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School, work or marriage?

Agricultural shocks and gender gaps in child development

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School, Work or Marriage? Agricultural Shocks and Gender Gaps in Child Development

Andre Groeger and Hanna Wang*

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Abstract

Using detailed child-level panel data and geo-coded data on agricultural weather and price shocks from Uganda, we examine how decisions regarding girls' and boys' schooling, employment and marriage respond to changes in household income and labor opportunities. Using a quasi-experimental approach involving changes in rainfall and commodity prices, we compute the effects of changes in agricultural income on each of the key outcomes. We develop a dynamic discrete-choice household model and target the causal effects in the estimation. We then evaluate a range of policies aimed at improving child welfare, paying particular attention to differential effects on girls compared to boys. Policies considered are conditional cash transfers for children to go to school and penalizing underage marriage and child labor.

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1 Introduction

In many low-income, agricultural-based economies, daughters receive differential treatments to sons when it comes to schooling, marriage and employment. These childhood outcomes have decisive consequences for the welfare of women relative to men in adult society and result in multifaceted gender-gaps. It is important to examine these key outcomes in conjunction, because they are tightly linked through time and monetary constraints, implying that policies affecting one outcome are likely to affect the others, too. For example, Field and Ambrus (2008) find that marrying later increases girls' education, which suggests that enforcing minimum marriage age laws not only decreases child marriage but also increases schooling. Our goal is to perform a comprehensive study by creating a unified theoretical framework that takes into account these interdependencies in household decisions. We combine quasi-experimental approaches and structural modelling which allows us to (1) examine the effects of agricultural shocks (identified from rainfall and international commodities data) on gendered household decisions for girls' and boys' child development, (2) based on these results construct a dynamic decision framework for child investments, and (3) make use of this framework to conduct counterfactual policy simulations

The setting we choose to study is Uganda, one of the worst performing countries in terms of gender equality and where children frequently quit school in order to work for a wage or take over household chores. More than one fifth of children are not enrolled in school at age 15, with young girls substantially less likely to attend school compared to their male peers (Morrow, 2013). Furthermore, formal and informal child labor are prevalent and many girls marry underage, which generally implies a premature end to their education. Consequently, there is a large scope for improvements through well-designed policies. Moreover, as agriculture is often the main source of income in Uganda, especially in rural communities, we can make use of agricultural shocks as wealth-shifters.

2 Literature Review

Following Todd and Wolpin (2006), this paper is one of few to combine rigorous quasi-experimental evidence with structural estimations and policy simulations. This approach carries significant benefits. It exploits exogenous variation in agricultural income to directly estimate the effect on the outcomes of interest. These causal effects are then employed in the estimation of a structural model, contributing to its credible identification. Because the model internalizes the interplay between household wealth and the key decisions regarding children, it is useful for evaluating the effects of novel or even hypothetical policies.

As a result, this project contributes to both the regression-based and structural literature on child labor, education and child marriage in developing countries. In particular, several papers have used quasi-experimental methods to study causal effects of negative rainfall shocks on a subset of the three outcomes. With respect to child education outcomes, for example, Björkmann-Nyqvist (2013) finds that extreme droughts in Uganda decrease female enrollment in primary schools. Maccini and Yang (2009) study the effect of early-life rainfall on adult outcomes. They find that higher rainfall increases health, schooling completion and later life wealth outcomes for women, but not for men.

There is a growing literature looking at child labor outcomes. For example, Marchetta et al. (2019) document for Madagascar that negative rainfall shocks encourage young women to work rather than go to school, especially among poorer households. Beegle et al. (2006) study the impact of negative agricultural shocks on child labor in Tanzania and find evidence that the former leads to increases in the latter. Shah and Steinberg (2017) find for rural India, that children switch out of school into productive work when rainfall is higher.

Finally, there is a small but growing literature looking on child marriage. For example, Corno et al. (2020) find that negative weather shocks make early child marriage in Sub-Saharan Africa and India more likely. Corno and Voena (2021) study the relationship between child marriage and income shocks in Tanzania. They find that that adverse weather

shocks during teenage years increase the probability of early marriages among girls.

Only few studies have made use of dynamic structural models in development economics (see Todd and Wolpin (2010) for an extensive survey). For example, previous work has studied conditional cash transfers to increase student or teacher attendance (Todd and Wolpin (2006) in Mexico and Duflo et al. (2012) in India) and insurance against harvest cycle (Rosenzweig and Wolpin (1993) in India).

The main innovation of this project will thus be to combine two state-of-the-art approaches, quasi-experiments and structural estimation, and apply them to an empirical topic of first order priority for international development. Due to the interdependency among education, child labor and child marriage, such an approach allows the holistic evaluation of the effects of policy interventions.

3 Data

We use data from the Living Standards Measurements Study (LSMS) from Uganda, a panel data set that collects detailed information on a representative sample of households across 1333 sub-counties in Uganda. The survey spans 16 years and 8 waves (2005-2020), observing 8245 children in various stages of their childhood. For each child it records schooling decisions, work activities, wages and marriage outcomes. This information is complemented by child development measures such as height and weight and test scores.

Summary statistics for the sample of children aged 6-18 are shown in Table 1. Although most children are attending school, a large share also work on family farm. This can also be seen from the hours spend doing agricultural work: boys spend on average 3.4 and girls 2.8 hours on agricultural activities. Wage work on the other hand less common, only 3% of all children pursue it. A significant amount of time is also spend on domestic activities, girls work around 8 and boys around 5 hours performing household chores. Child marriage is somewhat common for girls, around 15% are married by age 18, while the number of

married boys is negligible.

Table 1: Summary: Children

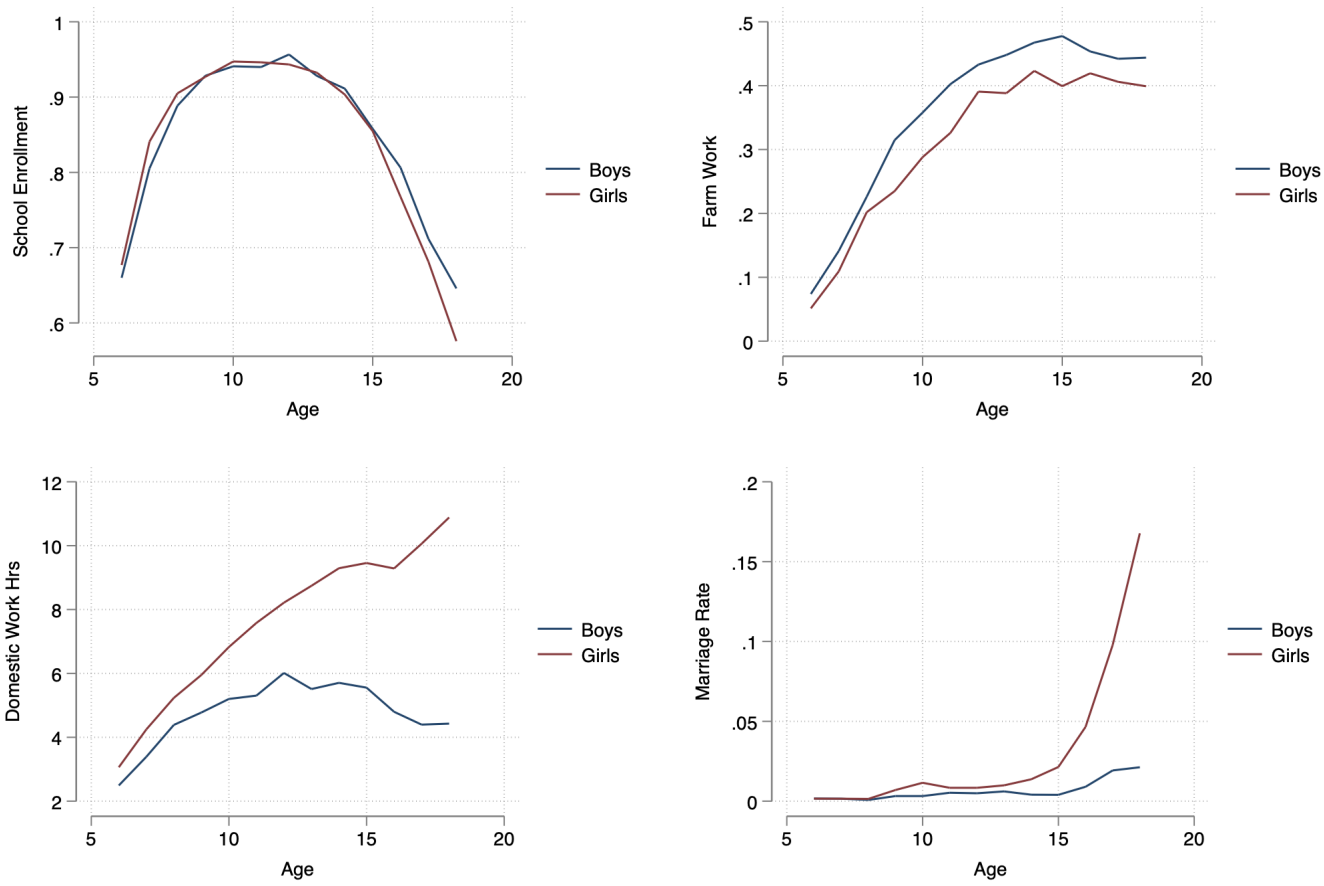
	Boys					Girls				
	Mean	Min.	Max.	S.D.	Obs.	Mean	Min.	Max.	S.D.	Obs.
Age	11.86	6.00	18.00	3.68	27050	11.75	6.00	18.00	3.68	28608
In School	0.85	0.00	1.00	0.36	24824	0.85	0.00	1.00	0.36	25484
Working for Wage	0.03	0.00	1.00	0.18	19211	0.02	0.00	1.00	0.15	19079
Working on Farm	0.38	0.00	1.00	0.49	19209	0.33	0.00	1.00	0.47	19079
Hours in Agr.	3.41	0.00	70.00	7.47	13712	2.83	0.00	66.00	6.59	13378
Hours Domestic	4.97	0.00	65.00	5.67	10408	8.03	0.00	70.00	8.29	10165
Married at 18	0.01	0.00	1.00	0.12	1651	0.15	0.00	1.00	0.35	1616

Sample covers children in all waves 2005, 2009, 2010, 2011, 2013, 2015, 2018, 2019. In School indicates whether child is currently attending school, Working for Wage indicates whether child is employed elsewhere, Working on Farm indicates whether child is working on the family farm. Hours in Agr. and Hours Domestic are the hours child spends working in agricultural or domestic activities.

Figure 1 further shows how outcomes vary by age for boys and girls. The top-left panel shows that enrolment is U-shaped. Almost all children (close to 95%) are enrolled between the ages 9 and 14, however by age 17 only roughly 70% are enrolled. Moreover, enrolment rates are almost identical for boys and girls. The top-right panel shows the proportion of children active in agriculture increases with the child's age, from less than 10% at age 6 to around 45% at age 18. Girls are around 10% less likely to be working on farms than boys from age 8 onwards. For hours spent with domestic chores, the gender difference is even more stark. The lower left panel shows that while girls aged 15 and above spent around 10 hours weekly on chores, for boys this number falls after age 15 with an average of around 5 weekly hours. Lastly, the lower right panel shows that some girls are married off between the ages of 15 and 18. For boys the proportion is negligible.

On the household level there is information on the composition, parental education, income, expenditures, agricultural land and crop portfolio. Table 2 shows the households' composition and characteristics of the household head. On average the head has complete seven years of education which is equivalent to having completed primary school in Uganda. Households tend to be quite large, with on roughly six members per household of

Figure 1: School Enrolment, Farm Work, Domestic Work Hours and Marriage Rate by Age and Gender



which two or three are children.

Table 2: Summary: Household

	Mean	Min.	Max.	S.D.	Obs.
HH Head Age	45.79	0.00	107.00	15.61	23976
HH Head Edu.	7.16	1.00	14.00	2.88	16597
No. of HH Members	6.20	1.00	58.00	3.68	24223
No. of Children	2.34	0.00	22.00	2.10	24223

We merge these data with village- and household-specific shocks to agricultural income from two sources of data: rainfall data and international commodity prices. For the former we use precipitation data from the Climate Hazards Group InfraRed Precipitation with Station (CHIRPS) project (Funk et al., 2015). These high-resolution (approximately 5 km at the equator) data allows us to generate fine-grained measures of rainfall deviations from the historical mean for specific regions of Uganda and for specific reference periods during the cropping season preceding the household survey measures. For the latter, combine household crop portfolios in the baseline period from the LSMS and yearly commodity prices in producing countries between 1991 and 2016 (Agricultural Producer Prices, APP, FAO). Together these data allow us to construct shock to agricultural returns that are orthogonal to local agricultural conditions.

4 Methodology

The empirical analysis consists of two parts. First, we identify and estimate the causal effect of agricultural shocks on household decisions of children's education, labor (informal and formal), and marriage. Second, we use the results from the first part to build and estimate a structural model of the household's decision regarding the child. This allows us to study the dynamic trade-offs between children's education, labor and marriage. Finally, with the help of the model, we evaluate a range of different policies in their effectiveness of decreasing child labor and child marriage.

The first part has two components: variation in agricultural income through rainfall deviations and changes in commodity prices. For the former, we construct a continuous and high-resolution proxy of drought and flood severity by means of the Standardized Precipitation Index (SPI). For the latter, in the spirit of Imbert et al. (2021), we combine households' crop portfolios in the baseline period with exogenous changes in international prices in a shift-share design to construct an exogenous shock to agricultural returns of rural households in Uganda.

To analyze the effects of agricultural shocks on household and individual outcomes, we match the shocks to the household-specific location and agricultural activities, respectively. The reference period of each shock will be aligned to that of the survey period (i.e. typically the 12 months leading up to the household interview). The following baseline equation is then estimated:

$$Outcome_{ist} = \beta_0 + \beta_1 Shock_{it-1} + \alpha X_{it} + \gamma_{st} + \epsilon_{ist}$$

where i indexes the child, s stands for the sub-county, and t indexes time. The dependent variables will be child outcomes schooling, work and marriage. The household-specific shocks are captured by the two measures during the given reference period. X_{it} is a vector of time-varying socio-demographic control variables of the household and its members, such as the household demographic composition. γ is a set of region-time specific fixed effects to absorb potentially confounding changes at the level of the region. ϵ_{ist} is the error term with standard errors clustered at the village level, given that there may exist some spatial correlation in the shock measures. , our parameter of interest, estimates the effect of the shocks on the respective outcome variable. In this estimation approach, our identification comes from variations in shock exposure across households within each region caused by variations in rainfall shocks across space or household heterogeneity in baseline cropping patterns.

The results from the first part and insights from aggregate statistics of the data will form the basis for developing a dynamic structural model of household decisions on labor, ed-

ucation, and marriage at different stages of a child's life. Using the model, we can examine how decisions are dynamically interlinked, taking into account current and future expected shocks to household income. The main goal is to study the substitution patterns among education, child labor, and marriage, and particularly how they vary across households with different characteristics. For example, if child marriage becomes more costly (for example due to a fine), it is unclear to what extent the households will be inclined to send their daughter to school more or to work more.

The outline of a basic model is as follows. The model is set up to have discrete choices made at two stages. The first stage spans ages 6-12 of the child; at this stage households choose between letting their child attend school or go to work. In the second stage the child is aged 13-18 and the decision is between school, work, and marriage (the latter is mostly relevant for girls who leave the household and stop their education upon marriage). At each stage, the household derives a flow utility that depends on the contemporaneous choice and income shocks. For each stage, the household must satisfy its budget constraint, such that household income (from agriculture, child labor) must cover all expenses (per-capita household consumption, school fee). Households make choices to maximize their utility subject to the budget constraint, taking into account that present actions affect future values.

The various choice options have different implications on household utility and the budget constraint. If the child goes to school, it accumulates human capital which implies higher utility at later stages because of better employment opportunities. Moreover, education can improve marriage outcomes. In contrast, child labor provides the household temporarily with additional income but forgoes human capital accumulation and increasing future returns. Marriage implies that the child will leave the household, thereby eliminating its contributions to income as well as consumption. When experiencing a negative income shock due to adverse agricultural conditions, a household might decide to marry their child because they cannot afford to pay for its consumption. Another option would be to have it work to earn additional income, the choice will depend on the income and marriage opportunity.

Depending on the household characteristics such as parents' education and number of children and adults present, households face different incentives when making decisions for their child. Parents with higher education earn higher income and might be more likely to send their child to school than to work or get married. There can be additional younger siblings in the household, who decrease per-capita consumption and increase the need for wages from child labor as well as assistance with household chores. In order to capture differential cultural customs and labor market opportunities for girls compared to boys, the model's parameters are allowed to differ by the child's gender.

The model is estimated using the Simulated Method of Moments (McFadden (1989)), targeting as moments the effects estimated from the first part, also known as indirect inference (Gourieroux, Monfort and Renault (1993)), as well as aggregate statistics by household and child characteristics. Some examples are the proportion of children working or in school conditional on the child's gender, household income or parental education.

With the estimated model we am then able to simulate a range of potential policy interventions and examine effects by gender. For example, we can study whether conditional schooling transfers can effectively increase school attendance and at the same time decrease the number of children working or instances of child marriage. Other relevant policies we can evaluate are penalizing underage age marriage or child labor. Either of these could have unintended consequences, for instance the former could increase child labor but not schooling, and the latter could force girls into marriage. Furthermore, the model allows us to retrace the dynamic mechanisms of different policies, for instance, does enforcing school attendance during ages 6-12 decrease child labor during ages 13-18? The possibility to flexibly evaluate the contemporaneous and future effects for changes various aspects of policy is one important advantage of the structural approach.

5 Results

5.1 Agricultural Shocks

5.1.1 Rainfall in the last 12 Months

We now present preliminary reduced-form results, showing how schooling, child labor and child marriage responds to changes in rainfall in the last 12 months.

For this, we construct different measures of rainfall. The first is precipitation in 1000 mm and the second is the Standardized Precipitation Index (SPI), which is constructed as the standardized deviation of actual precipitation in a sub-county (s) during the 12 months prior to the interview from its long-term mean (1981-2021). From this measure, we also calculate a drought indicator that takes value one if SPI falls below -1.

Table 3 shows the results on whether the child is currently enrolled in school, whether the child is doing any farm work and how many hours the child spent doing farm work. We can see that more rainfall seems to increase both schooling and hours spent on farm work. The coefficients for the effect on the extensive margin of farm work have the same signs as those for the intensive margin but are insignificant. These findings can be explained by the fact that higher rainfall increases agricultural production and therefor household income, allowing families to spent more resources on schooling of children. At the same time, returns to farming might increase, prompting households to increase the time children spent working.

At the same time, higher rainfall results in fewer hours spent on domestic chores. The effect is roughly the same size as the increase in time spent in farm work. If yearly precipitation increases by 1000 mm (roughly a 80% increase) children's enrolment would increase by 2.6 percentage points, weekly hours spend on agricultural activities would increase by 1.6 hours while time spent on domestic chores would decrease by 1.4 hours.

Overall, the drought measures has the opposite effect as the direct measure of precipi-

tation and the SPI but is insignificant for all regressions. The direct precipitation measure appears to have the highest significance out of the three measures, thus we use it to perform the analysis separately for girls and boys.

Table 3: The Effect of Rainfall on Children's Schooling, Farm Work and Farm Work Hours

	School			Farm Work			Farm Work Hrs			Dom. Work Hrs		
Precip.	0.026*			0.033			1.606**			-1.390*		
	(0.015)			(0.041)			(0.772)			(0.797)		
SPI		0.005*			0.006			0.202			-0.240*	
		(0.002)			(0.007)			(0.122)			(0.126)	
Low SPI			-0.002			-0.002			-0.158			0.079
			(0.005)			(0.012)			(0.260)			(0.324)
Obs.	47701	47701	47701	36396	36396	36396	26051	26051	26051	20100	20100	20100

$^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$. Standard errors in parentheses. All rainfall measures are for the twelve months previous to the interview month and vary at the sub-county level. Precipitation is measured in 1000 mm, SPI is the z-score, Low-SPI indicates an SPI below -1. Sample covers all children aged 6-18 in all waves. Regressions control for household, year and month fixed effects, age dummies, urban dummy, household size, number of children and child's gender.

Table 4 shows the regression results differ substantially by child gender. Boys are more likely to be enrolled in school following a year with relatively high rainfall, while the effect is smaller and insignificant for girls. For boys an increase of 1000 mm in rainfall results in an 4 percentage point increase in enrolment. It is further evident that this comes at the expense of girls working more in agriculture, both extensively and intensively. Girls are 8 percentage points more likely to do farm work and work 1.5 hours more per week. These estimates are both significant at the 10 % level. For boys, the effects are not significant, but the estimate for farm hours is of similar size. To compensate for more farm work, girls decrease the time spent on domestic chores by 1.9 hours. For boys, the the effect is also negative but insignificant.

Table 4: The Effect of Rainfall on Girls' and Boys' Schooling, Farm Work, Farm Work Hours and Domestic Work Hours

	Boys				Girls			
	School	Farm Work	Farm Hrs	Dom. Hrs	School	Farm Work	Farm Hrs	Dom. Hrs
Precip.	0.040**	-0.014	1.348	-1.093	0.011	0.083*	1.496*	-1.932*
	(0.020)	(0.049)	(1.112)	(0.876)	(0.017)	(0.049)	(0.782)	(1.135)
Obs.	23966	18491	13288	10239	23733	17905	12763	9861

$^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$. Standard errors in parentheses. Precipitation is measured in 1000 mm for the twelve months previous to the interview month and varies at the sub-county level. Sample covers all children aged 6-18 in all waves. Regressions control for household, year and month fixed effects, age dummies, urban dummy, household size, number of children and child's gender.

The results can further be broken down for younger and older children. Table 5 shows the regressions separately by gender and age group. It is apparent that the positive effect on boys' enrolment is concentrated among older boys in the 12-18 age group. Girls in the same age group increase enrolment by half as much, although the effect is not significant. Older girls make up for most of the increase in farm work, their hours increase by 2.7 and the likelihood to work by 11 percentage points. Younger girls enjoy a reduction in domestic chores by 2.9 hours per week, the largest out of all the groups.

Table 5: The Effect of Rainfall on Girls' and Boys' Schooling, Farm Work, Farm Work Hours and Domestic Work Hours By Age Group

	Boys				Girls			
	School	Farm Work	Farm Hrs	Dom. Hrs	School	Farm Work	Farm Hrs	Dom. Hrs
Ages 6-11								
Precip.	0.024	-0.005	0.392	-1.187	-0.008	-0.005	0.064	-2.891*
	(0.027)	(0.060)	(1.019)	(1.189)	(0.026)	(0.066)	(0.940)	(1.713)
Obs.	11472	6971	5199	3744	11740	6925	5169	3723
Ages 12-18								
Precip.	0.065*	-0.047	1.485	-1.049	0.036	0.112*	2.745**	-1.083
	(0.034)	(0.063)	(1.463)	(1.188)	(0.029)	(0.060)	(1.135)	(1.329)
Obs.	12494	11520	8089	6495	11993	10980	7594	6138

*$p < 0.10$, **$p < 0.05$, ***$p < 0.01$. Standard errors in parentheses. Precipitation is measured in 1000 mm for the twelve months previous to the interview month and varies at the sub-county level. Sample covers all children aged 6-18 in all waves. Regressions control for household, year and month fixed effects, age dummies, urban dummy, household size, number of children and child's gender.

Now we turn to the remaining key outcome for girls, child marriage. This can be identified from the LSMS survey either because the girl continues to be interviewed once she marries or because other household member respond that she left he household due to marriage. Using this information we create an identifier that takes value one when the girl is married in the current wave but was unmarried in the previous wave. Because we do not know the exact age at which the girl married and separate waves can be one to four years apart, we examine girls' marital status up to age 20. So if she is newly married at age 20, she could have gotten married at age 16 to 19. We include girls from age 10, as getting married at even earlier ages is unlikely.

We explore the effect of different rainfall measures on the probability of girls' marriage in Table 6. All measures are significant at least at the 5% level and indicate that higher rainfall leads to greater marriage rates among girls. In particular a 1000 mm increase in precipitation in the last 12 months increases the probability that the girl is married this period

by 2.5%. Again, the direct precipitation measure has the highest significance. Combined with the previous result on increased farm work of older girls, this result might suggest that girls are more demanded on the marriage market in order to take care of plots. Generally, wives tend to be responsible for growing crops while husbands raise cattle, which sometimes forces them to migrate to other areas seasonally.

Table 6: The Effect of Rainfall on Girls' Marriage Probabilities

	Get Married		
Precip.	0.025***		
	(0.009)		
SPI		0.004**	
		(0.001)	
Low SPI			-0.006**
			(0.003)
Observations	16574	16574	16574

*$p < 0.10$, **$p < 0.05$, ***$p < 0.01$. Standard errors in parentheses. Precipitation is measured in 1000 mm for the twelve months previous to the interview month and varies at the sub-county level. Outcome is an indicator that is equal to one if the girl got married between the previous and current wave. Sample covers girls aged 10-20 in all waves. Regressions control for household, year and month fixed effects, age dummies, urban dummy, household size and number of children.

5.1.2 Rainfall in Early Childhood

To examine the dynamic effects of weather shocks on child outcomes, we explore how rainfall shocks in the child's young ages affect schooling, child labor, domestic work and marriage rates.

Weather shocks can have long-lasting effects on children's outcomes for a number of reasons. First, a common finding is that many early life shocks or human capital investments have compounding effects as the child grows. For instance, a child that is malnourished during infancy, might be stunted and develop lower cognitive skills. It thus might be sick more often and perform worse in school which has further negative effects for its

development. Second, it has been documented, that parental investments adjust depending on external shocks. For children who suffer adverse shocks, parents might invest more resources to compensate in some settings or in others they might divert their attention to healthier or more skilled siblings.

To study child outcomes relate to early life shocks, we sum precipitation in three-year intervals for different ages of the child. Table 7 shows the regression results. We see that rainfall during ages 0-2 and 3-5 have significant effects. In contrast to the effects of recent rainfall, higher precipitation during the child's first years of life decrease school enrolment by 6.8 and 7.2 percentage points respectively. At the same time, there is a positive effect on the extensive margin of farm work, children are 15.9% and 5.7% more likely to work in agriculture (although the latter effect for rainfall during ages 3-5 is insignificant).

This can be interpreted as follows: children who experience positive agricultural shocks during young ages receive better nutrition and care. Therefore, they grow up to be healthier and physically stronger and are more likely to be chosen to work in agriculture instead of going to school. This effect has been documented in Bau et al. (2021).

Table 7: The Effect of Early Childhood Rainfall on Children's Schooling, Farm Work and Farm Work Hours

	School			Farm Work			Farm Work Hrs			Dom. Work Hrs		
Precip. 0-2	-0.068**			0.159***			0.621			1.574		
	(0.027)			(0.052)			(1.335)			(0.988)		
Precip. 3-5		-0.072**			0.057			-0.403			0.021	
		(0.030)			(0.047)			(0.872)			(0.934)	
Precip. 6-8			0.012			-0.041			-0.874			1.169
			(0.029)			(0.050)			(0.889)			(1.294)
Obs.	44720	47701	36120	33440	36396	30703	24149	26051	21734	18540	20100	17198

*$p < 0.10$, **$p < 0.05$, ***$p < 0.01$. Standard errors in parentheses. Precipitation is measured in 1000 mm summed over three years and vary at the sub-county level. Sample covers all children aged 6-18 in all waves. Regressions control for household, year and month fixed effects, age dummies, urban dummy, household size, number of children and child's gender.

Examining these effects separately for boys and girls in Table 8, we see that the negative effect on schooling and positive effect on farm work are only significant for boys. This makes sense, given that boys are more likely to perform heavy tasks in agriculture that re-

quire physical strength. For girls the effects are of the same sign but insignificant. However, higher rainfall during ages 3-5 seem to decrease the time girls spend on domestic chores by 2.9 hours.

Table 8: The Effect of Early Childhood Rainfall on Girls' and Boys' Schooling, Farm Work, Farm Work Hours and Domestic Work Hours

	Boys				Girls			
	School	Farm Work	Farm Hrs	Dom. Hrs	School	Farm Work	Farm Hrs	Dom. Hrs
Precip. Ages 0-2	-0.063*	0.146**	-0.513	1.445	-0.056	0.118	1.666	0.235
	(0.036)	(0.057)	(1.618)	(0.911)	(0.035)	(0.078)	(1.708)	(2.188)
Observations	22030	16757	12220	9380	22690	16683	11929	9160
Precip. Ages 3-5	-0.077*	0.056	0.379	0.281	-0.049	0.087	-1.310	-2.973*
	(0.039)	(0.061)	(1.509)	(1.158)	(0.042)	(0.065)	(1.097)	(1.562)
Observations	23534	18252	13188	10157	24167	18144	12863	9943

*$p < 0.10$, **$p < 0.05$, ***$p < 0.01$. Standard errors in parentheses. Precipitation is measured in 1000 mm summed over three years and varies at the sub-county level. Sample covers all children aged 6-18 in all waves. Regressions control for household, year and month fixed effects, age dummies, urban dummy, household size, number of children and child's gender.

We further show that early childhood rainfall can have implications for child marriage. Table 9 shows that girls experience 1000 mm more rainfall during ages 3-5 are 3% less likely to be married off when aged 10-20. One possible explanation is that girls who experience greater rainfall during young ages are also physically stronger and more productive when working on farms. Therefore households might decide to keep them in the household to help with agricultural tasks.

Table 9: The Effect of Early Childhood Rainfall on Girls' Marriage Probabilities

	Get Married		
Precip. Ages 3-5	-0.030**		
	(0.015)		
Precip. Ages 6-8		-0.009	
		(0.015)	
Precip. Ages 9-11			0.007
			(0.012)
Observations	16574	16574	14558

*$p < 0.10$, **$p < 0.05$, ***$p < 0.01$. Standard errors in parentheses. Precipitation is measured in 1000 mm summed over three years and vary at the sub-county level. Outcome is an indicator that is equal to one if the girl got married between the previous and current wave. Sample covers girls aged 10-20 in all waves. Regressions control for household, year and month fixed effects, age dummies, urban dummy, household size and number of children.

6 Conclusion

This paper analyzes the effects of contemporaneous and early life agricultural shocks on children's outcome by gender and age group. We show that effects vary substantially by gender and timing of the shocks. Boys schooling responds positively to higher recent rainfall while higher rainfall during early childhood has a detrimental effect. In contrast the effect on girls' enrolment is generally insignificant. However, greater early life rainfall decreases marriage rates of young girls while positive rainfall shocks during the past year has an positive impact.

References

Bau, Natalie, Martin Rotemberg, Manisha Shah, and Bryce Steinberg (2021), Human Capital Investment In the Presence of Child Labor. *Working Paper*.

Beegle, Kathleen, Rajeev H. Dehejia, and Roberta Gatti (2006), Child labor and agricultural shocks. *Journal of Development Economics*, 81, 80–96.

Björkmann-Nyqvist, Martina (2013), Income Shocks and Gender Gaps in Education: Evidence from Uganda. *Journal of Development Economics*, 105, 237–253.

Corno, Lucia, Nicole Hildebrandt, and Alessandra Voena (2020), Age of Marriage, Weather Shocks,and the Direction of Marriage Payments. *Econometrica*, 88, 879–915.

Corno, Lucia and Alessandra Voena (2021), Selling daughters: age of marriage, income shocks and the bride price tradition. *Working paper*.

Duflo, Esther, Rema Hanna, and Stephen P. Ryan (2012), Structural Estimation and Policy Evaluation in Developing Countries. *American Economics Review*, 102, 1241–78.

Field, Erica and Attila Ambrus (2008), Early Marriage, Age of Menarche, and Female Schooling Attainment in Bangladesh. *Journal of Political Economy*, 116, 881–930.

Funk, Chris, Pete Peterson, Martin Landsfeld, Diego Pedreros, James Verdin, Shraddhanand Shukla, Gregory Husak, James Rowland, Laura Harrison, Andrew Hoell, and Joel Michaelsen (2015), The climate hazards infrared precipitation with stations—a new environmental record for monitoring extremes. *Scientific Data*, 2.

Imbert, Clement, Marlon Seror, Yifan Zhang, and Yanos Zylberberg (2021), Migrants and Firms: Evidence from China. *American Economic Review*, forthcoming.

Jayachandran, Seema (2006), Selling Labor Low: Wage Responses to Productivity Shocks in Developing Countries. *Journal of Political Economy*, 114, 538–575.

Maccini, Sharon and Dean Yang (2009), Under the Weather: Health, Schooling, and Economic Consequences of Early-Life Rainfall. *American Economic Review*, 99, 1006–26.

Marchetta, Francesca, David E. Sahn, and Luca Tiberti (2019), The Role of Weather on Schooling and Work of Young Adults in Madagascar. *American Journal of Agricultural Economics*, 101, 1203–1227.

McFadden, Daniel (1989), A Method of Simulated Moments for Estimation of Discrete Response Models without Numerical Integration. *Econometrica*, 57, 995–1026.

Moorthy, Akshay (2021), The Effect of Rainfall Shocks on Early Childhood Development in Uganda. *Economics Letters*, 200, 109764.

Ravallion, Martin and Quentin Wodon (2000), Does Child Labour Displace Schooling? Evidence on Behavioural Responses to an Enrollment Subsidy. *The Economic Journal*, 110, C158–C175.

Rosenzweig, Mark R. and Kenneth Wolpin (1993), Credit Market Constraints, Consumption Smoothing, and the Accumulation of Durable Production Assets in Low-Income Countries: Investments in Bullocks in India. *Journal of Political Economy*, 101, 223–244.

Shah, Manisha and Bryce Millett Steinberg (2017), Drought of Opportunities: Contemporaneous and Long-Term Impacts of Rainfall Shocks on Human Capital. *Journal of Political Economy*, 125, 527–561.

Todd, Petra and Kenneth Wolpin (2006), Assessing the Impact of a School Subsidy Program in Mexico: Using a Social Experiment to Validate a Dynamic Behavioral Model of Child Schooling and Fertility. *American Economics Review*, 96, 1384–1417.

Todd, Petra and Kenneth Wolpin (2010), Structural Estimation and Policy Evaluation in Developing Countries. *Annual Review of Economics*, 2, 21–50.