Weather shocks and childrens' school attendance: evidence from Uganda

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Abstract

Tremendous strides have been made recently in increasing childrens' schooling in developing countries by addressing endemic challenges such as lack of school infrastructure, human resource and high tuition costs that bar children from enrolling and attending school. However, increasing climate change induced weather shocks affecting household income present parents with a remarkle decision puzzle of wether to send their children to school or withdraw them to provide shock coping support at home. The usual household shock coping strategies such as reduction in consumption, increase in adult off-farm labour supply which then increases the demand for childrens' labour on-farm affect childrens' welfare. We use a high resolution spatial rainfall data from the Rainfall Estimates (RFE 2.0) database of the National Oceanic and Atmospheric Adminstration (NOAA) matched with the georeferenced 2009/10 and 2011/12 waves of the Uganda National Panel Survey (UNPS) to estimate the effect of negative rainfall shock on childrens' school attendance, using a fixed effect model. We find that prolonged negative rainfall leads to a significant reduction in childrens' school attendance by 0.9%. There are also significant gendered effects, for example we find that girls' school attendance is upto 7.6% lower than boys. These results have important policy implications for improving the schooling of children in areas that have endemic erratic rainfalls in Uganda.

Key words: weather shocks, consumption, childrens' school attendance, Uganda
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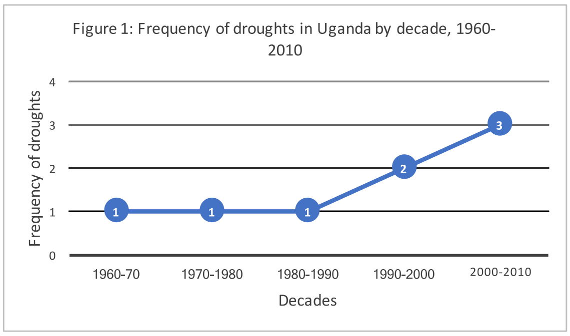
1. Introduction

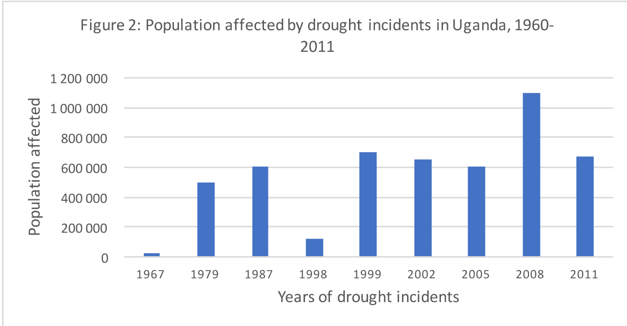
In the last three decades global efforts have galvanised to increase childrens' education in developing countries and this was initially espoused in the Millenium Development Goal two (MDG 2) and more recently in the Sustainable Development Goal four (SDG 4). These global development goals seek to promote childrens' school enrollement and attendance by addressing challenges such as lack of suitable school infrastructure, human resource in terms of teachers, teaching materials and high school tuition costs that prevent parents from sending their children to school (DeJaeghere et al, 2006; Boissiere, 2004; Verspoor, 2008). The desire to promote childrens' education has been inspired by the potential human capital development which has real benefits for improving individual welfare in addition to national economic development. For example using a cross section of countries, Barro (1991) shows that school enrollment taken as a proxy for human capital development is positively correlated with growth rate of real per capita growth of gross domestic product.

In line with the global development goals, Uganda introduced free universal primary education (UPE) in 1997 and ten years later in 2007 free universal secondary education (USE) (Uganda Ministry of Education and Sports, 1999). According to available data, primary school enrollement more than doubled within the first six years of the start of UPE program (ODI study). Due to special considerations in the program for girls and children with disabilities, their school enrollment also remarkably increased. Other empirical evidence by Deininger (2003) and Grogan (2008) show that the provision of free universal primary education in Uganda improved the school attendance of children who would otherwise previously not go to school especially those from poor households.

However there has been an increased frequency of climate change induced weather shocks in sub-Saharan Africa including Uganda which has experienced highly variable rainfall patterns over the past three decades exposing it to droughts[3] (Masih et al, 2014). The frequency of major drought incidences in Uganda increased from only one between 1980-1990 to three between 2000-2010 (figure 1). Frequent droughts generally weaken the coping capacity of people, thus with subsequent droughts, the number of people affected spirals upwards (De Haen and Hemrich (2007). This could partly explain the higher number of people affected by drought in 2008 because it came after three preceding drought incidents that affected the country in close succession in 1999, 2002 and 2005 (figure 2).

[3] The EMDAT database defines drought as "An extended period of unusually low precipitation that produces a shortage of water for people, animals and plants".





Source: EM-DAT: The Emergency Events Database (2018)

Households usually cope with these shocks by increasing off-farm labour supply (Rose, 2001; Ito and Kurosaki, 2009; Dimova et al, 2014), reducing consumption[4] (Kazianga and Udry, 2006), including reductions in expenses on childrens health and education (Skoufias et al, 2012; Björkman-Nyqvist, 2013). These coping mechanisms have both direct and indirect effect on childrens' school attendance. For example an increase in off-farm labour supply of adult household members may result in children being withdrawn from school to provide household labour or supply off-farm labour as well (Beegle et al, 2005; Gubert and Robilliard, 2007; Beegle et al, 2009). Beck et al, (2016) show that coffee price shocks causes coffee producing households in Vietnam to increase adult parents off-farm labour supply and childrens on-farm household labour supply. Additionally, a reduction in household expenditure on childrens' education directly affects their schooling (Jensen, 2000). In the face of free education and having to undertake shock coping strategies, we examine the decision puzzle parents have either to send their children to school or withdraw them to provide shock coping support at home.

We examine the impact of exogenous rainfall shocks on childrens' school attendance[5]. Studies have shown that school attendance is directly linked to higher educational attainment of children thus making it a good indicator to measure childrens schooling. For example Berlinski et al, (2009) show that childrens' attendance of preprimary significantly increases their mean test scores in the third grade by upto 8% in Argentina. Similarly, Ready (2010) shows that enhanced school attendance directly improves the literacy skills of children from disdvantaged socioeconomic backgrounds.

This paper makes three contributions to the literature. First, we provide a comparative analysis of childrens' school attendance in rural and urban areas. The current studies have tended to examine childrens' schooling in either rural (see for example Thai and Falaris, 2016; Jacoby and Skoufias, 1997; Gubert and Robilliard, 2007) or urban (see for example

[4] This generally tends to varry across wealth profiles – poorer households typically reduce consumption while wealthier households deplete savings at least in the immediate term (see Lawson and Kasirye (2013) for a deeper analysis of how the poor adjust their consumption and asset holding to cope with shocks). The reduction in household consumption is usually to smoothen the utilisation of the limited household resources and assets available to last for longer periods of time.

[5] We do not use school attainment for example because of the complexity in measuring it and our data does not contain enough information to sufficiently capture childrens' school attainment.

Akampumuza and Matsuda, 2017) areas. A comparative focus is necessary because of the socioeconomic differences between rural and urban areas. Even though most studies suggest a higher prevalence of poverty in rural than urban areas (Bird et al, 2002), with rapid urbanisation prevalence of poverty in urban areas is growing. The challenge for the urban dwellers is that the typical extended family and social networks that rural households rely on for help during shocks (Rosenzweig, 1988; Rosenzweig and Stark, 1989; Adams, 1993; Rosenzweig and Wolpin, 1994), are not quite as established in urban areas. These different social support mechanisms in rural and urban areas in the context of negative rainfall shocks may have complicated and different effects on childrens school attendance.

Secondly, we examine childrens' school attendance from primary to post-secondary education. This is especially necessary considering the finding of Björkman-Nyqvist (2013) that older girl children in primary school suffer more reduction in schooling compared to younger ones as a result of shocks. Current studies have mainly focused on school enrollment of young children in primary schools despite older children commonly being the first group households turn to for provision of household labour when shocks arise (Kruger, 2007). For example Zamand and Hyder (2016) analysed the effect of rainfall shocks on childrens' schooling but only covering children under the age of sixteen years. Additionally, older children are likely to require more scholarstic and educational support which may have higher cost implications than for example younger children or those in primary school. Excluding older children from childrens' school attendance studies may underestimate the true effect of shocks on childrens' school attendance.

Thirdly, we examine the lagged effect of shocks on childrens' school attendance[6]. The time lag examined in the current studies capture the effects of shocks during childhood on life time outcomes in adulthood. For example Maccini and Yang, 2009 examine the effects of early life rainfall shocks on the health, schooling and socioeconomic status of adults and find that more than average normal rains in childhood are directly correlated with good attainments on all those indicators especially for women in adulthood. We take a different approach in defining our shock lags which examines the immediate effect of the shocks on childrens school attendance. This is an interesting dimension to look at because later life outcomes crucially depend on childrens human capital formation in their childhood. This is different from the two points of examination in the study of Maccini and Yang, (2009) which looks at one point in childhood when a shock occured and examine adulthood outcomes for that child.

Our results show that school attendance of children only declines when the shocks are prolonged, relative to short term shocks. These results have important policy implications for improving the school attendance of children in areas that have endemic erratic rainfalls especially in the north eastern region of Uganda. The rest of the paper is organised as follows. In section 2, we present a brief literature summarising some of the current studies examining

[6] We define our lag period as the number of years the households experience negative rainfall shocks. As we construct a two wave panel dataset, we define two time lags (1) short shock (t); when the household suffers negative rainfall shock in the first wave i.e for one year (2) prolonged shock (t+2); when the household suffers negative rainfall shock in two consecutive waves i.e for two years.

effect of weather shocks on childrens schooling. This is followed by the definition of shock variable and the estimation strategy in section 3. We present the data and descriptive statistics in section 4 and estimation results and discussion in section 5. We then conclude the paper in section 6.

2. Weather shocks and childrens' schooling

A large part of the current literature examining the effect of shocks on household welfare, primarily focuses on household consumption and only looks at childrens welfare as a secondary element linked to the general decline of overall household welfare (see for example Skoufias et al, 2012; Asfaw and Maggio, 2017; Akampumuza and Matsuda, 2017). For example Asfaw and Maggio, (2017) and Akampumuza and Matsuda (2017) investigate how household consumption declines as a result of weather shocks in Malawi and Uganda respectively but only assert, in passing, that this reduces childrens' school attendance. This could be attributed to lack of individual level child data and the usual bias toward a household welfare focus. An earlier study by Björkman-Nyqvist (2013) atleast focusses on the effect of income shocks on childrens' schooling as a result of reduction of household non-food consumption which may include expenses on childrens' schooling. Similarly, Jensen (2000) studies effect of income shocks on childrens' educational attainment in the Ivory Coast using the Côte d'Ivoire Living Standards Survey of 1986 and 1987 and finds that school enrollment declines by about one-third to one-half for children aged 7-15 years old.

One of the biggest pathways that current studies cite as causing childrens' school attendance to decline is via engagement in work which effectively keeps them out of school and yet most of the studies only focus on primary school going children largely in lower primary that can seldom work. For example, Gubert and Robilliard, (2007) examine schooling decisions in rural Madagascar and find that children drop out of school to earn extra income for the household. Dillon (2012) studies child schooling responses to idiosyncratic production shocks in northern Mali and finds that it increases probability of withdrawal from school by 11% and participation in farm work by 24%. Importantly, Björkman-Nyqvist (2013) reports that older girl children especially in upper primary suffer a greater reduction in schooling compared to younger ones as a result of shocks to household income. By only focusing on younger children in primary schools who may not have the necessary physical capacity for work, the current range of studies may potentially underestimate the true effect of shocks on childrens' schooling in the household. In this study, we use a larger sample that includes all school attending children in the household from primary to post secondary level.

Prior literature has also provided some rural focus. For example, Jacoby and Skoufias (1997) find that for Indian agrarian households, income shocks significantly lower childrens' school enrollment. Gubert and Robilliard, (2007) examine schooling decisions in rural Madagascar and report that rainfall shocks significantly affect childrens' school dropout. They further note that parents generally allow their children to drop out of school to work to earn extra income for the household in order to smoothen household consumption. More recently, Thai and Falaris (2014) study the effect of rainfall shocks on childrens' schooling in rural VietNam and find that there is a gap of upto 0.392 years in childrens' schooling as a result of rainfall shocks. This focus on rural areas is understandable especially for developing countries where the World Bank estimates that more than 70% of the population are rural dwellers.

Evaluation of the evidence of the effect of shocks on childrens' schooling still shows some ambiguity. For example Ferreira and Schady (2009) in a detailed review of the empirical evidence of the effect of shocks on childrens' schooling find that the evidence is somewhat ambigous. For example on the specific indicator of childrens' school enrollment, they find that in developed countries, the evidence shows that it improves during shocks and in developing countries especially in Sub Saharan Africa, it drops. This could be explained by the likelihood of increased public investment in schools in developed countries whereas the same is not the case in developing countries particularly in sub Saharan Africa as the resources may not be there.

3.1 Data

We use the 2009/2010 and 2011/2012 waves of the UNPS data that is readily available for download from the World Bank website. The UNPS is part of the Living Standards Measurement Study – Intergrated Surveys on Agriculture (LSMS-ISA) project of the World Bank. The World Bank together with the Dutch government provided both technical and financial support to Uganda Bureau of Statistics which conducted the data collection on ground. The UNPS covers a wide range of topics from household, agriculture, livestock, women, community to the market. In our study, we mainly use the household and agriculture sections of the data by first merging the household and agriculture sections in one wave and then across the two waves (2009/2010 and 2011/2012) to create a panel data set for individual children in the households[7]. Detailed description of the construction of the panel is available upon request.Table 1 summarises the characteristics of our sample. In total our sample has 13292 children from 4310 households. Of the 14302 children, more than half i.e 6995 of them are boys and 6297 are girls.

[7] We construct an individual level panel of household children upto the age of 21 years. In Uganda, children usually start primary education at the age of 5 years (pre-primary nursery schools are not mandatory and often not even available for the vast majority of children in rural areas) and it takes 7 years to complete. Thereafter, secondary education takes 6 years and then post-secondary education can be anywhere from 2 years for lower qualifications to 3 years for undergraduate studies. Exceptions include some natural science and medical courses which take 4-5 years but only a very small proportion of students follow this path, thus we take the 3 year duration for the majority of students. Thereafore on average, a child in Uganda is expected to be in school upto the age of 21 years.

Table 1: Sample characteristics

Variable	2009/10	2011/12	Total
# households	2142	2168	4310
# children	6631	6661	13292
Male	3502	3493	6995
Female	3129	3168	6297
Regional distribution			
Central	0.29	0.26	0.27
Eastern	0.25	0.26	0.25
Northern	0.24	0.26	0.25
Western	0.22	0.23	0.22

Source: Authors calculations – UNPS Panel 2009/10 and 2011/2012

3.2 Rainfall shock

Uganda receives a bimodal type of rainfall with the first rainfall season starting from February to June / July and the second rainfall season starting from August/ September to November/ December. There is generally some slight variation in the start and end months of the rainfall seasons across the country. These have led to the sub division of the country into different agroecological zones depending on their specific rainfall seasons.

In defining our rainfall shock, we take two rainfall measures; current rainfall in the periods of our data (2009 and 2012) and long term average rainfall (2001-2008) and then calculate the negative deviation of current rainfall from its long term average as a shock[8]. Our current rainfall comes from the georeferenced rainfall data in the UNPS which comes from the National Oceanic and Atmospheric Adminstration's (NOAA) Climate and Prediction Center (CPC) rainfall estimates (RFE) database as our current rainfall. The current rainfall data in the UNPS is recorded at the enumeration area (EA) level and there are 320 EA's in our sample which is nationally representative[9]. We construct our long term average rainfall at EA level in two steps. We first extract rainfall data from the RFE 2.0 database from 2001 to 2008 (the last year preceding the year of our data, 2009). We then match this data to the EA level georeferences in the Uganda National Panel Survey (UNPS) data and calculate the average of the rainfall from 2001 to 2008 to generate our long term EA level average rainfall. Normally, long term average rainfall is computed using longer years but the RFE 2.0 database from which UNPS rainfall data are obtained only has available rainfall data from 2001 – present – which is relatively shorter compared to ten or more years generally used in some of the studies for computing long term average rainfall.

[8] We define our drought measure along the lines of Paxson (1992). Here drought is defined as a negative deviation of the current rainfall in an area from its long term average. We test the sensitivity of our rainfall data by running correlation tests between the rains in wave one (2009/2010) and wave two (2011/2012) and find a statistically significant positive correlation between the two.

[9] Unlike Paxson (1992) and other related studies that use rainfall data from local weather stations with usually serious missing data, we use a rich spatial rainfall data that has no missing observations and is recorded at lower geographical aggregation.

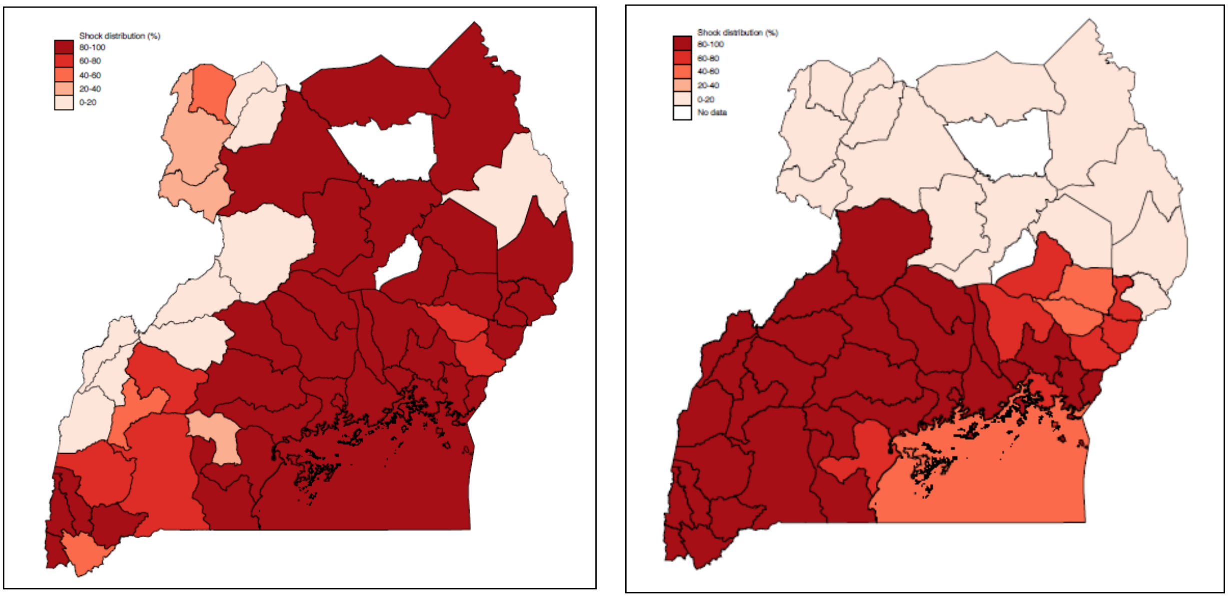
Prior studies, such as Paxson (1992), Skoufias et al, (1992), Skoufias and Vinha (2013) and Arslan et al, (2017) have however used rainfall data from local weather stations with a lot of missing data and higher geographical aggregation thus making it necessary to use data for much longer time periods. In contrast, the rainfall data used in this paper is more reliable, coming from spatial observation which has no missing data over the period of observation and is recorded at a lower geographical aggregation than the other studies. Recently some studies have tried to use the Africa Rainfall Climatology (ARC) 2.0 database which has a longer range of rainfall data (1983 - present) but the inputs for this database come from only two sources (specify the sources ??) as opposed to four in RFE 2.0. Technically, RFE 2.0 rainfall estimates have been shown to be of superior quality than the ARC 2.0 rainfall estimates (Novella and Thiaw, 2013). The calculation of our shock measure can be represented by the formula below;

$$x_e = ar_e - lr_e \qquad (1)$$

where *x* is the actual rainfall deviation from the long term average rainfall in an EA, *e*. *ar* is the actual rainfall recieved in an EA, and *lr* is the long term average rainfall recieved in an EA. Our shock measure takes the value of one if there is a negative deviation of *ar* from *lr*. Similarly, we also define short and prolonged shocks to account for lagged response of childrens' school attendance to shocks. A short shock is if the rainfall shock occurs in the enumeration area in the first wave only. A prolonged shock is if the shock occurs in an enumeration in the two waves. The distribution of shocks across the country in the two waves of our data is presented in figure 1 below.

Figure 1: Map showing distribution of rainfall shocks across the country

2009/2010 2011/2012



3.3 Estimation strategy

We estimate the effect of rainfall shocks on childrens' school attendance which is measured as school attendance using OLS fixed effects. The regression model is written as below;

$$y_{it} = \beta_0 + \beta_1 x_{et} + \beta_2 c_{it} + \beta_3 h_{it} + \beta_4 g_{it} + \mu_{it} \qquad (2)$$

where *y* is the school attendance of child, *i* in time, *t* (t=2009/2010 & 2011/2012). The school attendance[10] is a dummy that takes the value of one if the child is presently attending school and zero otherwise. The school attendance dummy has also been used in the study of Gubert and Robilliard, (2007) which examines the impact of shocks on childrens' schooling. *x* is a rainfall shock variable which is measured at the enumeration area *e*, level. The measure takes the value of one if there is a negative deviation of the current rainfall from its long term average in the enumeration area. In order to study the lagged response to shocks, we also define short and prolonged shocks. A short shock is if the rainfall shock occurs in the enumeration area in the first wave only. A prolonged shock is if the shock occurs in an enumeration in the two waves. β_1 is the parameter estimate that measures the effect of shocks on childrens school attendance.

c is a vector of child characteristics that include variables such as age and gender. Age is the number in years of the child and gender is a dummy which takes the value of one if the gender of the child is female and zero otherwise. β_2 is the parameter estimate that measures the effect of childrens characteristics on their school attendance. ***h*** is a vector of household and household head characteristics that may also affect childrens school attendance. The household characteristics include the household size, number of children, distance to school, geographical location (rural vs urban and regional location; central, eastern, northern and western) and poverty status. We use the national poverty threshold which ranges from US$1.36 to US$1.55 according to the different regions of the country which tend to have different costs of living and consumption patterns to define the poverty status of the household. The natioal poverty threshold in Uganda is approximately three quaters of the international extreme poverty threshold of US$ 1.90 which is broadly used to define poverty status in developing countries.

The household heads' characteristics include the age, gender, marital status and education. Age is the number in years of the household head. Gender of the head takes the value of one if female and zero otherwise. Marital status is a dummy variable which takes the value of one if the household head is married and zero otherwise. Our examination of the parental marital status is motivated by Astone and McLanahan (1991), who report that children who live in households with both parents married tend achieve more in school. We also include the highest level of education attained by the household head and this consists of a range of

[10] Related studies such as Jensen (2000), Ferreira and Schady (2009) and Björkman-Nyqvist (2013) have also used school enrollment which still indicates if children are attending school at the time of the interview.

mutually exclusive dummy variables which include; primary, secondary and post secondary education. β_3 is the parameter estimate that measures the effect of household and household head's characteristics on childrens schooling.

g is a vector of school level controls which includes school feeding and free tuition scholarship. School feeding is a dummy variable which takes the value of one if there is school feeding provided to the children and zero otherwise. Provision of food for children in schools has been shown to increase their school attendance (Jomaa et al, 2011). Similarly, tuition scholarship is a dummy variable which takes the value of one if children get a scholarship at school and zero otherwise. As noted earlier for two decades now, there has been free universal primary education provided in public schools in Uganda. Effectively, children who go to government aided schools receive a tuition scholarship. However, this scholarship does not provide other necessary school requirements such as scholarstic materials i.e. books, pens and school uniform. B_4 is the parameter estimate that measures the effect of school feeding and tuition scholarship on childrens school attendance. μ is the idiosyncratic error.

4.1 Descriptive statistics

Table 2 summarises the key descriptive statistics of childrens' demographics and school attendance. The average age of the children in our sample is roughly 11 and 13 years in the first and second waves respectively. Girls constitute 46% of the sample. Even though over 80% of the women in our sample are married, just under 30% of them head households. The average household size in our sample is about 8 persons and the average number of children per households is about 5. The household size in our sample appears to be slightly higher than the national average in studies which tends to range from 5-7 (Bongaarts, 2001). However, the household size in our sample is expected considering that our sample is constructed based on the presence of children in the household. Recent data shows that on average Ugandan women have about 5.68 children thereby explaining our average household size (World Bank, 2015). Estimates from early 2000's national fertility surveys and Demographic and Health Survey (DHS) put the fertility rate at 7.0 and 6.87 children per woman respectively (Blacker et al, 2005). Other household results show that the prevalence of poverty ranges from 27-38% for the two waves. This mean is close to the recent national poverty estimate of 27% by the Uganda National Bureau of Statistics (UBOS, 2017).

More than 79% of the children report school attendance[11] with the vast majority in primary school. This is consistent with the average age of children in the sample, just under 15 years, meaning they would be attending primary school in the Ugandan school system. Over 50% of the children report to be in receipt of a school scholarship. This could be attributed to the free universal primary education in Uganda now in which children attending government aided school have all their educational tuition paid for by the government. Less than 50% of the children report having school provided meals. There have been numerous attempts to provide

[11] Childrens' school attendance is taken as regular registration and going to school at the time of the survey.

school meals and it has been shown that school feeding programs improve children's school attendance and performance (Jomaa et al, 2011).

Our sample is roughly equally distributed across the different regions of Uganda. This is consistent with the nationally representative UNPS data which has been carefully designed to cover the whole country. The seemingly high attrition rate in the table below is largely attributed to the sample restrictions we impose on our data. As stated earlier, we only consider children upto the age of 21 years who are ordinarily expected to be going to school in Uganda. Considering that we have one year gap between the two waves of our data, some children who where 21 years old in the first wave would not be present in the second wave as they would have finished school. We also disagregate the descriptive statistics above of children's demographics and school attendance by gender (table 3). We pooled the means across the two waves, 2009/10 and 2011/12.

Table 2: Descriptive statistics of household children's schooling

Variable	2009/2010 Obs	Mean	SD	2011/2012 Obs	Mean	SD	Attrited Obs	Mean	SD
Children characteristics									
Female	4665	0.46	0.50	4665	0.46	0.50	1966	0.49	0.50
Age	4665	10.73	3.84	4665	12.67	3.82	1966	13.31	4.83
School attendance									
Never	4642	0.14	0.35	4665	0.04	0.20	1951	0.11	0.31
Past	4642	0.04	0.19	4665	0.08	0.28	1951	0.16	0.37
Current	4642	0.82	0.38	4665	0.87	0.33	1951	0.73	0.44
Current education level									
Primary	3825	0.88	0.32	4073	0.82	0.39	1435	0.71	0.45
Secondary	3825	0.12	0.32	4073	0.17	0.38	1435	0.26	0.44
Post secondary	3825	0.00	0.04	4073	0.01	0.10	1435	0.02	0.15
Household/ head's characteristics									
Female	4665	0.25	0.43	4665	0.28	0.45	1966	0.33	0.47
Married	4652	0.82	0.39	4665	0.81	0.39	1966	0.70	0.46
Household size	4665	7.98	2.96	4665	7.70	2.81	1966	8.42	3.82
Hh dependency ratio	4665	0.73	0.11	4665	0.74	0.11	1966	0.75	0.13
# Children in hh	4665	4.74	2.56	4665	4.54	2.54	1966	4.47	3.09
Girls ratio	4419	0.49	0.26	4359	0.48	0.26	1794	0.49	0.28
# children by age									
<5 yrs	4665	0.86	0.98	4665	0.73	0.90	1966	0.60	0.91
5-12 yrs	4665	1.97	1.42	4665	1.81	1.42	1966	1.59	1.60
13-18 yrs	4665	1.29	1.15	4665	1.35	1.13	1966	1.35	1.31
19-21 yrs	4665	0.31	0.59	4665	0.38	0.62	1966	0.49	0.73
Household assets value ('000 UGX)									
House	4645	8822	59201	4601	9283	44950	1951	9770	36456
Land	4645	15492	1E+05	4601	14567	55823	1951	13846	52786
Furniture	4645	280.7	1354	4601	267.4	850.4	1951	431.4	2319
Radio	4645	28.29	80.6	4601	28.6	75.57	1951	37.99	88.92
Poor household	4659	0.27	0.44	4651	0.38	0.49	1955	0.26	0.44
School scholarship	3814	0.65	0.48	4072	0.58	0.49	1409	0.55	0.50
School meal	3548	0.40	0.49	3060	0.30	0.46	1240	0.48	0.50
Rural	4665	0.81	0.40	4665	0.81	0.39	1966	0.76	0.43

Source: Authors calculations – UNPS Panel 2009/10 and 2011/2012

Table 3: Pooled sample descriptive statistics by gender

	Male			Female			Whole sample		
Variable	Obs	Mean	SD	Obs	Mean	SD	Obs	Mean	SD
Children characteristics									
Age	5011	11.85	4.00	4319	11.52	3.88	9330	11.70	3.95
School attendance									
Never	4996	0.09	0.29	4311	0.09	0.29	9307	0.09	0.29
Past	4996	0.07	0.25	4311	0.05	0.22	9307	0.06	0.24
Current	4996	0.84	0.37	4311	0.86	0.35	9307	0.85	0.36
Current education level									
Primary	4205	0.85	0.36	3693	0.85	0.36	7898	0.85	0.36
Secondary	4205	0.15	0.35	3693	0.15	0.35	7898	0.15	0.35
Post secondary	4205	0.00	0.07	3693	0.01	0.09	7898	0.01	0.08
Household/ head's characteristics									
Female	5011	0.26	0.44	4319	0.27	0.45	9330	0.27	0.44
Married	5003	0.82	0.39	4314	0.81	0.39	9317	0.81	0.39
Household size	5011	7.88	2.93	4319	7.80	2.84	9330	7.84	2.89
Hh dependency ratio	5011	0.74	0.11	4319	0.73	0.11	9330	0.74	0.11
# Children in hh	5011	4.66	2.57	4319	4.61	2.53	9330	4.64	2.55
# children by age									
<5 yrs	5011	0.79	0.94	4319	0.80	0.94	9330	0.79	0.94
5-12 yrs	5011	1.87	1.43	4319	1.91	1.42	9330	1.89	1.42
13-18 yrs	5011	1.35	1.14	4319	1.29	1.13	9330	1.32	1.14
19-21 yrs	5011	0.35	0.61	4319	0.34	0.60	9330	0.35	0.60
Household assets value ('000 UGX)									
House	4961	8755	42885	4285	9396	61963	9246	9052	52592
Land	4961	16364	1E+05	4285	13489	74404	9246	15032	89352
Furniture	4961	279.2	1189	4285	268.2	1062	9246	274.1	1132
Radio	4961	28.21	76.04	4285	28.71	80.5	9246	28.44	78.13
Poor household	4998	0.33	0.47	4312	0.32	0.46	9310	0.32	0.47
School scholarship	4201	0.62	0.49	3685	0.61	0.49	7886	0.61	0.49
School meal	3506	0.36	0.48	3102	0.34	0.48	6608	0.35	0.48
Rural	5011	0.81	0.39	4319	0.81	0.39	9330	0.81	0.39

Source: Authors calculations – UNPS Panel 2009/10 and 2011/2012

4.2 Regression results and discussion

4.2.1 Effect of shocks on childrens' school attendance in rural and urban areas

Table 4 summarises the results of the fixed effect estimation of the effect of rainfall shocks on childrens' school attendance dependent in rural and urban areas. The results show that rainfall shock leads to a significant reduction in childrens' school attendance in urban areas by upto 1.1% whereas in rural areas there is no significant change. This could be attributed to the lack of family and social network support system in urban areas that rural dwellers have. Urban dwellers have limited opportunities to borrow or get donations from extended family or relatives when shocks hit unlike people in rural areas. The challenge in urban areas has been further augmented by the growing urbanisation coupled with increased prevalence of poverty and undernutrition in urban areas is growing (Haddad et al, 1999). This can be seen by the results for poor households in urban areas in which childrens school attendance significantly declines by upto 1.8%. As expected, provision of school feeding increases childrens' school attendance in urban areas by upto 1%. Evidence on the impact of school feeding programs already indicates that it increases school attendance (Jomaa et al, 2011; Acham et al, 2012; Alderman et al, 2012).

Other results show that girls' school attendance is upto 7.6% lower than boys' in the national estimate and rises to 8.4% for rural areas. This is not entirely strange considering the patriachal context of Uganda which generally tends to favour boys rather than girls. It has been shown that in East Africa, more boys than girls generally enroll and attend primary and secondary schools which may suggest some household preferences discriminating against girls (Grant and Behrman, 2010). Looking at this result in the specific context of rainfall shocks when adult household members engage in shock coping activities such as off-farm labour supply, children end up being withdrawn from school to replace adult labour on-farm or in the household to do domestic work (Grant and Behrman, 2010; Beck et al, 2016). For example a domestic task such as fetching water has been documented to waste alot of girls time at home since they may have to walk longer distances to get water (Asaad et al, 2010). Effectively, household bias and increased demand for girls labour for household domestic work leads to a significant decline in their school attendance.

An interesting result is the household dependency ratio which increases childrens school attendance by upto 3.5% nationaly, rising to 5% in rural areas. Our definition of dependecy is based on age with people over 60 years and school going children upto the age of 21 years. The increase in childrens school attendance is logical considering the fact that since many elderly people in Ugandan society do not have formal retirement benefits, ordinarily they continue to work even when standard classification of dependents based on age would suggest otherwise. Effectively, when households suffer a rainfall shock, the so called dependent members of the household are able to provide additional support to cope with the shocks which then enables children to attend school.

Table 4: Effect of shocks on childrens' school attendance in rural and urban areas

		Location	
	All	Rural	Urban
Shock	-0.000	0.001	-0.011*
	(0.003)	(0.003)	(0.006)
Female - child	-0.076***	-0.084***	-0.007
	(0.022)	(0.024)	(0.056)
Female - hh head	-0.007	-0.009	0.003
	(0.007)	(0.009)	(0.013)
Married - hh head	-0.011	-0.014	-0.001
	(0.009)	(0.011)	(0.014)
# children in household	0.000	0.000	-0.001
	(0.001)	(0.002)	(0.003)
Hh girls ratio	-0.009	-0.008	-0.027
	(0.012)	(0.013)	(0.025)
Hh dependency ratio	0.035*	0.050**	-0.020
	(0.021)	(0.025)	(0.036)
Poor household	-0.005*	-0.005	-0.018**
	(0.003)	(0.003)	(0.007)
Hh assets (UGX): House	-0.000	-0.000	-0.000
	(0.000)	(0.000)	(0.000)
Land	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)
Furniture	-0.000	-0.000	-0.000
	(0.000)	(0.000)	(0.000)
Radio	0.000	-0.000	0.000
	(0.000)	(0.000)	(0.000)
School meal	0.003	0.001	0.010*
	(0.003)	(0.004)	(0.005)
School scholarship	-0.004	-0.004	0.000
	(0.003)	(0.004)	(0.006)
Wave 2	0.007***	0.007***	0.002
	(0.002)	(0.002)	(0.003)
Observations	8065	6598	1467
R-squared: Within	0.0169	0.0198	0.0461

The dependent variable is childrens' school attendance. Robust standard errors are in parenthesis. *p<0.10, ** p<0.05, *** p<0.01.

4.2.2 Effect of shocks on childrens' school attendance in the different age groups

Table 5 summarises the results of the fixed effect estimation of the effect of rainfall shocks on childrens' school attendance in the different age groups. The results show that there is a significant increase in school attendance of primary and post-secondary age children of 1.8% and 2.3% respectively. The increase in the school attendance of primary and post-secondary children could be explained by their age. First, primary children upto the age of 12 years are quite young and thus can not contribute much labour in the household to cope with the shock thereby freeing their time to attend school. This is consistent with the finding of Björkman-Nyqvist (2013) who shows that generally, older girl children suffer more decline in school attendance as a result of income shocks to the household than younger ones. Whereas, post-secondary education in Uganda usually entails children moving away from home to those institutions. Therefore, since they are away from home, they can be expected to continue to attend their school even when shocks hit the household.

School scholarship significantly reduces childrens' school attendance for the post-secondary age group. This result may appear to be counterintuitive but there is an explanation in the way post-secondary education is funded. In Uganda, most post-secondary education is tuition free, however this does not cover additional living costs for the children. So, in the context of rainfall shocks that destroy household income, parents may fail to cover the living costs for their children thus the decline in their school attendance even when they have school scholarship.

Similar to the results for estimates dependent on location, we also find that household dependency tends to significantly increase childrens school attendance. However, this appears to be driven by pre-schooling as the results for that age category is the only one that is significant. Similarly, the provision of school meals increases school attendance of primary and post-secondary children. On the other hand, household poverty also reduces childrens school attendance even though we do not see any significant results for any specific age group.

Table 5: Effect of negative rainfall shocks childrens' school attendance by age group

		Age group			
	All	<5 yrs	5-12 yrs	13-18 yrs	19-21 yrs
Shock	-0.000	-0.007	0.018*	-0.010	0.023**
	(0.003)	(0.005)	(0.009)	(0.007)	(0.010)
Female - child	-0.076***	0.006	0.000	0.002	-0.058
	(0.022)	(0.042)	(0.064)	(0.048)	(0.079)
Female - hh head	-0.007	-0.007	-0.007	-0.004	-0.002
	(0.007)	(0.015)	(0.028)	(0.019)	(0.021)
Married - hh head	-0.011	0.005	0.014	-0.000	0.022
	(0.009)	(0.020)	(0.028)	(0.020)	(0.035)
# children in household	0.000	-0.003	0.002	0.000	0.007
	(0.001)	(0.003)	(0.005)	(0.004)	(0.006)
Hh girls ratio	-0.009	0.004	0.011	-0.011	0.006
	(0.012)	(0.029)	(0.034)	(0.037)	(0.043)
Hh dependency ratio	0.035*	0.106**	0.021	-0.013	-0.003
	(0.021)	(0.051)	(0.059)	(0.053)	(0.065)
Poor household	-0.005*	-0.004	-0.000	-0.002	-0.006
	(0.003)	(0.006)	(0.011)	(0.008)	(0.012)
Hh assets (UGX): House	-0.000	-0.000	-0.000	0.000	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Land	0.000	-0.000	0.000	0.000	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Furniture	-0.000	0.000	-0.000	-0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Radio	0.000	-0.000	0.000	-0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
School meal	0.003	-0.000	0.021*	0.001	0.024**
	(0.003)	(0.007)	(0.011)	(0.010)	(0.010)
School scholarship	-0.004	-0.001	-0.015	0.001	-0.023*
	(0.003)	(0.008)	(0.010)	(0.010)	(0.012)
Wave 2	0.007***	0.003	0.009	0.003	0.018**
	(0.002)	(0.004)	(0.007)	(0.005)	(0.008)
Observations	8065	2136	1536	2051	1693
R-squared: Within	0.0169	0.0266	0.0661	0.0143	0.0880

The dependent variable is childrens' school attendance. Robust standard errors are in parenthesis. *p<0.10, ** p<0.05, *** p<0.01.

4.2.3 Effect of lagged rainfall shocks on childrens' school attendance

Table 6 summarises the results of the fixed effect estimation of the effect of lagged shocks on childrens' school attendance. The results show that short term shocks do not have any significant effect on childrens' school attendance. However, when the shocks are prolonged, childrens' school attendance significantly declines by upto 0.9%. A prolonged shock essentially leads to serious depletion of household assets (Kinsey et al, 1998; Kazianga and Udry, 2006) which in turn forces households to engage in drastic coping activities such as increasing off-farm labour supply (Rose, 2001; Ito and Kurosaki, 2009; Dimova, et al, 2014; Asfaw and Maggio, 2017). The increased household off-farm labour supply increases chances of children being withdrawn from school to provide household labour. Beck et al, (2016) show that increased off-farm labour supply by adult household members leads to children having to provide subsitute labour on-farm directly reducing their school attendance. This also explains the significant reduction in the school attendance of primary and post-secondary age children under prolonged shocks.

Additionally, the increased off-farm labour supply may also increase the likelihood of adult household members migrating thereby forcing children to provide substitute labour on-farm. A related study by Mu and Van de Walle (2011) shows that when men in households migrate off-farm, women tend to step in to fill the household labour gap. Similarly, it can be expected that when any adult household member migrates because of prolonged negative rainfall shocks, children then have to provide substitute labour at home which may reduce their school attendance. There is empirical evidence that household parents migration has a negative effect on children school attendance (Giannelli and Mangiavacchi, 2010).

The lagged results for estimation by location show that unlike previously, childrens' school attendance does decline in rural areas but only when the shock is prolonged. Even though people in rural areas have strong family and social networks for support when shocks hit (Rosenzweig, 1988; Rosenzweig and Stark, 1989; Adams, 1993; Rosenzweig and Wolpin, 1994), other studies such as Moser (1998) and Devereux (1999) have shown that these support networks are declining across sub Saharan Africa. This could be explained by the likelihood that asset reserves of those who provide this support get depleted and thus the recipient households consumption suffers which effectively leads to a decline in their childrens' school attendance. Further to the previous result for urban areas which shows that childrens' school attendance declines, these results show that they only decline in the short term.

Table 6: The effect of lagged shocks on childrens' school attendance

	All	Location		Age group			
		Rural	Urban	<5 yrs	5-12 yrs	13-18 yrs	19-21 yrs
Short shock	0.003	0.006	-0.018*	-0.011	0.029*	-0.018	0.034*
	(0.005)	(0.005)	(0.009)	(0.010)	(0.017)	(0.013)	(0.018)
Prolonged shock	-0.009**	-0.011**	-0.001	0.001	-0.032**	-0.000	-0.031**
	(0.004)	(0.005)	(0.007)	(0.009)	(0.015)	(0.011)	(0.015)
Female - child	-0.074***	-0.081***	0.001	0.007	0.000	-0.001	-0.046
	(0.022)	(0.024)	(0.056)	(0.042)	(0.064)	(0.048)	(0.079)
Female - hh head	-0.005	-0.007	0.005	-0.005	-0.001	-0.001	0.007
	(0.007)	(0.009)	(0.013)	(0.016)	(0.028)	(0.020)	(0.022)
Married - hh head	-0.010	-0.014	0.001	0.004	0.021	-0.002	0.017
	(0.009)	(0.011)	(0.014)	(0.021)	(0.029)	(0.020)	(0.035)
# children in household	0.000	0.000	-0.001	-0.002	0.001	-0.000	0.006
	(0.001)	(0.002)	(0.003)	(0.003)	(0.005)	(0.004)	(0.006)
Hh girls ratio	-0.010	-0.008	-0.028	0.002	0.013	-0.012	0.015
	(0.012)	(0.013)	(0.025)	(0.030)	(0.034)	(0.037)	(0.043)
Hh dependency ratio	0.035*	0.050**	-0.020	0.106**	0.027	-0.005	0.003
	(0.021)	(0.025)	(0.036)	(0.051)	(0.059)	(0.054)	(0.065)
Poor household	-0.005*	-0.005	-0.018**	-0.003	0.000	-0.003	-0.001
	(0.003)	(0.003)	(0.007)	(0.006)	(0.011)	(0.008)	(0.013)
Hh assets (UGX): House	-0.000	-0.000	-0.000	0.000	-0.000	-0.000	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Land	0.000	0.000	0.000	-0.000	0.000	0.000	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Furniture	-0.000	-0.000	-0.000	0.000	-0.000	-0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Radio	0.000	-0.000	0.000	-0.000	0.000	-0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
School meal	0.003	0.001	0.010*	-0.000	0.023**	-0.000	0.023**
	(0.003)	(0.004)	(0.005)	(0.007)	(0.011)	(0.010)	(0.010)
School scholarship	-0.003	-0.004	-0.001	-0.001	-0.014	0.001	-0.024*
	(0.003)	(0.004)	(0.006)	(0.008)	(0.010)	(0.010)	(0.012)
Wave 2	0.012***	0.014***	0.000	0.000	0.031**	0.000	0.037**
	(0.003)	(0.004)	(0.006)	(0.008)	(0.013)	(0.010)	(0.014)
Observations	8065	6598	1467	2136	1536	2051	1693
R-squared: Within	0.0193	0.0226	0.0514	0.0276	0.0733	0.0182	0.0845

The dependent variable is childrens' school attendance. Robust standard errors are in parenthesis. *p<0.10, ** p<0.05, *** p<0.01.

6. Conclussion

Our results show that negative rainfall shocks lead to significant reduction in childrens school attendance in urban areas. Additionally, the results also show that only prolonged shocks significantly reduce childrens school attendance. Contrary to the prevailing assertions that tend to suggest that shocks have more welfare impacts in rural areas, we show that specifically for childrens school attendance, there is decline in urban areas as opposed to rural areas. This could be attributed to the growing incidence of urban poverty. Besides, the urban poor lack the extended family and social networks that rural poor can rely on to cope during shock events. These results have serious implications for policies aimed at promoting childrens education in urban areas and areas that receive eratic rainfalls such as the north eastern region and the cattle corridor of Uganda.

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