and well being of pregnant mothers, whereas reduced educational investment may suggest a need for early economic incentives for girls' education. However, regardless of which mechanism is more dominant, existing social protection programs, such as cash transfer programs, could be used to assist households that experience multiple, negative shocks, particularly those with pregnant women.

Additionally, our findings seem to align with previous research that shows Malawian girls who drop out of school are more likely to experience learning loss after dropping out of school (Soler-Hampejsek *et al.* 2018). Girls who experience economic shocks in the year of birth have poorer reading and numeracy skills than girls who do not experience shocks. We find that this is mediated by girls' school enrollment status. That is, girls whose households experience economic shocks in the year of their birth are less likely to be enrolled in school as adolescents, which explains why they have lower scores on cognitive outcomes. Interventions that provide long-term educational incentives for these girls to stay in school may help mitigate the impact of experiencing early life shocks.

The importance of our findings notwithstanding, our study has some limitations. First, for better causal interpretation, testing models with family fixed effects using sibling data would be useful, but we are unable to do so given data limitations. Second, household shocks in our study are self-reported and these reports may be subject to recall bias (this concern, however, is somewhat alleviated as shocks were reported by parents in 2008 and 2010 at the time when the adolescents were born, rather than being recalled retrospectively from more than a decade ago). Third, variation in tests of cognitive skills based on age and

grade level may yield a more nuanced understanding of the cognitive impact of shocks on the ability to learn progressively difficult concepts.

Overall, our study is among the first to show evidence of girls' long-term educational disadvantage as a result of experiencing multiple, moderate early life economic shocks. These shocks represent an additional pathway through which girls' educational progress may be curtailed in Malawi. More broadly, our findings emphasize that LIC program developers and policymakers consider vulnerability from early life shocks as an important target for intervention, including early-life shocks that are "only" moderately-severe and fairly commonly experienced in utero or during early life.

Acknowledgement and statements

Funding statement: Research reported in this publication was supported by the Eunice Kennedy Shriver National Institute of Child Health & Human Development of the National Institutes of Health under Award Numbers R01HD090988, R01HD087391 and R01 RHD053781. The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health. We also gratefully acknowledge the generous support from the Swiss Programme for Research on Global Issues for Development (SNF r4d Grant 400640_160374) and the Swiss National Science foundation (grant number: P2LAP1_187736).
Conflicts of interest: The authors have no relevant financial or non-financial interests to disclose.
Data availability statement: The public-use data of the Malawi Longitudinal Study for Families and Health (MLSFH) are available from https://malawi.pop.upenn.edu/malawi-data-mlsfh. Additional data of the MLSFH Adverse Childhood Experiences (ACE) project that are used for our analyses can be requested from the authors, and will ultimately be made publicly available as part of the MLSFH.
Acknowledgment: We would like to thank Jere R. Behrman and the MLSFH team for their comments and feedback that greatly improve the quality of our manuscript.

References

Adhvaryu, A., Nyshadham, A., Molina, T., and Tamayo, J. (2018). Helping children catch up: Early life shocks and the PROGRESA experiment. Technical report, National Bureau of Economic Research.

Aguilar, A. and Vicarelli, M. (2011). El Nino and Mexican children: medium-term effects of early-life weather shocks on cognitive and health outcomes. *Cambridge, United States: Harvard University, Department of Economics. Manuscript*.

Aizer, A., Stroud, L., and Buka, S. (2016). Maternal stress and child outcomes: Evidence from siblings. *Journal of Human Resources*, **51**(3), 523–555.

Akresh, R., Bagby, E., De Walque, D., and Kazianga, H. (2012). Child ability and household human capital investment decisions in Burkina Faso. *Economic Development and Cultural Change*, **61**(1), 157–186.

Alderman, H., Hoddinott, J., and Kinsey, B. (2006). Long term consequences of early childhood malnutrition. *Oxford Economic Papers*, **58**(3), 450–474.

Almond, D. and Currie, J. (2011). Killing me softly: The fetal origins hypothesis. *Journal of Economic Perspectives*, **25**(3), 153–72.

Almond, D., Mazumder, B., and Van Ewijk, R. (2015). In utero Ramadan exposure and children's academic performance. *The Economic Journal*, **125**(589), 1501–1533.

Almond, D., Currie, J., and Duque, V. (2018). Childhood circumstances and adult outcomes: Act II. *Journal of Economic Literature*, **56**(4), 1360–1446.

Ampaabeng, S. K. and Tan, C. M. (2013). The long-term cognitive consequences of early childhood malnutrition: the case of famine in Ghana. *Journal of Health Economics*, **32**(6), 1013–1027.

Azam, M. and Kingdon, G. G. (2013). Are girls the fairer sex in India? Revisiting intra-household allocation of education expenditure. *World Development*, **42**, 143–164.

Barker, D. J. (1990). The fetal and infant origins of adult disease. *BMJ: British Medical Journal*, **301**(6761), 1111.

Beach, B., Ferrie, J. P., and Saavedra, M. H. (2018). Fetal shock or selection? The 1918 Influenza pandemic and human capital development. Technical report, National Bureau of Economic Research.

Becker, G. S. and Tomes, N. (1976). Child endowments and the quantity and quality of children. *Journal of Political Economy*, **84**(4, Part 2), S143–S162.

Behrman, J. R. and Knowles, J. C. (1999). Household income and child schooling in Vietnam. *The World Bank Economic Review*, **13**(2), 211–256.

Behrman, J. R., Pollak, R. A., and Taubman, P. (1982). Parental preferences and provision for progeny. *Journal of Political Economy*, **90**(1), 52–73.

Beshir, H. A. and Maystadt, J.-F. (2020). In utero seasonal food insecurity and cognitive development: Evidence on gender imbalances from Ethiopia. *Journal of African Economies*, **29**(4), 412–431.

Brossard, M., Coury, D., and Mambo, M. (2010). *The education system in Malawi*. The World Bank.

Brown, R. (2018). The Mexican drug war and early-life health: The impact of violent crime on birth outcomes. *Demography*, **55**(1), 319–340.

Bundervoet, T. and Fransen, S. (2018). The educational impact of shocks in utero: Evidence from Rwanda. *Economics & Human Biology*, **29**, 88–101.

Chin, B. (2010). Income, health, and well-being in rural Malawi. *Demographic research*, **23**(35), 997.

Cook, C. J., Fletcher, J. M., and Forgues, A. (2019). Multigenerational effects of early-life health shocks. *Demography*, **56**(5), 1855–1874.

Currie, J. and Vogl, T. (2013). Early-life health and adult circumstance in developing countries. *Annu. Rev. Econ.*, **5**(1), 1–36.

Deb, P. and Norton, E. C. (2018). Modeling health care expenditures and use. *Annual Review of Public Health*, **39**, 489–505.

Duque, V., Rosales-Rueda, M., Sanchez, F., *et al.* (2018). How do early-life shocks interact with subsequent human-capital investments? Evidence from administrative data. In *IZA World of Labor Conference*.

Filmer, D. and Pritchett, L. (1998). Estimating wealth effects without expenditure data–or tears: An application to educational enrollments in states of India. *Policy Research Working Papers No. 1994*.

Georgiadis, A., Benny, L., Galab, S., Reddy, P., Woldehanna, T., *et al.* (2017). Growth recovery and faltering through early adolescence in low-and middle-income countries: Determinants and implications for cognitive development. *Social Science & Medicine*, **179**, 81–90.

Greve, J., Schultz-Nielsen, M. L., and Tekin, E. (2017). Fetal malnutrition and academic success: Evidence from Muslim immigrants in Denmark. *Economics of Education Review*, **60**, 20–35.

Haddad, L. and Reardon, T. (1993). Gender bias in the allocation of resources within households in Burkina Faso: a disaggregated outlay equivalent analysis. *The Journal of Development Studies*, **29**(2), 260–276.

Hadley, C., Lindstrom, D., Tessema, F., and Belachew, T. (2008). Gender bias in the food insecurity experience of Ethiopian adolescents. *Social Science & Medicine*, **66**(2), 427–438.

Heckman, J. J. (2007). The economics, technology, and neuroscience of human capability formation. *Proceedings of the national Academy of Sciences*, **104**(33), 13250–13255.

Hoddinott, J. and Kinsey, B. (2001). Child growth in the time of drought. *Oxford Bulletin of Economics and Statistics*, **63**(4), 409–436.

Hyder, A., Behrman, J. R., and Kohler, H.-P. (2015). Negative economic shocks and child schooling: Evidence from rural Malawi. *Development Southern Africa*, **32**(4), 458–476.

Kaul, T. (2018). Intra-household allocation of educational expenses: Gender discrimination and investing in the future. *World Development*, **104**, 336–343.

Kidman, R., Piccolo, L., and Kohler, H.-P. (2020). Adverse childhood experiences: Prevalence and association with adolescent health in Malawi. *American Journal of Preventive Medicine*, **58**(2), 285–293.

Kohler, H.-P., Watkins, S. C., Behrman, J. R., Anglewicz, P., Kohler, I. V., Thornton, R. L., Mkandawire, J., Honde, H., Hawara, A., Chilima, B., Bandawe, C., and Mwapasa, V. (2015). Cohort profile: The Malawi Longitudinal

Study of Families and Health (MLSFH). *International Journal of Epidemiology*, **44**(2), 394–404.

Lee, C. (2014). Intergenerational health consequences of in utero exposure to maternal stress: Evidence from the 1980 Kwangju uprising. *Social Science & Medicine*, **119**, 284–291.

Levitsky, D. A. and Strupp, B. J. (1995). Malnutrition and the brain: changing concepts, changing concerns. *The Journal of Nutrition*, **125**(suppl_8), 2212S–2220S.

Millett, B. and Shah, M. (2012). The effects of in-utero shocks on cognitive test scores: Evidence from droughts in India. Technical report, Mimeo.

Park, R. E. (1966). Estimation with heteroscedastic error terms. *Econometrica (pre-1986)*, **34**(4), 888.

Parman, J. (2015). Childhood health and human capital: New evidence from genetic brothers in arms. *The Journal of Economic History*, **75**(1), 30–64.

Psaki, S. R., McCarthy, K. J., Mensch, B. S., *et al.* (2018). Measuring gender equality in education: Lessons from trends in 43 countries. *Population and Development Review*, **44**(1), 117–142.

Rosales, M. F. (2013). Impact of early-life shocks on human capital formation: evidence from el Nino floods in Ecuador. *University of Chicago, Job Market Paper*.

Sauerborn, R., Berman, P., and Nougtara, A. (1996). Age bias, but no gender bias, in the intrahousehold resource allocation for health care in rural Burkina Faso. *Health Transition Review*, pages 131–145.

Soler-Hampejsek, E., Mensch, B. S., Psaki, S. R., Grant, M. J., Kelly, C. A., and Hewett, P. C. (2018). Reading and numeracy skills after school leaving in southern malawi: A longitudinal analysis. *International Journal of Educational Development*, **59**, 86–99.

Tafere, K. (2016). Inter-generational effects of early childhood shocks on human capital: Evidence from Ethiopia. *Working paper, No. 333-2016-14569*.

Thomas, D. and Strauss, J. (1992). Prices, infrastructure, household characteristics and child height. *Journal of Development Economics*, **39**(2), 301–331.

Thomas, D., Strauss, J., and Henriques, M.-H. (1990). Child survival, height for age and household characteristics in Brazil. *Journal of Development Economics*, **33**(2), 197–234.

Uauy, R. and Dangour, A. D. (2006). Nutrition in brain development and aging: role of essential fatty acids. *Nutrition Reviews*, **64**(suppl_2), S24–S33.

UNICEF (2020). Girls' education. https://www.unicef.org/education/girls-education. Accessed: 2020-09-21.

von Hinke Kessler Scholder, S., Wehby, G. L., Lewis, S., and Zuccolo, L. (2014). Alcohol exposure in utero and child academic achievement. *The Economic Journal*, **124**(576), 634–667.

Vyas, S. and Kumaranayake, L. (2006). Constructing socio-economic status indices: how to use principal components analysis. *Health Policy and Planning*, **21**(6), 459–468.

WHO (1995). The use and interpretation of anthropometry. Report 8854, World Health Organization.

Wolf, S. and McCoy, D. C. (2019). Household socioeconomic status and parental investments: Direct and indirect relations with school readiness in Ghana. *Child Development*, **90**(1), 260–278.

Yi, J., Heckman, J. J., Zhang, J., and Conti, G. (2015). Early health shocks, intra-household resource allocation and child outcomes. *The Economic Journal*, **125**(588), F347–F371.

Appendix

Table A1: Additional cognitive outcomes

	All	Boys	Girls
	(1)	(2)	(3)
	Can't read English		
1 shock at birth	-0.098	-0.137	-0.044
	(0.093)	(0.131)	(0.140)
2 shocks or more at birth	0.209	-0.012	0.444^{+}
	(0.168)	(0.238)	(0.231)
	Math basic questions		
1 shock at birth	-0.081	-0.061	-0.113
	(0.116)	(0.148)	(0.195)
2 shocks or more at birth	-0.400*	-0.278	-0.597*
	(0.180)	(0.232)	(0.276)
	Math index		
1 shock at birth	0.004	0.023	-0.032
	(0.059)	(0.088)	(0.083)
2 shocks or more at birth	-0.177	-0.093	-0.284^{+}
	(0.113)	(0.160)	(0.157)

Note: The sample is derived from the ACE sample collected in 2017 and 2018. Economic shocks are reported by adolescent's household as part of the MLSFH collected in 2008 and 2010. All regressions control for age (in years) and region fixed effects, age and marital status of the caregiver at birth, educational level of the caregiver (no school, primary level of education, secondary level of education and higher of education), a continuous wealth index of the household and sex of the adolescent. Standard errors are clustered at the household level ($^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$).

Table A2: Effects of economic shocks at birth on cognitive outcomes and educational attainment - interactions between shock and sex

	Reading score (1)	Can't read Chichewa (2)	Working memory (3)	WM score of 0 (4)	Math score (5)	Math score of 0 (6)	Educational attainment (7)	Age for grade ⩾ 3 (8)
				Sex-specific age dummies				
1 shock at birth	0.240	-0.041	0.101	-0.276	-0.003	0.040	0.109	-0.015
	(0.287)	(0.125)	(0.148)	(0.218)	(0.298)	(0.173)	(0.113)	(0.130)
2 shocks or more at birth	0.045	0.140	-0.069	0.282	-0.418	-0.186	0.208	-0.014
	(0.489)	(0.235)	(0.243)	(0.308)	(0.524)	(0.312)	(0.202)	(0.252)
1 shock at birth × girls	-0.263	0.064	-0.178	0.602*	-0.108	0.281	-0.210	-0.008
	(0.420)	(0.196)	(0.235)	(0.300)	(0.440)	(0.279)	(0.173)	(0.192)
2 shocks or more at birth × girls	-0.971	0.293	-0.458	0.420	-0.321	0.883*	-0.623+	0.252
	(0.722)	(0.328)	(0.388)	(0.447)	(0.754)	(0.435)	(0.319)	(0.359)
Observations	1541	1543	1276	1276	1510	1510	1554	1447

Note: The sample is derived from the ACE sample collected in 2017 and 2018. Economic shocks are reported by adolescent's household as part of the MLSFH collected in 2008 and 2010. All regressions control for age (in years) and region fixed effects, age and marital status of the caregiver at birth, educational level of the caregiver (no school, primary level of education, secondary level of education and higher of education), a continuous wealth index of the household and sex of the adolescent. Age dummy variables are also interacted with sex. Standard errors are clustered at the household level ($^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$).

Table A3: Effects of economic shocks at birth on cognitive outcomes and educational attainment - including also shocks occurring two years after the year of birth

	All (1)	Boys (2)	Girls (3)	All (4)	Boys (5)	Girls (6)
			Reading skills			
	Reading score			Can't read Chichewa		
1 shock at birth	0.180	0.245	0.054	-0.030	-0.051	-0.002
	(0.211)	(0.300)	(0.306)	(0.096)	(0.129)	(0.154)
2 shocks or more at birth	-0.486	-0.033	-0.954^{+}	0.330^{+}	0.194	0.506*
	(0.386)	(0.532)	(0.547)	(0.177)	(0.253)	(0.249)
1 shock 2 years after birth	0.054	0.058	0.078	-0.085	-0.108	-0.074
	(0.179)	(0.255)	(0.249)	(0.086)	(0.112)	(0.132)
2 shocks or more 2 years after birth	0.358	0.208	0.527	-0.062	0.048	-0.223
	(0.252)	(0.356)	(0.348)	(0.113)	(0.153)	(0.167)
			Cognitive skills			
	Cognitive score			Score of 0		
1 shock at birth	0.094	0.189	0.009	-0.062	-0.439^{+}	0.312
	(0.119)	(0.158)	(0.187)	(0.153)	(0.240)	(0.232)
2 shocks or more at birth	-0.298	-0.066	-0.599^{+}	0.478*	0.421	0.609^{+}
	(0.223)	(0.265)	(0.340)	(0.232)	(0.319)	(0.368)
1 shock 2 years after birth	0.082	0.146	0.012	-0.113	0.004	-0.316
	(0.115)	(0.151)	(0.171)	(0.129)	(0.172)	(0.212)
2 shocks or more 2 years after birth	0.204	0.189	0.272	-0.126	-0.276	0.006
	(0.151)	(0.191)	(0.206)	(0.177)	(0.253)	(0.249)
			Math skills			
	Math score			Score of 0		
1 shock at birth	-0.045	-0.072	-0.025	0.155	0.055	0.334
	(0.221)	(0.310)	(0.325)	(0.140)	(0.177)	(0.235)
2 shocks or more at birth	-0.494	-0.522	-0.585	0.210	-0.204	0.898**
	(0.400)	(0.561)	(0.567)	(0.233)	(0.342)	(0.330)
1 shock 2 years after birth	-0.131	-0.275	0.084	-0.091	-0.121	-0.049
	(0.190)	(0.265)	(0.271)	(0.126)	(0.160)	(0.220)
2 shocks or more 2 years after birth	0.136	-0.148	0.439	-0.157	-0.183	-0.082
	(0.266)	(0.356)	(0.380)	(0.173)	(0.221)	(0.256)
			Schooling			
	Educational attainment			Age for grade $\geqslant 3$		
1 shock at birth	0.019	0.124	-0.120	-0.028	-0.062	0.020
	(0.090)	(0.117)	(0.139)	(0.099)	(0.132)	(0.152)
2 shocks or more at birth	-0.109	0.295	-0.508*	0.047	-0.133	0.270
	(0.173)	(0.227)	(0.251)	(0.194)	(0.267)	(0.285)
1 shock 2 years after birth	0.002	-0.017	0.037	-0.054	-0.024	-0.106
	(0.086)	(0.115)	(0.124)	(0.087)	(0.125)	(0.127)
2 shocks or more 2 years after birth	0.057	0.062	0.058	0.115	0.030	0.178
	(0.109)	(0.152)	(0.154)	(0.121)	(0.166)	(0.171)

Note: The sample is derived from the ACE sample collected in 2017 and 2018. Economic shocks are reported by adolescent's household as part of the MLSFH collected in 2008 and 2010. All regressions control for age (in years) and region fixed effects, age and marital status of the caregiver at birth, educational level of the caregiver (no school, primary level of education, secondary level of education and higher of education), a continuous wealth index of the household and sex of the adolescent. Standard errors are clustered at the household level ($^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$).

Table A4: Effects of economic shocks at birth on cognitive outcomes and educational attainment - including only shocks occurring two years after the year of birth

	All (1)	Boys (2)	Girls (3)	All (1)	Boys (2)	Girls (3)
			Reading skills			
	Reading score			Can't read Chichewa		
1 shock 2 years after birth	0.054	0.050	0.099	-0.092	-0.111	-0.090
	(0.178)	(0.254)	(0.249)	(0.085)	(0.111)	(0.132)
2 shocks or more 2 years after birth	0.343	0.198	0.509	-0.062	0.046	-0.221
	(0.250)	(0.353)	(0.346)	(0.111)	(0.151)	(0.165)
			Cognitive skills			
	Cognitive score			Score of 0		
1 shock 2 years after birth	0.081	0.144	0.018	-0.118	-0.007	-0.365^{+}
	(0.114)	(0.150)	(0.171)	(0.128)	(0.170)	(0.212)
2 shocks or more 2 years after birth	0.198	0.183	0.255	-0.139	-0.300	-0.071
	(0.150)	(0.190)	(0.203)	(0.177)	(0.248)	(0.243)
			Math skills			
	Math score			Score of 0		
1 shock 2 years after birth	-0.116	-0.260	0.101	-0.106	-0.119	-0.120
	(0.189)	(0.265)	(0.269)	(0.126)	(0.159)	(0.216)
2 shocks or more 2 years after birth	0.147	-0.129	0.439	-0.167	-0.177	-0.155
	(0.264)	(0.354)	(0.374)	(0.172)	(0.222)	(0.251)
			Schooling			
	Educational attainment			Age for grade $\geqslant 3$		
1 shock 2 years after birth	0.003	-0.028	0.060	-0.053	-0.018	-0.115
	(0.085)	(0.114)	(0.122)	(0.086)	(0.124)	(0.125)
2 shocks or more 2 years after birth	0.056	0.048	0.077	0.118	0.039	0.180
	(0.107)	(0.151)	(0.149)	(0.120)	(0.164)	(0.169)

Note: The sample is derived from the ACE sample collected in 2017 and 2018. Economic shocks are reported by adolescent's household as part of the MLSFH collected in 2008 and 2010. All regressions control for age (in years) and region fixed effects, age and marital status of the caregiver at birth, educational level of the caregiver (no school, primary level of education, secondary level of education and higher of education), a continuous wealth index of the household and sex of the adolescent. Standard errors are clustered at the household level ($^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$).

Table A5: Effects of economic shocks at birth on cognitive outcomes and educational attainment - land ownership (percentile rank)

	All	Boys	Girls	All	Boys	Girls
	(1)	(2)	(3)	(4)	(5)	(6)
			Reading skills			
	Reading score			Can't read Chichewa		
1 shock at birth	0.175	0.332	-0.068	-0.031	-0.067	0.052
	(0.214)	(0.304)	(0.309)	(0.095)	(0.128)	(0.151)
2 shocks or more at birth	-0.379	-0.069	-0.809	0.263	0.205	0.394
	(0.376)	(0.518)	(0.559)	(0.167)	(0.239)	(0.248)
Observations	1450	731	719	1452	732	720
			Cognitive skills			
	Cognitive score			Score of 0		
1 shock at birth	0.047	0.212	-0.156	0.011	-0.393^{+}	0.489*
	(0.120)	(0.154)	(0.191)	(0.152)	(0.236)	(0.230)
2 shocks or more at birth	-0.286	-0.141	-0.473	0.502*	0.392	0.745*
	(0.216)	(0.261)	(0.330)	(0.225)	(0.314)	(0.358)
Observations	1202	600	602	1202	600	518
			Math skills			
	Math score			Score of 0		
1 shock at birth	-0.005	0.095	-0.168	0.163	0.050	0.381
	(0.223)	(0.313)	(0.332)	(0.141)	(0.184)	(0.232)
2 shocks or more at birth	-0.554	-0.430	-0.816	0.242	-0.092	0.850**
	(0.404)	(0.549)	(0.590)	(0.220)	(0.319)	(0.326)
Observations	1421	716	705	1421	716	648
			Schooling			
	Educational attainment			Age for grade $\geqslant 3$		
1 shock at birth	0.028	0.136	-0.139	-0.045	-0.049	-0.022
	(0.090)	(0.115)	(0.141)	(0.099)	(0.132)	(0.150)
2 shocks or more at birth	-0.080	0.209	-0.442	0.108	0.018	0.275
	(0.175)	(0.220)	(0.276)	(0.184)	(0.267)	(0.273)
Observations	1463	737	726	1366	689	677

Note: The sample is derived from the ACE sample collected in 2017 and 2018. Economic shocks are reported by adolescent's household as part of the MLSFH collected in 2008 and 2010. All regressions control for age (in years) and region fixed effects, age and marital status of the caregiver at birth, educational level of the caregiver (no school, primary level of education, secondary level of education and higher of education), land ownership (average percentile rank) and sex of the adolescent. Standard errors are clustered at the household level ($^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$).

Table A6: Effects of economic shocks at birth on cognitive outcomes and educational outcomes - asset ownership subset

	All	Boys	Girls	All	Boys	Girls
	(1)	(2)	(3)	(4)	(5)	(6)
			Reading skills			
	Reading score			Can't read Chichewa		
1 shock at birth	0.139	0.250	-0.030	-0.027	-0.059	0.029
	(0.209)	(0.300)	(0.303)	(0.095)	(0.129)	(0.151)
2 shocks or more at birth	-0.381	0.034	-0.900	0.259	0.127	0.445^{+}
	(0.377)	(0.517)	(0.557)	(0.169)	(0.237)	(0.246)
Observations	1468	742	726	1470	743	727
			Cognitive skills			
	Cognitive score			Score of 0		
1 shock at birth	0.041	0.162	-0.090	-0.023	-0.421^{+}	0.413^{+}
	(0.116)	(0.153)	(0.183)	(0.152)	(0.238)	(0.231)
2 shocks or more at birth	-0.312	-0.142	-0.498	0.516*	0.371	0.778*
	(0.211)	(0.254)	(0.321)	(0.224)	(0.312)	(0.350)
Observations	1219	610	609	1219	610	524
			Math skills			
	Math score			Score of 0		
1 shock at birth	-0.046	-0.025	-0.113	0.170	0.073	0.319
	(0.219)	(0.307)	(0.326)	(0.140)	(0.176)	(0.233)
2 shocks or more at birth	-0.638	-0.451	-0.932	0.264	-0.094	0.748*
	(0.404)	(0.545)	(0.588)	(0.221)	(0.311)	(0.328)
Observations	1439	727	712	1439	727	655
			Schooling			
	Educational attainment			Age for grade $\geqslant 3$		
1 shock at birth	0.015	0.119	-0.137	-0.002	-0.007	0.020
	(0.089)	(0.115)	(0.138)	(0.099)	(0.133)	(0.149)
2 shocks or more at birth	-0.115	0.215	-0.474^{+}	0.061	-0.043	0.218
	(0.174)	(0.215)	(0.271)	(0.183)	(0.260)	(0.269)
Observations	1480	748	732	1379	698	681

Note: The sample is derived from the ACE sample collected in 2017 and 2018. Economic shocks are reported by adolescent's household as part of the MLSFH collected in 2008 and 2010. All regressions control for age (in years) and region fixed effects, age and marital status of the caregiver at birth, educational level of the caregiver (no school, primary level of education, secondary level of education and higher of education), a continuous wealth score based on a subset of assets own by the household and sex of the adolescent. Standard errors are clustered at the household level ($^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$).

Table A7: Effects of economic shocks at birth on cognitive outcomes and educational outcomes - wealth score 2004

	All	Boys	Girls	All	Boys	Girls
	(1)	(2)	(3)	(4)	(5)	(6)
			Reading skills			
	Reading score			Can't read Chichewa		
1 shock at birth	0.119	0.214	-0.105	-0.002	-0.017	0.037
	(0.264)	(0.379)	(0.381)	(0.118)	(0.160)	(0.197)
2 shocks or more at birth	-0.487	-0.335	-0.733	0.423^{+}	0.358	0.562
	(0.500)	(0.629)	(0.818)	(0.218)	(0.293)	(0.361)
Observations	918	451	467	919	452	467
			Cognitive skills			
	Cognitive score			Score of 0		
1 shock at birth	0.042	0.107	0.007	-0.135	-0.526^{+}	0.236
	(0.147)	(0.181)	(0.235)	(0.182)	(0.277)	(0.303)
2 shocks or more at birth	-0.339	-0.081	-0.636	0.545*	0.276	0.820^{+}
	(0.295)	(0.341)	(0.439)	(0.271)	(0.375)	(0.429)
Observations	763	374	389	763	374	338
			Math skills			
	Math score			Score of 0		
1 shock at birth	-0.224	-0.177	-0.356	0.056	-0.183	0.238
	(0.279)	(0.391)	(0.416)	(0.173)	(0.217)	(0.289)
2 shocks or more at birth	-0.865	-0.452	-1.464^{+}	0.343	-0.072	0.906*
	(0.546)	(0.703)	(0.853)	(0.276)	(0.351)	(0.424)
Observations	893	439	454	893	439	422
			Schooling			
	Educational attainment			Age for grade $\geqslant 3$		
1 shock at birth	-0.023	-0.015	-0.098	-0.047	0.100	-0.177
	(0.113)	(0.145)	(0.172)	(0.121)	(0.168)	(0.178)
2 shocks or more at birth	-0.192	0.010	-0.476	0.072	0.091	0.093
	(0.237)	(0.275)	(0.420)	(0.251)	(0.337)	(0.411)
Observations	924	454	470	863	426	437

Note: The sample is derived from the ACE sample collected in 2017 and 2018. Economic shocks are reported by adolescent's household as part of the MLSFH collected in 2008 and 2010. All regressions control for age (in years) and region fixed effects, age and marital status of the caregiver at birth, educational level of the caregiver (no school, primary level of education, secondary level of education and higher of education), a continuous wealth index of the household measured in 2004 and sex of the adolescent. Standard errors are clustered at the household level ($^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$).

Table A8: Effects of economic shocks at birth on cognitive outcomes - not controlling for wealth score

	All	Boys	Girls	All	Boys	Girls
	(1)	(2)	(3)	(4)	(5)	(6)
			Reading skills			
	Reading score			Can't read Chichewa		
1 shock at birth	0.188	0.325	-0.024	-0.037	-0.075	0.042
	(0.208)	(0.291)	(0.304)	(0.092)	(0.123)	(0.146)
2 shocks or more at birth	-0.525	-0.066	-1.038*	0.313*	0.190	0.484*
	(0.362)	(0.497)	(0.522)	(0.159)	(0.231)	(0.225)
Observations	1543	786	757	1545	787	758
			Cognitive skills			
	Cognitive score			Score of 0		
1 shock at birth	0.060	0.158	-0.066	-0.001	-0.293	0.389+
	(0.116)	(0.147)	(0.186)	(0.144)	(0.210)	(0.220)
2 shocks or more at birth	-0.337	-0.137	-0.558+	0.501*	0.380	0.725*
	(0.209)	(0.250)	(0.316)	(0.218)	(0.306)	(0.341)
Observations	1277	644	633	1277	644	545
			Math skills			
	Math score			Score of 0		
1 shock at birth	0.027	0.082	-0.088	0.131	0.018	0.324
	(0.218)	(0.302)	(0.324)	(0.136)	(0.173)	(0.228)
2 shocks or more at birth	-0.652+	-0.501	-0.910+	0.224	-0.148	0.759*
	(0.386)	(0.531)	(0.552)	(0.213)	(0.309)	(0.314)
Observations	1512	770	742	1512	770	680
			Schooling			
	Educational attainment			Age for grade $\geqslant 3$		
1 shock at birth	0.056	0.165	-0.100	-0.041	-0.055	-0.008
	(0.089)	(0.115)	(0.136)	(0.096)	(0.129)	(0.145)
2 shocks or more at birth	-0.156	0.164	-0.470+	0.146	0.025	0.327
	(0.166)	(0.212)	(0.256)	(0.178)	(0.259)	(0.256)
Observations	1556	792	764	1449	738	711

Note: The sample is derived from the ACE sample collected in 2017 and 2018. Economic shocks are reported by adolescent's household as part of the MLSFH collected in 2008 and 2010. All regressions control for age (in years) and region fixed effects, age and marital status of the caregiver at birth, educational level of the caregiver (no school, primary level of education, secondary level of education and higher of education) and sex of the adolescent. Note that wealth score is not controlled for in these estimations. Standard errors are clustered at the household level ($^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$).

Table A9: Effects of economic shocks at birth on anthropometric characteristics of the adolescents measured in 2017/2018

	Height in cm			Height z-score		
	All	Boys	Girls	All	Boys	Girls
	(1)	(2)	(3)	(4)	(5)	(6)
1 shock at birth	0.463	0.066	0.953	0.080	0.020	0.141
	(0.504)	(0.661)	(0.764)	(0.072)	(0.091)	(0.110)
2 shocks or more at birth	0.647	0.447	1.014	0.094	0.080	0.143
	(0.837)	(1.159)	(1.193)	(0.122)	(0.167)	(0.177)
Observations	1499	767	732	1499	767	732

Note: The sample is derived from the ACE sample collected in 2017 and 2018. Economic shocks are reported by adolescent's household as part of the MLSFH collected in 2008 and 2010. All regressions control for age (in years) and region fixed effects, age and marital status of the caregiver at birth, educational level of the caregiver (no school, primary level of education, secondary level of education and higher of education), a continuous wealth index of the household and sex of the adolescent. Standard errors are clustered at the household level ($^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$).

Table A10: Effects of economic shocks at birth on anthropometric characteristics of the adolescents measured in 2008

	Height in cm			Height z-score		
	All	Boys	Girls	All	Boys	Girls
	(1)	(2)	(3)	(4)	(5)	(6)
Shock at birth	-0.940	-0.706	-0.766	-0.175	-0.115	-0.141
	(0.750)	(0.990)	(1.232)	(0.226)	(0.309)	(0.355)
Observations	313	157	156	313	157	156

Note: The sample is derived from the ACE sample collected in 2017 and 2018 and match to information collected in 2008 as part of the 2008 MLSFH survey. Economic shocks are reported by adolescent's household as part of the MLSFH collected in 2008 and 2010. All regressions control for age (in years), month of birth and region fixed effects, age and marital status of the caregiver at birth, educational level of the caregiver (no school, primary level of education, secondary level of education and higher of education), a continuous wealth index of the household and sex of the adolescent. Standard errors are clustered at the household level ($^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$).

Table A11: Effects of economic shocks on investment in education - including only shocks that occurred 2 years after the year of birth

	Total			Household			Others		
	All	Boys	Girls	All	Boys	Girls	All	Boys	Girls
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Extensive margin (Probit)									
Shock 2 years after birth	0.012	0.113	-0.122	0.049	0.163	-0.084	-0.027	-0.067	0.037
	(0.124)	(0.168)	(0.180)	(0.123)	(0.163)	(0.179)	(0.141)	(0.204)	(0.194)
Intensive margin (GLM)									
Shock 2 years after birth	-0.030	0.130	-0.147	-0.077	0.110	-0.234	-0.005	0.341	0.259
	(0.112)	(0.151)	(0.155)	(0.111)	(0.151)	(0.158)	(0.309)	(0.407)	(0.368)
Observations	692	333	359	694	334	360	694	333	361

Note: The sample is derived from the ACE sample collected in 2017 and 2018 for which we have information about the amount that were spent for their schooling. Economic shocks are reported by adolescent's household as part of the MLSFH collected in 2008 and 2010. All regressions control for age (in years) and region fixed effects, age and marital status of the caregiver at birth, educational level of the caregiver (no school, primary level of education, secondary level of education and higher of education), a continuous wealth index of the household, sex of the adolescent, total number of children present in the household, the total number of girls, the age order and the number of children that are reported in the educational investment module of the 2010 MLSFH survey. Standard errors are clustered at the household level ($^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$).

Table A12: Effects of economic shocks on investment in education - including also shocks that occurred 2 years after the year of birth

	Total			Household			Others		
	All	Boys	Girls	All	Boys	Girls	All	Boys	Girls
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Extensive margin (Probit)									
Shock at birth	0.023	-0.047	0.101	0.001	-0.081	0.090	-0.187	0.082	-0.616^{+}
	(0.183)	(0.238)	(0.262)	(0.182)	(0.235)	(0.263)	(0.209)	(0.270)	(0.344)
Shock 2 years after birth	0.014	0.110	-0.106	0.049	0.157	-0.070	-0.042	-0.061	-0.006
	(0.124)	(0.169)	(0.179)	(0.124)	(0.163)	(0.177)	(0.144)	(0.203)	(0.200)
Intensive margin (GLM)									
Shock at birth	-0.154	0.347	-0.475*	-0.051	0.223	-0.259	-0.625	0.740	-1.355*
	(0.174)	(0.253)	(0.225)	(0.173)	(0.265)	(0.215)	(0.470)	(0.925)	(0.677)
Shock 2 years after birth	-0.044	0.149	-0.200	-0.081	0.118	-0.257	-0.042	0.465	0.143
	(0.113)	(0.152)	(0.158)	(0.112)	(0.152)	(0.158)	(0.304)	(0.501)	(0.396)
Observations	692	333	359	694	334	360	694	333	361

Note: The sample is derived from the ACE sample collected in 2017 and 2018 for which we have information about the amount that were spent for their schooling. Economic shocks are reported by adolescent's household as part of the MLSFH collected in 2008 and 2010. All regressions control for age (in years) and region fixed effects, age and marital status of the caregiver at birth, educational level of the caregiver (no school, primary level of education, secondary level of education and higher of education), a continuous wealth index of the household, sex of the adolescent, total number of children present in the household, the total number of girls, the age order and the number of children that are reported in the educational investment module of the 2010 MLSFH survey. Standard errors are clustered at the household level ($^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$).

Table A13: Effects of economic shocks at birth on investment in education at the household level

	Mean investment on boys		Mean investment on girls	
	Boys	Girls	Boys	Girls
	(1)	(2)	(3)	(4)
Extensive margin (Probit)				
Shock at birth	0.028	0.466*	0.260	0.105
	(0.202)	(0.226)	(0.187)	(0.161)
Intensive margin (GLM)				
Shock at birth	0.264+	-0.014	0.206	0.141
	(0.148)	(0.157)	(0.163)	(0.159)
Observations	431	403	480	562

Note: The sample is derived from the ACE sample collected in 2017 and 2018 for which we have information about the amount spent on education at the household level. Economic shocks are reported by adolescent's household as part of the MLSFH collected in 2008 and 2010. All regressions control for age (in years) and region fixed effects, age and marital status of the caregiver at birth, educational level of the caregiver (no school, primary level of education, secondary level of education and higher of education), a continuous wealth index of the household, sex of the adolescent, total number of children present in the household, the total number of girls, the number of children that are reported in the educational investment module of the 2010 MLSFH survey as well as their average age and the one of the girls in the module. Standard errors are clustered at the household level ($^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$).

Table A14: Effects of economic shocks on the probability of being currently at school

	All	Boys	Girls
	(1)	(2)	(3)
1 shock at birth	0.173	0.475*	-0.135
	(0.165)	(0.241)	(0.231)
2 shocks or more at birth	0.032	0.627+	-0.653
	(0.284)	(0.351)	(0.423)
Observations	1554	792	658

Note: The sample is derived from the ACE sample collected in 2017 and 2018. Economic shocks are reported by adolescent's household as part of the MLSFH collected in 2008 and 2010. All regressions control for age (in years) and region fixed effects, age and marital status of the caregiver at birth, educational level of the caregiver (no school, primary level of education, secondary level of education and higher of education), a continuous wealth index of the household and sex of the adolescent. Standard errors are clustered at the household level ($^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$).