Selling daughters: age of marriage, income shocks and bride price tradition*

Lucia Corno[†] Alessandra Voena [‡]

December 2015

Abstract

When markets are incomplete, cultural norms may play an important role in shaping economic behavior. In this paper, we explore whether the custom of bride price –a transfer made by the groom to the bride's family at marriage– increases the probability of child marriages. We develop a simple model in which households are exposed to income shocks and have no access to credit markets and show that girls have a higher probability of marrying early when their parents have higher marginal utility of consumption because of adverse income shocks. We test the prediction of the model by exploiting variation in rainfall shocks over a woman's life cycle, using a survey dataset from rural Tanzania. We find that adverse shocks during teenage years increase the

*We thank Veronica Guerrieri, Eliana La Ferrara, Costas Meghir, Michèle Tertilt and participants to the workshop at COSME, Barcelona GSE Summer Forum, SED meetings "Families and the Macroeconomy" and EDePo for helpful comments. We are grateful to Helene Bie Lilleor and Sofya Krutikova for useful discussion on the Kagera Health Development Survey and to Kalle Hirvonen for the clarification regarding weather data. Simone Lenzu and Jorge Rodriguez provided outstanding research assistance. Data obtained from the NASA Langley Research Center are greatefully acknowledged. This research was partly funded by a Research Grant from the Social Sciences Division at the University of Chicago.

†Queen Mary, University of London and IFS. Email: `l.corno@qmul.ac.uk`.

‡The University of Chicago and NBER. Email: `avoena@uchicago.edu`.

probability of early marriages among women, particularly in villages where the average bride price is higher. We use these empirical results to structurally estimate our model. In counterfactual exercises, we show that access to credit markets could substantially reduce teenage marriage. *Keywords*: Marriage payments, age of marriage, income shocks.

1 Introduction

Adolescent and child marriage is still a common practice in many countries, especially among girls. Worldwide, one third of women aged 20-24 years married before turning 18. This phenomenon is particularly widespread in the poorest regions: in Sub-Saharan Africa, for example, 40% of women aged 20-24 years are child brides (UNICEF, 2014). A direct consequence of early marriages is adolescent fertility. In Tanzania, the setting of our study, 22.8% of girls aged 15-19 had children or were pregnant in 2010 and the adolescent fertility rate of 126 (births per 1,000 girls aged 15-19) is the highest in the world (World Development Indicator, 2014).[1] The relationship between female early marriage, early fertility and poor physical and socio-economic outcomes is now well established in the literature. Child marriages are associated with reduced educational attainment, lower use of preventive health care services, lower bargaining power within the household, more physical abuse and domestic violence (Jensen and Thornton, 2003; Field and Ambrus, 2008). Based on this findings, the eradication of child marriages is now a priority in a policy agenda of many governments and international

[1]For comparison, adolescent fertility rates in 2010 were equal to 26 in United Kingdom, 5 in Italy and 3 in Switzerland (The World Bank, 2014).

organizations such as UNICEF, UNFPA and the World Bank.[2]

Despite this evidence, little research has examined the important question of why such a practice is still so widespread in many countries. Understanding what lies underneath adolescent and child marriages is crucial to improve women's socio- economic outcomes and ultimately promote economic development (Duflo, 2005; Doepke, Tertilt and Voena, 2012).

This paper explores the relationship between the probability of child marriages – defined as a formal or informal union in which at least one member married before the age of 18 (UNICEF, 2014)– and one specific social norm, namely the bride price payment. Bride price is defined as a transfer from the groom to the family of the bride at the time of marriage. It is often interpreted as the purchase of the rights to the woman's labor and reproductive ability and is prevalent in many part of the world, including most Sub-Saharan Africa countries and in some regions of Asia (Anderson, 2007*a*). Although bride price varies substantially across cultures and countries, it can constitute a sizable transfer to the bride's household. Young girls are hence a potentially important asset for their family, since they can be given in marriage in exchange for a bride price. Households, hit by negative income shocks and with little access to credit market, may therefore "sell" their girls before they reach adulthood, thus exacerbating the practice of early marriages.

With this framework in mind, this paper examines the following questions:
(i) are households more likely to marry off their daughters earlier when hit by adverse income shocks?
(ii) can the custom of bride price explain the relationship between income

[2] See for example, UNFPA (2012) and UNICEF (2014).

shocks and age of marriage?
(iii) could well-functioning credit markets overcome the impact of the bride price tradition and thus reduce the probability of child marriages?

To attempt to answer to these questions, we first develop a simple dynamic model in which households are exposed to income shocks and have no access to credit markets. Upon the marriage of their daughter, parents obtain a bride price payment, which depends on her age. Hence, in the absence of income uncertainty, parents will want to marry their daughter when bride price is highest relative the the daughter's contribution to the household budget. We show instead that, right after a negative income shock, parents may decide to marry off their daughter sooner.

Second, we test the prediction of the model using a survey dataset from Kagera, Tanzania - the Kagera Health Development Survey 1991-2010 (KHDS), which elicited detailed information on bride price payments - and weather data from the NASA Langley Research Center. In particular, we exploit exogenous variation in rainfall shocks to study the causal effects of income shocks on the age of marriage. This identification strategy allows us to address the endogeneity that would be otherwise present when analyzing the direct effect of the social norm on individual outcomes since unobserved individual characteristics, such as physical appearance and ability, may simultaneously influence the amount of the bride price paid and the age of marriage. Our hypothesis is that daughters can be "sold" to a groom when the household is hit by a negative income shock, in particular when the household has little access to credit markets. After controlling for village and cohort fixed effects, we find that girls hit by a rainfall shock at the age of 17 or 18 have a higher probability of being married in before or in the year they turn 18, while negative income shocks after that age do not have any statistically significant effect on the likelihood of teenage marriages. Interestingly, rainfall shocks early in life are not associated with early marriages for boys. Because men tend to marry later than girls, we verify that rainfall shocks do not affect age of marriage for men also at later ages. These different results for girls and boys suggest the presence of a custom that mainly matters for adverse income shocks for the girls but not for boys, such as the bride price. In the paper, we conduct a number of tests to validate this interpretation.

Finally, we estimate the parameters of the model by the method of simulated moments. We use the estimates to perform counterfactual simulations to study whether well-functioning credit markets can overcome the impact of the bride price tradition and thus reduce the probability of child marriages. In particular, we use the estimated parameters to perform two counterfactual simulations: one in which households have access to saving and one with perfect credit market. In both setups, the probability of child marriage is substantially higher compared to the setting with incomplete markets in the estimated model. However, marriage at a very young age is also eliminated in the counterfactual.

Our paper fits into the broad literature in economics investigating the role of cultural norms – behaviors that are enforced through social sanctions - on economic development (Fernandez, Fogli and Olivetti, 2004; Fernandez and Fogli, 2009). Previous works have examined the implications of descent rules on different economic outcomes. La Ferrara (2007) tests the implication of the matrilineal inheritance rule in Ghana, where the largest ethnic group

(Akan) is traditionally matrilineal, on inter-vivos transfer. She finds that children respond to the threat of disinheritance, due to the enforcement of the matrilineal rule, by increasing transfers to their parents during lifetime to induce a donation of land before the matrilineal inheritance is enforced. In a companion paper, La Ferrara and Milazzo (2012) investigate the effects of the matrilineal inheritance rule on children's human capital accumulation. Using data from Western Ghana, Quisumbing et al. (2001) explore the impact of matrilineal land tenure institutions on women's rights and the efficiency of cocoa tree resource management. A strand of this literature has focused on the role of marriage practices (e.g., polygyny and patrilocal norms) and marriage payments (dowry and bride price) on development (Rosenzweig and Stark, 1989; Jacoby, 1995; Gaspart and Platteau, 2010; Botticini and Siow, 2003; Ashraf et al., 2014; Bau, 2012). The latter is a particularly worthwhile and underexplored topic to study, because marriage payments are large and widespread transfers of wealth. They affect households' saving behavior and wealth accumulation (Botticini, 1999). Tertilt (2005) and Tertilt (2006) study the relationship between polygyny, often associated with bride price, and different socio-economic outcomes, such as higher fertility, larger spousal age gap and lower investment in daughters. In a recent paper, Ashraf et al. (2014) show that bride price plays an important role in women's educational attainment.

The remainder of the paper is organized as follows. In section 2, we describe the tradition of marriage payment, in section 3 we develop a theoretical framework to highlight the relationship between income shocks, bride price payments and the timing of marriage. Section 4 describes the data and shows some descriptive statistics. In section 5, we describe the identification strategy and in section 6 we show our main results. Section 7 reports the results of the numerical policy simulations of the model under different assumptions about the credit markets. Section 8 concludes.

2 Child marriages and bride price payments

Transfers of resources between spouses and their families are a crucial element in the marriage culture of many developing countries. Bride prices and dowries are the most well-known types of marriage payments. Bride price payment is a cash or in-kind transfer given by or on behalf of the groom to the family of the bride upon the marriage. Paying a bride price is an ancient tradition practiced throughout Africa. In the southern regions it is known as *lobola* and in East Africa as *mahari*. On the contrary, dowry payments involve a transfer from the bride to the family of the groom upon the marriage.

Many hypotheses have attempt to explain the occurrence of bride price and dowry. In his seminal work, Becker (1981) explains the existence of dowry and bride price as means to clear the marriage market. When grooms are scarce (e.g., in monogamous and virilocal societies), brides pay dowries to grooms; when women are scarce (e.g., in polygamous societies) grooms pay bride price to brides. Another hypothesis links marriage payments to the economic value of women. Bride price customs exist in cultures where women make valuable contributions to agricultural work or other economic activity in the household (Boserup, 1970; Giuliano, 2014). In regions where women do not make such contribution, women are an economic liability and hence pay a dowry at the time of marriage. A third hypothesis links marriage payments to the rights of inheritance held by women and explains dowry as a *pre mortem* bequest made to daughters (Botticini and Siow, 2003; Maitra, 2007).

Historically, the custom of bride price has been more common than that of dowry. Less than 4 percent of the cultures listed in Murdock's Ethnographic Atlas (Murdock, 1967) have dowry payments, whereas two-thirds follow a norm of bride price (Anderson, 2007*b*). However, dowry payments have played a more significant role in the economics literature, possibly because they occur mainly in Europe and Asia, where more than 70 percent of the world's population resides. Although the custom of dowry has disappeared in most of the western region, it remains widespread in South Asia. Bride prices have prevailed extensively and are still very common in Africa, South and East Asia (Maitra, 2007). In the data from Tanzania we are examining in this study, bride price was paid in 81.5% of marriages, with an average amount of 97,298 Tanzanian Shilling (about 45 USD) and the maximum amount is 1,005,000 (about 468 USD). Tanzanian law governing marriages allows for bride price payments.

The debate over the adverse consequences of the bride price custom is currently lively in Africa (see, among others, Kizito (2013), Mtui (2013)). It is argued that this practice increases the incentive for parents to "sell off" their girls in order to receive a bride price and decreases the probability for married women to end a marriage because their parents have to return the bride price. In a recent interview of the Thompson Reuters Foundation conducted in a village in Bagamoyo, Tanzania, a 15 years old bride says "I was very shocked because I was too young and I didn't want to get married since I was still at school. But I couldn't go against my father's wishes who wanted to get a payment to cover his financial problem" and "My dream was to become a teacher, but I could not fulfil it as I got married and became pregnant. Now I have a child it's unlikely I would go back to school" (Kizito, 2013).

Although anecdotal evidence suggests a relationship between bride price custom and child marriages, so far no rigorous evidence of this association has been provided.

3 Conceptual framework

In this section, we develop a simple dynamic model with incomplete markets in which households are exposed to idiosyncratic shocks to their income and cannot borrow nor save. We later estimate the parameters of this structural model and use it to perform counterfactual exercises where we relax the assumption on capital markets.

Decisions are made by parents, who have one daughter and obtain a bride price payment BP_a upon her marriage. The bride price BP_a is a function of the daughter's age. Income y_a is an i.i.d. stochastic process.

Households live till time T and can marry their daughter by age A. They maximize discounted expected utility over their consumption and have felicity function $u(\;)$. In each period, a state of nature s_a is realized, which corresponds to a realization of the i.i.d income process $y_a(s_a)$. Denote $s^a =$

$\{s_{14}, ...s_a\}$ the history of states of nature between age 14 and age a.[3] Parents observe $y_a(s_a)$ and choose consumption $c_a(s^a)$. If their daughter is unmarried (denoted as $M_{a-1}(s^{a-1}) = 0$), they choose whether or not to give her in marriage at that age $m_a(s^a) \in \{0, 1\}$. If the daughter marries, $m_a(s^a) = 1$, which will result in $M_a(s^a) = 1$.

Parents allocate consumption to their daughter when she is not married ($i_a(1 - M_a(s^a))$), which depends on her age and needs not to be positive, i.e. the daughter can contribute to the parents' consumption through her home production or her labor.

The parents solve the following problem:

$$
\begin{aligned}
max_{c \geq 0, m \in \{0,1\}} \quad & \sum_{a=14}^{A} \sum_{s^a} \delta^{a-14} \pi(s^a) u\left(c_a(s^a)\right) \\
s.t. \quad & c_a(s^a) + i_a(1 - M_a(s^a)) \leq y_a(s_a) + BP_a \cdot m_a(s^a) \\
& M_{13} = 0.
\end{aligned}
$$

For every period t and state of nature s^a :

$$
\begin{aligned}
& \text{if } M_{a-1}(s^{a-1}) = 1, \text{ then } m_a(s^a) = 0 \\
& \text{if } M_{a-1}(s^{a-1}) = 0 \text{ and } m_a(s^a) = 0, \text{ then } M_a(s^a) = 0 \\
& \text{if } m_a(s^a) = 1, \text{ then } M_a(s^a) = 1, ..., M_A(s^A) = 1.
\end{aligned}
$$

In this simple framework, the daughter is an indivisible assets (Evans, Henderson and Hobson, 2008). When a negative income shock hits, the parents' marginal utility of consumption is higher, and the value of marrying the daughter and immediately obtaining the bride price payment, rather than

[3] We chose 14 years as a starting age because it is when we start to observe a consistent number of marriages.

waiting until the value of the bride price is the highest, is greater.

We examine the relationship between the realization of income in a given period ($y_a(s_a)$) and the marriage probability over the life cycle.

This framework assumes that there is an inelastic supply of husbands and hence that daughters can get married in any period as long as the parents choose so.

Proposition 1. *Whenever it is costly to support a daughter ($i_a \geq 0$), a low realization of income at time a increases the probability that the daughter marries at age a, if she is not yet married.*

Proof. See Appendix. □

The proposition tells us that we should expect a positive relationship between the probability of a woman getting married at time a and idiosyncratic income shocks in the same period, as long as it is costly to support her. Note that the proposition is not an if and only if statement: if i_a is negative but relatively high compared to the bride price, the timing of marriage may still respond to a low income realization.

In what follows, we will test this prediction using rainfall shocks as an exogenous source of variation in income. We will then structurally estimate the above model to establish the quantitative importance of credit market imperfections in determining age of marriage when bride price payments are customary.

This setup relies on the assumption that we can identify idiosyncratic shocks to households that do not affect the overall marriage market. One limitation of using rainfall realizations is that other households in the same marriage market may be hit by the same income shocks. These shocks should affect both the supply of brides and, possibly, the supply of grooms. These changes may affect the equilibrium bride price payments: a negative income shocks should be associated with lower bride price payments. It is important to note that making bride price payments state-dependent does not invalidate proposition 1. That is, the proof of the proposition applies if $BP_a(s^a) > 0$ in all states of nature.

4 Data and descriptive statistics

We describe below the sources of data we used in our empirical analysis and in the structural estimation.

4.1 Kagera Health Development Survey (1991-2010)

[Insert figure 1]

The main dataset we used come from the Kagera Health and Development Survey (KHDS), a survey designed by the World Bank and the University of Dar es Salaam in the Kagera region, Tanzania. The Kagera region is located in the north-western corner of Tanzania, covering an area of 40.838 square kilometers, out of which 11.885 are covered by the waters of Lake Victoria. The KHDS involved 6 rounds of data collections between 1991 and 2010, then creating a 19-years panel dataset. The survey interviewed 6,353 individuals living in 51 villages (also referred to as clusters) for the first time in 1991 and then again in 1992, 1993, 1994, 2004 and 2010, irrespective of whether they had moved out of the original village, region, or country, or were residing in a new household. Figure 1 (right panel) shows the location of the cluster in the first survey round. Excluding those who died, 85% of all the respondents surveyed during the baseline were re-interviewed in 2010.[4]

Several features makes this dataset particularly appropriate for studying the effect of the bride price on marital outcomes. First, the last wave of the survey contains detailed retrospective information on marriage, including the date of marriage, the characteristics of the marriage (i.e. formal or informal) as well as all the cash and in-kind transfers from the groom's family to the bride's family and viceversa.

Second, a fairly high share of the married respondents report that payments were made at the time of their marriage, giving us the opportunity to study the effect of the bride price custom on outcomes. Finally, the large majority of the respondents in the KHDS have been married at least once (71% among respondents older than 15 year old) and this provides us a reasonable sample size to analyze.

Our final sample includes 1,250 married individuals, aged 18-46, born between 1965 and 1991 with non-missing information on the age of marriage and on weather shocks. Given that our main outcome variable - the age of marriage - does not change across survey rounds, the answers we use in our sample mainly come from the 2010 wave (97.76%) and only a small portion from the 2004 wave (3.24%).

[Insert figure 2]

Figure 2 shows the distribution of ages of marriages for the men and women in the sample. The average age of marriage for women is approxi-

[4]For additional information on the KHDS see De Weerdt et al. (2012).

mately 20 years, while the average age of marriage for the males is 24 years. A sizable portion of women marry in their teenage years, while typically fewer men do so.

[Insert table 1]

In Tanzania, the legal minimum age of marriage for boys is 18, while girls are legally eligible to marry at 15. However, either sex can marry at 14 with court approval. The current minimum age of marriage was established by the Law of Marriage Act (LMA), adopted in 1971. The LMA governs all matters pertaining to marriage, including the minimum age of marriage, divorce procedures, and guidelines for the division of property following dissolution of marital union (USAID (2013)). In our data, the age of marriage has been computed by taking the difference between the year of marriage and the year of birth. Therefore, some measurement error is plausible. For example, individuals that are recorded to be married at the age of 18 could have been married instead at the age of 17, if the month of the wedding is before the month of birth in the calendar year. With this in mind, we defined child marriages in our sample as a union where at least one member got married at 18 or younger. Table 1 shows summary statistics for the main variables of interest and the controls in our sample. Approximately 4% of the respondents got married in the year they turned 15 and nearly 20% of the sample reported an age of marriage below or equal to 18 years. The other key variable for our analysis is the bride price. The bride price payment include any transfer in cash, in livestock and in-kind made to the parents, grandparents, brothers, aunts and uncles of the bride at the time of marriage.[5] In our data, we deflated the bride price amount with the Consumer Price Index recorded in Tanzania in the year of marriage by using 2010 as a base year (The World Bank, 2015). The bride price is paid both in formal and informal marriage (about 77% of the sample) - that is when the couple starts to live together and, after a certain period of time, approach the relevant family member to formalize the marital arrangement. In this type of marriage is common for the groom to pay a "fine" for taking a bride without her family consent, which is considered as a type of bride payment (Kudo, 2015). A large share of married individuals (81%) reported that a bride price payment was made at the time of marriage. The average amount of bride price payment in the sample is 97,298 Tanzanian Shilling (about 45 USD) and the maximum amount is 1,005,000 (about 468 USD) (Panel A). By matching our data based on the ethnic group of the household head with the *Ethnographic Atlas* (Murdock, 1967), which provide descriptive information on the culture and practice of different tribes in the world, we note that in all the ethnic groups in our sample the bride price custom is a common practice in marital arrangements. Hence, unlike Ashraf et al. (2014), we cannot exploit ethnic group variation to test the effect of bride price on outcomes.[6] More than half of the sample are women and only 16% of the respondents live in urban areas (Panel B). Approximately 87% (72%) of the respondents have a mother (father) with primary education and only 0.2% (7%) of them report a mother (father) with a university degree. 20% of the respondents live in inadequate houses, with floor, outside walls and roof made by made

[5]In-kind payments include clothes, blankets, banana beers, raw meat, other food including sugar, cooking oil, milk tea, handtools, and kerosene.

[6]Respondents were asked to report the corresponding value in Tanzanian Shelling of bride prices paid in-kind or in livestock (44% of the total bride price amount).

by mud, bamboo tree or earth. The average food and total consumption per capita in the past 12 months is equal to 299,701 Tzs (about 131.5 USD) and 480,352 Tzs (about 211 USD), respectively. Food and total consumption are used in natural logarithm in the empirical analysis.

In line with our theoretical framework and with a vast literature in development economics (Dupas and Robinson, 2013; De Magalhaes and Santaeulàlia-Llopis, 2015; Rosenzweig and Wolpin, 1993), the majority of Tanzanian households appear to not save and to not accumulate assets to smooth consumption. In our data, only 34% of the parents owned livestock at the time of their children's marriage.

In table A1 in the appendix, we report the correlation between the probability of marrying by the year they turn 18 or before and women's socio-economic outcomes. In line with the previous literature (Jensen and Thornton, 2003; Field and Ambrus, 2008), we found that child marriages are negative associated to higher educational attainment, greater husband-wife age gap and higher probability to have a child by the age of 18 (column 1-3). The survey also elicited information about respondents' agreement with the following statements: (i) "Many times you feel that you have little influence over the things that happen to you"; (ii) "All in all you are inclined to feel that you are a failure"; (iii) "At times you think you are no good at all"; (iv) "If you try hard you can improve your situation in life". In columns 4-7 we test whether child marriages influence the above attitudes. Results show that girls married by 18 are more likely to agree to have little influence over things, to feel they are a failure or not good at all and to disagree with the fact that they can improve situation in their life. Finally, in column 8 we create an index of "Low self-esteem" by summing up all the statements used in columns 4-7. It is very interesting to note that early marriage is positive and statistically significant correlated at 1% level with a lower degree of self-esteem. Although not causal, the evidence reported in table A1 is suggestive: child marriages are linked to a number of poor women socio-economic outcomes, thus exacerbating gender gap and poverty.

4.2 Rainfall data

In Tanzania, almost 80% of the labor force (15-64 years) is employed in the agricultural sector. At 90%, the ratio of females engaged in agriculture work is even higher (International Labor Organization, 2013). Kagera region is not an exception. In our sample, 83% of the respondents do mention agriculture as one of the main activity carried on in the household. The main cultivated crops are banana (53.3%), coffee (about 12%), maize (11%) and cassava (9.6%). Agricultural practices strongly depend on weather patterns and variations in rainfall may result in a large variation in income and consumption for Tanzanian households. Because the region is bordering with the Lake Victoria, Africa's largest lake (see figure 1), natural hazards include both flooding and drought. We then use the Modern-Era Retrospective analysis for Research and Applications (MERRA) database at the NASA Langley Research Center on rainfall estimates as a source of exogenous variation for income shocks.[7] MERRA is a global gridded dataset based on retrospective

[7] The use of weather variations as proxy for income shocks is not new in the economic literature. See Miguel, Satyanath and Sergenti (2004); Nyqvist (2013); Dustmann, Fasani and Speciale (2015), among others. In constructing a measure that treats both extremely low and extremely high rainfall realizations as a negative shock, we also follow existing literature (Bobonis, 2009).

analysis of historical weather data obtained from a combination of weather stations as well as satellite images on the density of cold cloud cover, a reliable proxy for actual rainfall precipitation. The dataset provides daily precipitation (in millimeters) aggregated into 10 grids that are $1/2°$ in latitudes $*2/3°$ in longitude (roughly 55 km $*75$ km at the equator) $1/2°$ in latitudes $* \, 2/3°$ in longitude). Daily precipitation from 1981 to 2010 are linked to our 51 baseline villages (or clusters) through GPS coordinates.

For each village, we then compute the historical mean level of annual precipitations (in millimeters) during the growing seasons (which in Kagera is in March, April, May and October, November, December) between 1981 and 2010.[8] As shown in panel C, table 1, the historical annual mean level of precipitation during the growing seasons is about 812 millimeters per year. For each cluster and for each year of birth, we then compute rainfall deviations (in millimeters) from the rainfall historical mean. Our measures of rainfall shocks, called $Rainfall\,Shock\,At\,Age\ a_{i,v,y}$ is the absolute value of rainfall deviation from the historical mean for the individual i, in village v, born in year y, at a particular age a. For example, the variable "Rainfall Shock At Age 18" in panel C in table 1 measures the difference (in absolute value) between the yearly millimeters of rainfall during the growing season in the village of residence of the respondent when she/he was 18 and the historical mean of rainfall for the same village during the growing season. Similarly, we compute measures of average rainfall shocks within some age ranges: 15-18, 16-18, 19-20 and 19-21.

[8]Northern Tanzania has a long rainy season (*Masika*) and a short rainy season (*Vuli*). In the long rainy season, planting starts in February/ March, and harvest is in July/August. During the short rainy season planting is around October/November and harvest in January/February (United States Department of Agriculture, 2003).

Therefore our shocks variation comes from a combination of 8 to 10 grids (10 for 2010 and 8 from 2004), 51 clusters and 27 cohorts (1965 to 1991). This combination generate for example 183 different shocks at the age of 18 spread among 1,250 individuals.

[Insert figure 3(a) and 3(b)]

Figure 3(a) and 3(b) indicate that there is considerable variation in the rainfall shock (for example, at the age of 18) in our sample and the variation holds both within village of residence and across year of birth (figure 2a) and within year of birth and across villages (figure 2b).

[Insert table 2]

In table 2, we test the relationship between weather shocks and consumption. Specifically, we run OLS regressions using the KHDS panel dataset from 1991 to 2010, of the logarithm of total yearly aggregate consumption per capita (columns 1-5) and food consumption per capita (columns 6-10) on the absolute values of rainfall deviation from the historical mean, including year and village fixed effects. Because rainfall in the growing seasons is measured between March and May and again between October and December of a given year, while consumption is measured over the 12 months that precedes the interview, which occurs between March and December, we expect rainfall shocks in period $t-1$ to be more likely to influence consumption in year t relative to rainfall shocks measured in period t. Results show that the rainfall shocks are negatively correlated with the measure of consumption in our data at $t-1$. The coefficient on rainfall in the previous year is statistically significant at 1% level in all the specifications and it seems therefore a reliable measure of income shocks. The non-statistically significant coefficient on rainfall shock in the current period suggests that households were likely not yet hit by the consequences of the adverse shock in the same period when answering the question on consumption during the KHDS. In columns 4-9 of table 2, we include in the specification the current, the previous and the shocks in the following year and show a statistically significant correlation only between weather shock in the previous year and consumption. Various alternative measures of weather variation were explored (i.e., proportional change in rainfall from the previous year; the growing degree days (GDD) variation from its historical mean in each cluster) but these measures are not as strongly correlated with consumption as the ones we used.[9]

5 Empirical Strategy

The empirical analysis of the effects of social norms on individual's outcomes (i.e. age of marriage) is typically complicated by the endogenous nature of the social norm itself. First, unobserved individual's characteristics, such as physical appearance and cleverness may simultaneously influence the amount/existence of the bride price and the age of marriage, thus providing a spurious correlation between social norms and outcomes. Second, age of marriage is likely to influence the amount of a bride price, again providing a biased estimate of the effect of bride price payments on age of marriage. For this reason, we exploit exogenous variation in weather shocks across villages

[9] The growing degree days (GDD) is a measure of heat accumulation and it is used, for example, to predict when crop reach maturity.

and birth years in Tanzania to study the causal effects of income shocks on the probability of girls and boys marrying by the year they turn 18. Specifically, we estimate the following linear probability model:

$$Y_{i,v,y} = \alpha + \sum_{a} \beta_a Rainfall\, Shock\, At\, Age\, a_{i,v,y} + \lambda X_{_{i,v,y}} + \delta_v + \gamma_y + \epsilon_{i,v,y} \quad (1)$$

where $Y_{i,v,y}$ takes value 1 if person i, in village v, born in year y, got married in the year she turns 18 or before, and 0 otherwise. $Rainfall\, Shock\, At\, Age\, a_{i,v,y}$ is our proxy for income shocks experienced at different ages and it is computed as the absolute values of the rainfall deviation from the historical mean in each village. $X_{_{i,v,y}}$ is a set of individual controls which include dummies for the highest level of education of the mother and the father; a dummy equal to one if the respondent lives in urban area, 16 dummies indicating the ethnic group of the head of household and a dummy for an inadequate type of dwelling.[10] Village fixed effects (δ_v) and year of birth fixed effects (γ_y) are included in the estimating equation, to capture time-invariant village characteristics (e.g., richer versus poorer villages) and time-invariant cohort characteristics (e.g., marriage reforms in some particular year) that may be related to the probability of early marriages.

Our coefficients of interest are the β_as, which capture how income shocks affect the probability of marrying before or at age of 18: a positive coefficient indicates that an adverse income shock increases the probability of child marriage. We estimate equation (1) using OLS with standard errors clustered

[10]The type of dwelling is described by the floor, the roof and the construction material of outside walls. Inadequate dwellings are those with wall, floor and roof made by mud, bamboo tree or earth; good dwellings are those with wall, floor and roof made by iron, stone or cement.

at the village level. We report results for the sample of married individuals, separately for women and men.

6 Results

This section examines the empirical relationship between rainfall shocks and the probability of child marriage and child fertility.

6.1 Child marriages and income shocks

[Insert Table 3]

Table 3 reports the estimated coefficients for equation (1) for the sample of females. In column 1, we start by including the averse rainfall shocks one year before and during respondent's 18 years. Results show that being exposed to a rainfall shock at the age of 18 ($Rainfall\,Shock\;At\,Age\,18$) increases the probability of marriages by the year of the 18th birthday. This result is robust to the inclusion of controls for mother and father education, a dummy indicating respondents living in inadequate dwelling and the ethnic group of the head of household (column 2). Among the other controls, it is interesting to note the coefficients on mother secondary and tertiary education is negatively and statistically significant correlated with the probability of child marriages. In columns 3 and 4, we add control for rainfall shock at the age of 16 and in columns 5 and 6 we control for rainfall shock at the age of 15: results show that the coefficient on adverse shocks at age 18 remain positive and statistically significant at 5 percent. On average (across villages), a one standard deviation in the rainfall shock at age 18 is associated with approximately 8.7 percentage points higher probability of early marriage (column 6). In columns 7-12 of table 3, we check the robustness of our findings by including in the main specification rainfall shocks after the age of 18. We should not observe significant impacts of adverse rainfall shocks that hit a girl after she turned 18 on her prior marriage probability. Results still shows that individuals exposed to negative income shocks at 17 or 18 years have a higher probability of marriage in the year they turn 18, suggesting that current and previous shocks are a good predictors for early marriages. In particular, it is interesting to note that the coefficients on rainfall shocks before or at 18 are all positive and their size increases as we move towards the threshold of 18 years. On the other hand, rainfall shocks happened after the 18 years threshold are not statistically significant.

[Insert Table 4]

In table 4, we show the results for the sample of males. Almost all the coefficients on rainfall shocks are negative but not statistically significant. Table A2 in the appendix reports estimated coefficients for equation (1) using the age of marriages as dependent variable. Results are very similar to the ones shown in tables 3 and 4 above. This gender asymmetry is consistent with evidence from the same region in Tanzania that indicates that parental death affects the timing of marriage of girls, but not of boys (Beegle and Krutikova, 2007).

[Insert Table 5]

Finally, in table 5, we aggregate the rainfall shocks by taking their averages two and three years before and after the 18 years threshold. Results are striking: women exposed to adverse rainfall shocks between 16 to 18 years of age (columns 1-2) and between 15 to 18 years of age (columns 3-4) have a higher probability of being married by the year they turn 18, while the dependent variable is not influenced by shocks happened later in life, at 19 to 20 years of age (column 2) or at 19 to 21 years of age (column 4). In column 4, on average, one standard deviation increase in rainfall shocks between 15 to 18 years increases the probability for a girl to be married by the year she turns 18 by 9.22 percentage points. Once again, adverse income shocks do not seem to influence the likelihood of child marriages for boys.

[Insert Table 6]

In table 6, we show that the effect of adverse rainfall shock at age 18 on early marriage probability is persistent until the age 21. Table A3 in the appendix reports the same specifications for males. Finally, as further robustness test, in table A4 in the appendix, we check the influence of adverse rainfall shocks happen later in life on the probability of being married by 17 years or younger and by 16 years or younger. For both girls (columns 1-4) and boys (columns 5-8), negative rainfall shocks at 17 and 18 years do not influence the probability of marriage in the year turning 16 and, similarly, negative rainfall shocks at 18 and 19 years do not influence the probability of marriage in the year turning 17.

Our main takeaway from tables 3 to 6 is therefore that adverse income shocks during and before 18 years old led to an increase in the probability of marriages by the year they turn 18 for girls but not for boys. A potential interpretation of these findings is that households hit by adverse income shocks are more likely to marry off their daughters to receive a bride price transfer from her future groom. On the contrary, boys may be able to better smooth their own consumption and the consumption of their family when hit by a negative rainfall shock, for example by migrating for the season (Morten, 2013; De Weerdt and Hirvonen, 2013; Afifi, Liwenga and Kwezi, 2014), or by marrying a younger (and cheaper) spouse or by exploiting better opportunities in the labor market.

An alternative interpretation could be that rainfall shocks increase early marriages because households want to give away the less productive members and in some households, this may meaning marry off girls. While a rigorous analysis of the endogenous choice of the bride price on age of marriage is not possible with the data at hand, in what follow, we try to rule out some competing explanations and gather some evidence to validate the proposed interpretation.

6.2 Evidence on the bride price mechanism

[Insert Table 7]

The last two waves of the KHDS include two questions that allows us to verify the plausibility of the bride price interpretation. The questions ask to married respondents if there were any payments agreed and made for the marriage on behalf of the groom to the bride's family, including parents, but also brothers, aunts, uncles, grandparent and how much was it worth. We then construct the average bride price amount received by the women living in the same village of the respondent and married before the respondent turned 18. The idea behind this analysis is that the bride price amount received by neighboring women may provide an indication to parents on how much they can get by "selling" their daughter, without being directly correlated with their daughter's characteristics (e.g. education, physical appearance, etc). In table 7 we augmented the main equation (1) with the interaction between rainfall shocks in a women's life cycle and the bride price amount received by the neighboring women. It is interesting to note, that the coefficient on the interactions between adverse shocks at 18 and the bride price amount of the neighboring woman is positive and statistically significant in most of the specifications, suggesting that women exposed to income shocks before or at the age of 18 and living in villages where the average bride price is higher have a higher probability to be married by the year they turn 18. These results seem to point in the direction of interpreting the bride price as a source of insurance for income shocks in the presence of credit constraint.

[Insert Table 8]

In table 8, we test the correlation between rainfall shocks at different ages and the natural logarithm of the amount of the bride price payment among the sample of ever-married women. If households hit by the shock are in the same marriage market we should observe a negative correlation between the shock and the bride price amount: a higher supply of brides would be associated with lower bride price payment. This does not seem to be the case. The coefficients on rainfall shocks at different ages are not statistically significant, suggesting that, in line with the setup of the model, we are able to identify idiosyncratic shocks to households that do not affect the overall marriage market. Interestingly, controlling for age of marriage and age of marriage squared (columns 4-6) considerably increases the point estimates on the rainfall shocks, consistently with our finding that rainfall shocks are associated with more marriage among younger women, who command somewhat lower payments. However, the coefficients on rainfall shocks at age 17 and 18 turn out to be positive, and hence do not suggest that price effects are important.

Further evidence on the fact that the idiosyncratic shocks we exploit (by wave, village and year birth, as shown in figures 2a and 2b) are small relative to the size of the marriage market comes from the descriptive statistics in the KHDS. First, we observe that 73.5% of women leave their village of origin upon the marriage compared to only 12% of men: this is due to the tradition that in Tanzania, brides, after the marrige, move to live with their groom's family, again suggesting that spouses generally do not come from the same village. Second, looking at the data on migration, nearly 60% of women declare that marriage is the first reason for migrating. Using the same dataset, Hirvonen and Lilleør (2015) also document that the end of a marriage is the main reason for return migration to a woman's village of origin.

6.3 Child Fertility

[Insert Table 9]

A dramatic consequence of child marriage is child fertility. In figure 4, we plot the difference in the age of marriage and the age of first child. We note that most of the observations are around zero, suggesting that the age of marriage and of the first birth are the same in most of the cases. In table

9, we test the effect of negative rainfall shocks on the probability to have a child by 18 in the sample of women. The coefficients on rainfall shocks at 18 are positive and statistically correlated with the likelihood of having a child by age 18 in almost all specifications.

7 Estimation and counterfactual simulations (preliminary and incomplete)

In this section, we estimate the parameters of the model described in section 3 and combine it with a model of marriage choice for men. We use the estimates to perform counterfactual simulations evaluating the impact of policies that allow households to borrow and save on the distribution of age of marriage.

7.1 Man's problem

A man starts life at t=1 when he is 18 and lives till T and maximizes discounted expected utility over his consumption. He has felicity function $u(\ )$. In each period, a state of nature s_t is realized, which corresponds to a realization of the i.i.d income process $y_t(s_t)$. Denote $s^t = \{s_1, ...s_t\}$ the history of states of nature since period 1. The man observes $y_t(s_t)$ and choose consumption $c_t(s^t)$. If he is unmarried (denoted as $M_{t-1}(s^{t-1}) = 0$), he choose whether or not to marry in that period $m_t(s^t) \in \{0, 1\}$ and what age a his bride has. If he marries, $m_t(s^t) = 1$, which will result in $M_t(s^t) = 1$.

A bride contributes to the newly formed household consumption through a contribution k_a, which depends on her age at marriage and the husband's age.

The man solves the following problem:

$$
\begin{aligned}
max_{c\geq 0, m\in\{0,1\},a} \qquad & \sum_{t=1}^{T}\sum_{s^t}\delta^{t-1}\pi(s^t)u\left(c_t(s^t)\right) \\
s.t. \quad & c_t(s^t) + k_{a,t}\cdot M_t(s^t) \leq y_t(s_t) - BP_{a_t}\cdot m_t(s^t) \\
& M_1 = 0.
\end{aligned}
$$

For every period t and state of nature s^t :

$$
\begin{aligned}
& \text{if } M_{t-1}(s^{t-1}) = 1, \text{ then } m_t(s^t) = 0 \\
& \text{if } M_{t-1}(s^{t-1}) = 0 \text{ and } M_t(s^t) = 0, \text{ then } M_t(s^t) = 0 \\
& \text{if } m_t(s^t) = 1, \text{ then } M_t(s^t) = 1, ..., M_T(s^T) = 1 \\
& \text{if } M_t(s^t) = 1, \text{ then } a_t = a_{t-1} + 1.
\end{aligned}
$$

7.2 Parametrization

The utility function for all households is set to be CRRA with coefficient of relative risk aversion b:

$$u(c) = \frac{c^{1-b}}{1-b}.$$

The cost of raising a daughter is parametrized as an equivalence scale and changes over time as dictated by a quadratic function: $i_a = e_0 + e_1\cdot a + e_2\cdot a^2$. Similarly, the contribution of a wife to household consumption is also a quadratic in her age and in her husband's age, plus an interaction term: $k_{a,t} = g_0 + g_1\cdot a + g_2\cdot a^2 + +g_3\cdot t + g_4\cdot t^2 + g_5\cdot z\cdot t$.

Bride price evolves over time as a polynomial the girl's age, which is estimated directly fro the data: $ln(BP_a) = p_0 + p_1 \cdot a + p_2 \cdot a^2 + p_3 \cdot a^3 + p_4 \cdot a^4$.

Income y_a follows an i.i.d. log-normal distribution with mean μ and standard deviation σ. Consistently with what we observe in the KHDS data, μ is independent of a.

7.3 Exogenous parameters

We estimate BP_a as the profile of bride price payments over a women's age of marriage in the KHDS data, shown in figure 5. The intercept is the mean natural logarithm of bride price payment at age 14. The growth rate of bride price by age is estimated a fourth-degree polynomial without controls, with controls for the woman's education (specification #1), adding controls for parental assets (specification #2), adding wedding year dummies (specification #3) and adding controls for parental education (specification #4). Compared to the raw data, education is the observable variable that modifies the shape of the bride price profile by age the most. Additional socio-economic controls do not modify this relationship. In the structural estimation, we consider the values resulting from the fourth, most comprehensive specification.

[Insert figure 5]

In the model, we assume that the bride price amount is uniquely determined by a woman's age, and not by other observed or unobserved characteristics. This is clearly an important simplification: we are assuming that brideprice amount is uniquely determined by a woman's age and not by other unobserved characteristics. The presence of unobserved characteristics related to the age of marriage would bias our estimates of the relationship between bride price amounts and the daughter's age. Because of the small number of observations available, we restrict marriage to occur between age 14 and age 35, since few marriages occur outside of this window. We then use KHDS data on consumption to calibrate the random income process. The standard deviation of unexplained log income is equal to 0.62. We set the annual discount factor δ to 0.9, as common in the development literature (Morten, 2013).

7.4 Auxiliary model and structural estimation

We estimate the parameters $\theta = \{b, e_0, e_1, e_2, g_0, g_1, g_2, g_3, g_4, g_5, g_6\}$ by the method of simulated moments. We first estimate the parameters of an auxiliary model (denoted as ϕ) in the KHDS data, and then find the structural parameters that solve the following problem:

$$min_\theta(\hat{\phi}^{data} - \phi^{sim})G(\hat{\phi}^{data} - \phi^{sim})' \tag{2}$$

where G is the symmetric and positive semi-definite matrix.

The auxiliary model comprises of two components. We set the first parameter of the auxiliary model as the elasticity of female teenage marriage to resource shocks. We use the KHDS to estimate:

$$P(M_{i,18} = 1)_i = \delta + \beta \cdot Shock\, at\, 18_i + \theta' X_i$$
$$ln(c_{it}) = \alpha + \eta \cdot Shock_{i,t-1} + \gamma' Z_{it} + \epsilon_{it}.$$

We then use these estimates to compute the elasticity:

$$\phi_1^{data} = \frac{\frac{\partial P(M_{18}=1)}{P(M_{18}=1)}}{\partial ln(c_{18})} = \frac{\beta}{\eta} \cdot \frac{1}{P(M_{18}=1)}.$$

Second, we target the vector of probability of marriage by each age between 14 and 35 for women and age 18 and 39 for men: $\phi_{\mathbf{2}}^{\mathbf{data}} = \{P(M_a^{female} = 1)\}_{a=14}^{35}$ and $\phi_{\mathbf{3}}^{\mathbf{data}} = \{P(M_t^{male} = 1)\}_{t=18}^{39}$. Third, we target the average marriage age gap denoted asϕ_4. Hence, $\phi = \{\phi_1, \phi_{\mathbf{2}}, \phi_{\mathbf{3}}, \phi_4\}$. In the model, we estimate the simulated counterpart of these moments.

We estimate a risk aversion parameter b equal to 3.6. We estimate $e_0 = 1.5$, $e_1 = -0.0455$ and $e_3 = 0.0009$: the daughter contributes to the household consumption when young (up to 4 percent), but after age 16 becomes a net cost.

7.5 Counterfactual simulations

We simulate two simple counterfactual cases, in which households have access to a savings technology but no borrowing (counterfactual A) and then to perfect credit markets (counterfactual B). This simply implies that the parents' problem is modified in the following way:

$$max_{c\geq 0, m\in\{0,1\}} \quad \sum_{a=14}^{T}\sum_{s^a}\delta^{a-14}\pi(s^a)u(c_a(s^a))$$

$$s.t. \quad c_a(s^a)+i_a(1-M_a(s^a))+A_{a+1}(s^a)\leq y_a(s_a)+BP_a\cdot m_a(s^a)+(1+r)A_a(s^{a-1})$$

$$M_1=0$$

$$A_{T+1}(s^T)=0.$$

For every age a and state of nature s^a :

if $M_{a-1}(s^{a-1})=0,$ then $m_a(s^a)\in\{0,1\}$

if $M_{a-1}(s^{a-1})=1,$ then $m_a(s^a)=0$

if $m_a(s^a)=1,$ then $M_a(s^a)=1$

if $M_{a-1}(s^{a-1})=0$ and $m_a(s^a)=0,$ then $M_a(s^a)=0.$

We calibrate the interest rate r to be equal to 12% (Bank of Tanzania, 2010). In counterfactual A, we add the constraint that assets need to be positive at all times and states of nature:

$$A_a(s^a)\geq 0.$$

[Insert figure 6]

Figure 6 shows the two counterfactual cases. Letting the households the possibility to save (counterfactual A), no girls will be married before 16 years old. In the case of perfect credit markets (counterfactual B), all daughters get married when the cost of supporting a daughter begins to exceed the expected bride price gain, which is exactly 16. Hence, access to credit market reduces marriages at extrenely young age, but also raises child marriages overall.

8 Concluding remarks

In this paper, we shed light on one important reason why child marriages are still a widespread practice in many developing countries, despite the adverse consequences for women socio-economic status (e.g., lower educational attainment, domestic violence, etc.). We show, theoretically and empirically, that the traditional social norm of the bride price can be an important mean to insure households against negative income shocks, in the absence of well-functioning credit markets. Households who are exposed to adverse income shocks have a higher probability of marrying their daughters earlier, in exchange for a bride price payment.

Our results suggest that limits to credit, in combination with the custom of bride price, are a key driver of teenage marriage. However, access to credit markets does not eliminate child marriages in our framework. A natural question arising from our results is weather insurance schemes may allow households to delay their girls' marriages in practice, by providing an alternative consumption smoothing mechanism. Answering this question may require collecting experimental evidence on the impact of insurance on the timing of marriage.

References

Adda, Jerome, and Russell W Cooper. 2003. *Dynamic economics: quantitative methods and applications.* MIT press.

Afifi, Tamer, Emma Liwenga, and Lukas Kwezi. 2014. "Rainfall-induced crop failure, food insecurity and out-migration in Same-Kilimanjaro, Tanzania." *Climate and Development*, 6(1): 53–60.

Anderson, Siwan. 2007*a*. "The Economics of Dowry and Brideprice." *Journal of Economic Perspectives*, 21, No. 4: 151–174.

Anderson, Siwan. 2007*b*. "Why the Marriage Squeeze Cannot Cause Dowry Inflation." *Journal of Economic Theory*, 137: 140–152.

Ashraf, Nava, Natalie Bau, Nathan Nunn, and Alessandra Voena. 2014. "Bride price and the returns to education." *Unpublished Manuscript.*

Bank of Tanzania. 2010. *Monthly Economic Review.*

Bau, Natalie. 2012. "Cultural Norms, Strategic Behavior, and Human Capital Investment." *working paper.*

Becker, Gary. 1981. *A Treatise on the Family.* Cambridge, MA:Harvard University Press.

Beegle, Kathleen, and Sofya Krutikova. 2007. "Adult Mortality And Children's Transition Into Marriage." *Policy Research Working Papers.*

Bobonis, Gustavo J. 2009. "Is the allocation of resources within the household efficient? New evidence from a randomized experiment." *Journal of Political Economy*, 117(3): 453–503.

Boserup, Ester. 1970. *Woman's Role in Economic Development.* London:George Allen and Unwin Ltd.

Botticini, Maristella. 1999. "A Loveless Economy? Intergenerational Altruism and the Marriage Market in a Tuscan Town, 1415-1436." *The Journal of Economic History*, 59, No. 1: 104–121.

Botticini, Maristella, and Aloysius Siow. 2003. "Why Dowries?" *The American Economic Review*, 93, No. 4: 1385–1398.

De Magalhaes, Leandro, and Raul Santaeulàlia-Llopis. 2015. "The Consumption, Income and Wealth of the Poorest: Cross-Sectional Facts of Rural and Urban Sub-Saharan Africa for Macroeconomists." *Unpublished Manuscript, Bristol University and Washington University in St. Louis.*

De Weerdt, Joachim, and Kalle Hirvonen. 2013. "Risk sharing and internal migration." *World Bank Policy Research Working Paper*, , (6429).

De Weerdt, Joachim, Kathleen Beegle, Helene Bie Lilleør, Stefan Dercon, Kalle Hirvonen, Martina Kirchberger, and Sofya Krutikova. 2012. "Kagera Health and Development Survey 2010: Basic information document."

Doepke, Matthias, Michele Tertilt, and Alessandra Voena. 2012. "The Economics and Politics of Women's Rights." *Annual Review of Economics.*

Duflo, Esther. 2005. "Gender Equality in Development." *BREAD Policy Paper No. 011.*

Dupas, Pascaline, and Jonathan Robinson. 2013. "Why Don't the Poor Save More? Evidence from Health Savings Experiments." *American Economic Review*, 103(4): 1138–71.

Dustmann, Christian, Francesco Fasani, and Biagio Speciale. 2015. "Illegal migration and consumption behavior of immigrant households." *working paper*.

Evans, Jonathan, Vicky Henderson, and David Hobson. 2008. "Optimal timing for an indivisible asset sale." *Mathematical Finance*, 18(4): 545–567.

Fernandez, Raquel, Alessandra Fogli, and Claudia Olivetti. 2004. "Mothers and Sons: Preference Formation and Female Labor Force Dynamics." *Quarterly Journal of Economics*, 119(4): 1249–1299.

Fernandez, Raquel, and Alessandra Fogli. 2009. "Culture: An Empirical Investigation of Beliefs, Work, and Fertility." *American Economic Journal: Macroeconomics*, 1(1): 146–177.

Field, Erica, and Attila Ambrus. 2008. "Early Marriage, Age of Menarche and Female Schooling Attainment in Bangladesh." *Journal of Political Economy*, 116(5): 881–930.

Gaspart, Frederic, and Jean-Philippe Platteau. 2010. "Strategic behavior and marriage payments: theory and evidence from Senegal." *Economic development and cultural change*, 59(1): 149–185.

Giuliano, Paola. 2014. "The Role of Women in Society: from Pre-Industrial to Modern Times." *CESifo Economic Studies*, forthcoming.

Hirvonen, Kalle, and Helene Bie Lilleør. 2015. "Going Back Home: Internal Return Migration in Rural Tanzania." *World Development*, 70: 186–202.

International Labor Organization. 2013. "Tanzania. Decent work country program 2013-2016."

Jacoby, Hanan G. 1995. "The Economics of Polygyny in Sub-Saharan Africa: Female Productivity and the Demand for Wives in Côte d'Ivoire." *Journal of Political Economy*, 103, No. 5: 938–971.

Jensen, Robert, and Rebecca Thornton. 2003. "The Consequences of Early Marriage in the Developing World." *Oxfam Journal of Gender and Development.*

Kizito, Makoye. 2013. "Child marriage in Tanzania: cash for parents, problems for girls." *Newspaper article, Thomson Reuters Foundation.*

Kudo, Yuya. 2015. "Female migration for marriage: Implications from the land reform in rural Tanzania." *World Development*, 65: 41–61.

La Ferrara, Eliana. 2007. "Descent Rules and Strategic Transfers. Evidence from Matrilineal Groups in Ghana." *Journal of Development Economics*, 83 (2): 280–301.

La Ferrara, Eliana, and Annamaria Milazzo. 2012. "Customary Norms, Inheritance and human capital: evidence from a reform of the matrilineal system in Ghana." *working paper.*

Maitra, Sudeshna. 2007. "Dowry and Bride Price." *Prepared for the International Encyclopedia of the Social Sciences, 2nd Edition.*

Miguel, Edward, Shanker Satyanath, and Ernest Sergenti. 2004. "Economic Shocks and Civil Conflict: An Instrumental Variables Approach." *Journal of Political Economy*, 112 (41)): 225–253.

Morten, Melanie. 2013. "Temporary Migration and Endogenous Risk Sharing in Village India." *Unpublished Manuscript.*

Mtui, Janet. 2013. "Bride Price to unborn girls deplorable custom." *Newspaper article, Daily News, Tanzania's leading online new edition.*

Murdock, George Peter. 1967. *Ethnographic Atlas.* Pittsburgh:University of Pittsburgh Press.

Nyqvist, Martina Bjorkman. 2013. "Income Shocks and Gender Gap in education: Evidence from Uganda." *Journal of Development Economics*, 105): 237–253.

Quisumbing, A., E. Panyongagayong, J.B. Aidoo, and K. Otsuka. 2001. "Land Rights in the Transition to Individualized Ownership: implications for the Management of Tree Resources in Western Ghana." *Economic Development and Cultural Change*, 50 (1): 157–81.

Rosenzweig, Mark R, and Kenneth I 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*, 223–244.

Rosenzweig, Mark R, and Oded Stark. 1989. "Consumption smoothing, migration, and marriage: Evidence from rural India." *The Journal of Political Economy*, 905–926.

Tertilt, Michele. 2005. "Polygyny, fertility, and savings." *Journal of Political Economy*, 113(6): 1341–1371.

Tertilt, Michèle. 2006. "Polygyny, women's rights, and development." *Journal of the European Economic Association*, 4(2-3): 523–530.

The World Bank. 2014. "World Development Indicator."

The World Bank. 2015. "World Development Indicator."

UNFPA. 2012. "Marrying too young: End Child Marriages." *UN Population Fund.*

UNICEF. 2014. "The State of the World's Children reports." *Report.*

United States Department of Agriculture. 2003. "Tanzania Agricultural Seasons Production Estimates and Crop Assessment Division." *Foreign Agricultural Service.*

USAID. 2013. "Advocating for a change to Tanzania's legal age of marriage: efforts under the health policy initiative."

Appendix

Proof of proposition 1

Proof. The parents' problem admits the following recursive formulation:

$$\begin{aligned} V_a(M_a, s_a) = max_{c_a \geq 0, m_a \in \{0,1\}} \qquad & u(c_a) + \delta E[V_{a+1}(M_a, s^{a+1})|s^a] \\ s.t. \quad c_a(s^a) + i_a(1 - M_a(s^a)) & \leq y_a(s_a) + BP_a \cdot m_a(s^a). \end{aligned}$$

The problem can be solved backwards (Adda and Cooper, 2003). In the last period, for every realization of the state of nature, if the daughter is not yet married ($M_{A-1}(s^{A-1}) = 0$), she will marry and the parents consume all the cash on hand if and only if: $y_A(s_A) + BP_A \geq y_A(s_A) - i_A$. If the daughter is already married, ($M_{A-1}(s^{A-1}) = 1$), then $c_A(s^A) = y_A(s_A)$ $\forall$ states s_A and histories s^A.

This decision process leads to a terminal value $V_A(M_{A-1}, s^A) = u(c_A(s^A))$. In every other period, conditional on a marriage choice,

$$c_a = y_a + BP_a \cdot m_a - i_a \cdot (1 - M_a).$$

The value of marrying at time a is equal to:

$$V_a(m_a = 1) = u(y_a + BP_a) + \delta E_a[V_{a+1}(M_a = 1)]$$

and the value of waiting to marry at age a is equal to:

$$V_a(m_a = 0) = u\left(y_a - i_a\right) + \delta E_a[V_{a+1}(M_a = 0)].$$

where we omit the s^a for simplicity.

Hence, when $M_a = 0$, parents decide to marry off their daughter, $m_a = 1$, if and only if

$$\begin{aligned} & u(y_a + BP_a) - u\left(y_a - i_a\right)) \\ & + \delta\{E_a[V_{a+1}(M_a = 1)] - E_a[V_{a+1}(M_a = 0)]\} > 0. \end{aligned} \tag{3}$$

Based on equation 3, the probability that the daughter will marry at age a, given the random distribution of shocks y_a, is then:

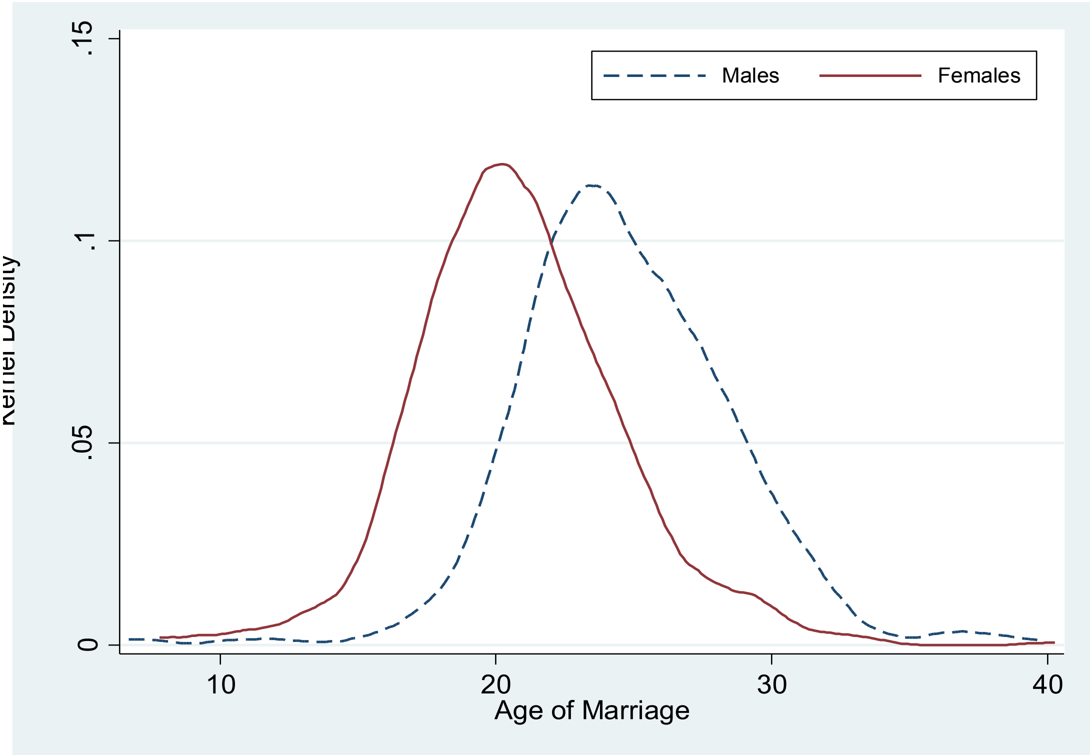
$$\begin{aligned} P\Big(m_a = 1\Big) = P\Big(& u(y_a + BP_a) - u\left(y_a - i_a\right) \\ & + \delta\{E_a[V_{a+1}(M_a = 1)] - E_a[V_{a+1}(M_a = 0)]\} > 0\Big) \end{aligned}$$

which is decreasing in y_a if $BP_a > 0$. This is because the continuation values $V_{a+1}(\ )$ do not depend on y_a, in the absence of credit markets, and because $\frac{\partial[u(y_a+BP_a)-u(y_a-i_a)]}{\partial y_a} = u'(y_a + BP_a) - u'(y_a - i_a) < 0$ as long as $BP_a \geq 0$ and $i_a \geq 0$. $\square$

Figures and Tables

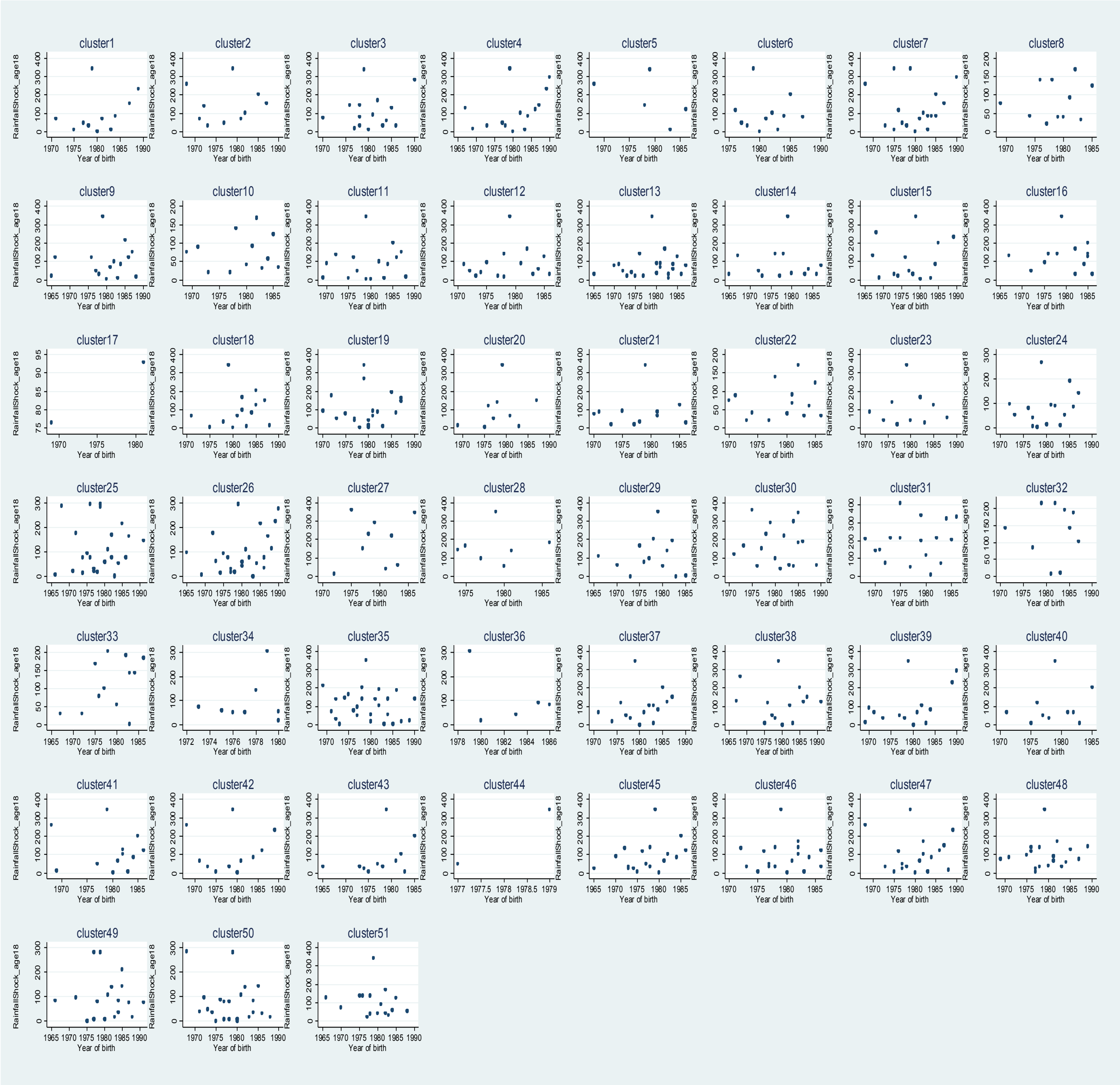
Figure 1: Kagera Region in Tanzania

Figure 2: Age at marriage, by gender



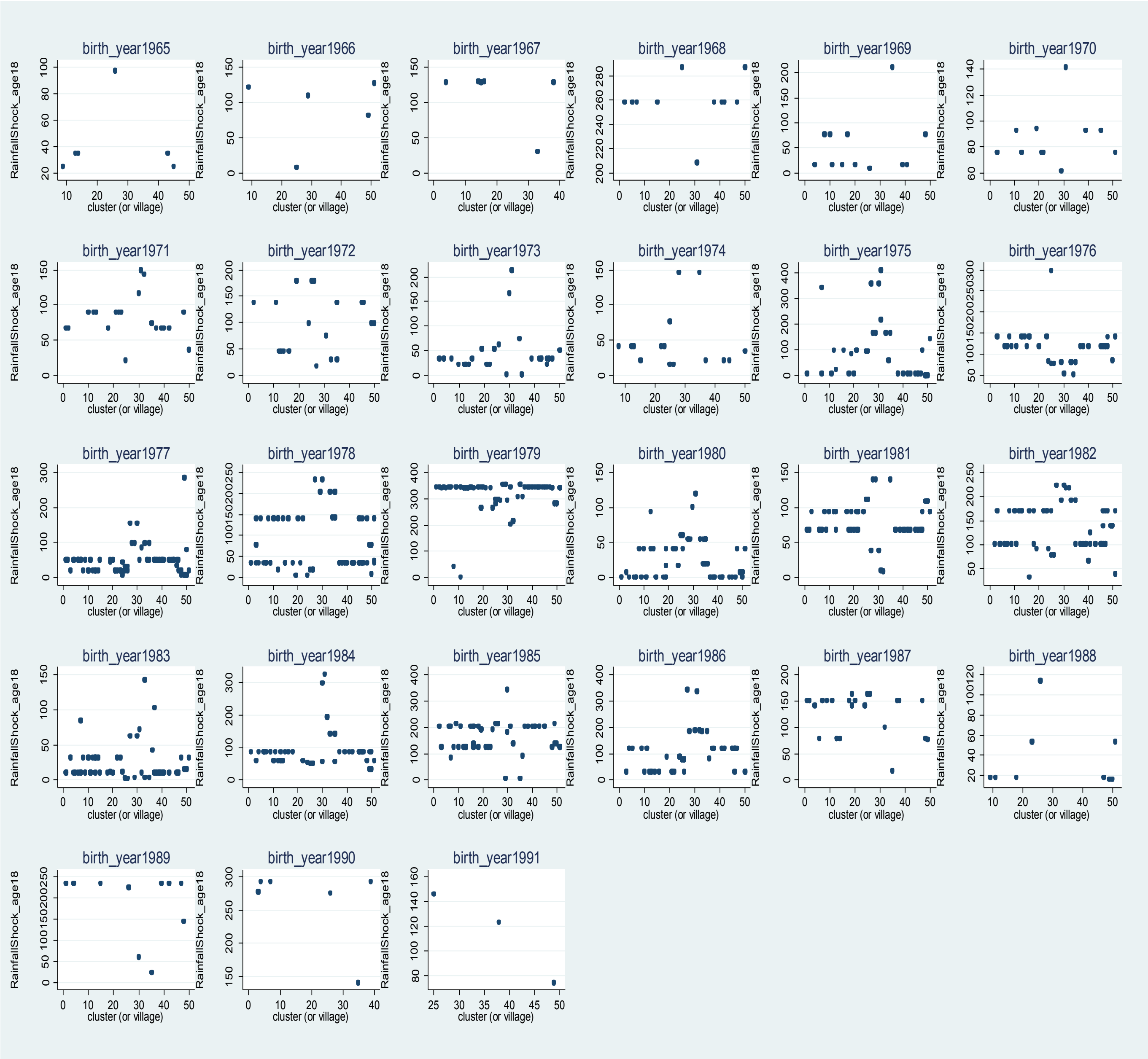
Notes: Sample of respondents with non-missing value for the age at marriage. Kernel density of distribution of ages at marriages in Kagera (Tanzania). Source: Kagera Health Development Survey.

Figure 3a: Rainfall shocks in the year turning 18, within clusters and across years of birth



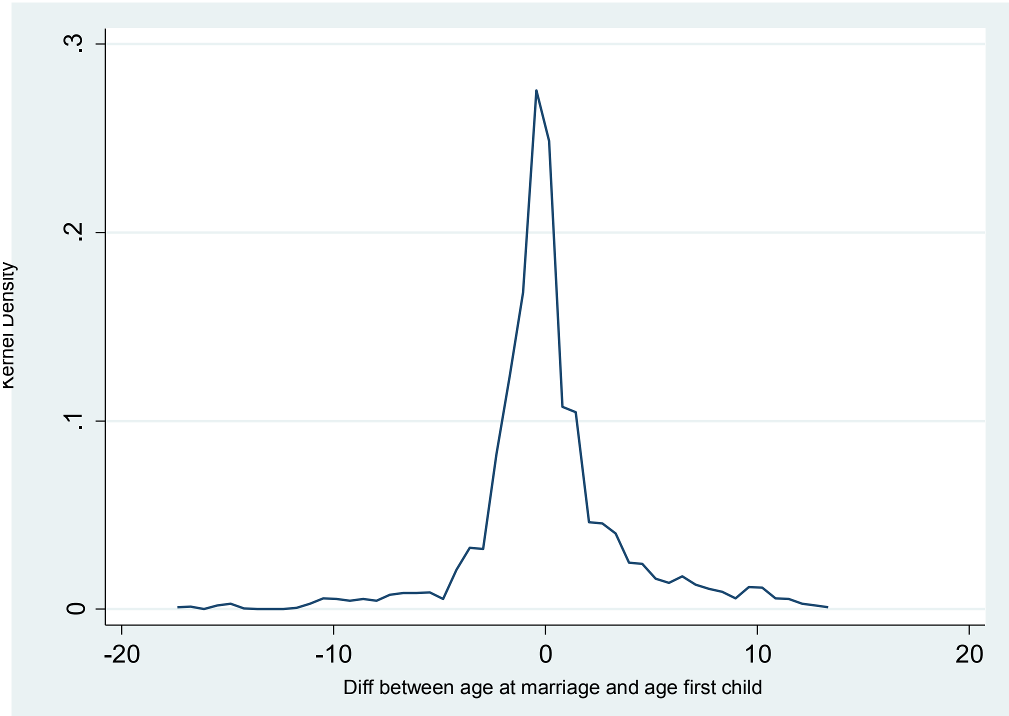
Notes: Sample of respondents with non-missing value for the age at marriage. The figure shows the variation in the rainfall shocks within cluster and across years of birth. On the horizontal axis, we report the year of birth and on the vertical axis we report the absolute value of rainfall deviation (in millimetres) from the rainfall historical mean in each cluster from 1981 to 2010 in the six months of the growing seasons (March, April, May and October, November, December) in the year when the respondent is turning 18. Source: Kagera Health Development Survey for the year of birth and NASA Langley Research Centre for data on precipitation in Kagera.

Figure 3b: Rainfall shocks in the year turning 18, across clusters and within year of birth



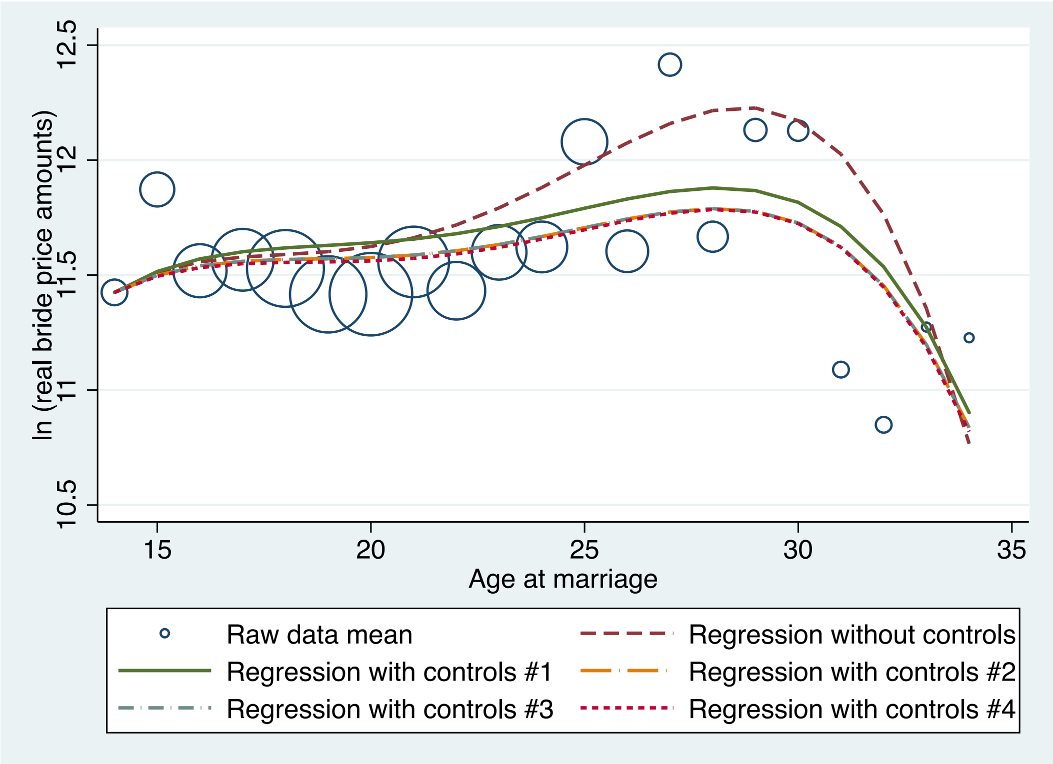
Notes: Sample of respondents with non-missing value for the age at marriage. The figure shows the variation in the rainfall shocks across clusters and within year of birth. On the horizontal axis, we report the cluster of the respondents and on the vertical axis we report the absolute value of rainfall deviation (in millimetres) from the rainfall historical mean in each cluster from 1981 to 2010 in the six months of the growing seasons (March, April, May and October, November, December) in the year when the respondent is turning 18. Source: Kagera Health Development Survey for the year of birth and NASA Langley Research Centre for data on precipitation in Kagera.

Figure 4: Difference between age at marriage and age at first child



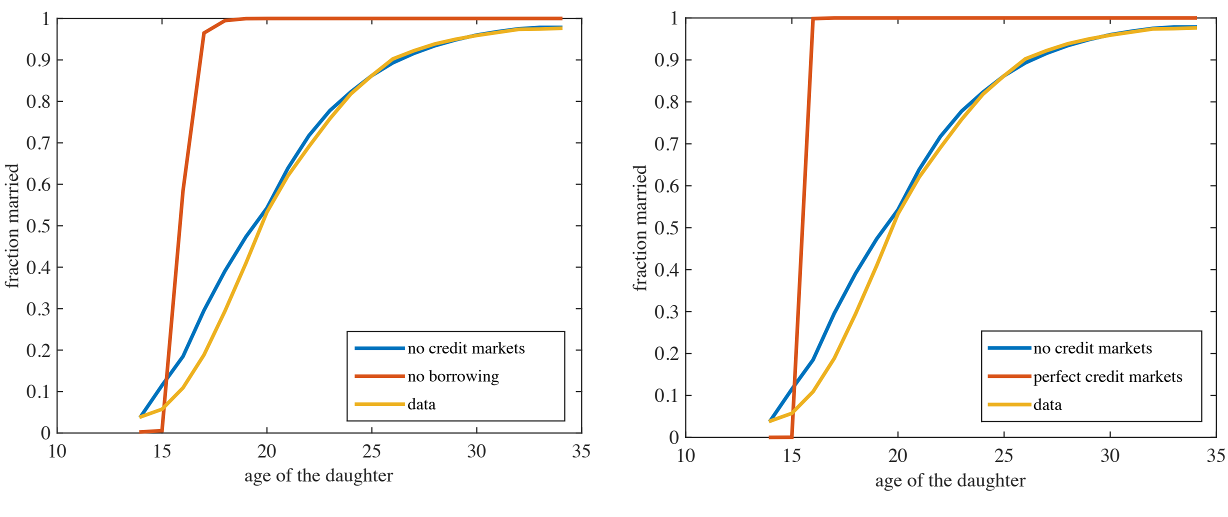
Notes: Sample of respondents with non-missing value for the age at marriage. Kernel density of distribution of the difference between the age at marriage and the age of the first child. Source: Kagera Health Development Survey.

Figure 5: Average bride price amounts earned, by daughter's age



Notes: Sample of respondents with positive bride price payment. The intercept is the mean bride price payment at age 14. The growth rate of bride price by age is estimated as a fourth-degree polynomial without controls, with controls for the woman's education (specification #1), adding controls for parental assets (specification #2), adding wedding year dummies (specification #3) and adding dummies for parental education (specification #4). Source: Kagera Health Development Survey.

Figure 6: Distribution of ages at marriage in the counterfactuals



Counterfactual A

Counterfactual B

Table 1: Summary Statistics

	Mean	*Std. Dev*	*Min*	*Max*
Panel A: Marriage's characteristics				
Age at marriage	21.911	4.267	6.000	40.000
Marriage before or in the year turning 15	0.042	0.200	0.000	1.000
Marriage before or in the year turning 18	0.198	0.399	0.000	1.000
Bride price	0.815	0.388	0.000	1.000
Bride price amount	97,298	132,923	0.000	1,005,000
Panel B: Demographic characteristics				
Female	0.590	0.492	0.000	1.000
Urban area	0.161	0.367	0.000	1.000
No education (mother)	0.087	0.188	0.000	1.000
Primary education (mother)	0.870	0.215	0.000	1.000
Secondary education (mother)	0.041	0.115	0.000	1.000
Tertiary education (mother)	0.002	0.028	0.000	1.000
No education (father)	0.106	0.224	0.000	1.000
Primary education (father)	0.717	0.316	0.000	1.000
Secondary education (father)	0.107	0.226	0.000	1.000
Tertiary education (father)	0.069	0.159	0.000	1.000
Bad House	0.202	0.402	0.000	1.000
Total consumption p/c (in TZS)	480,352	352,558	50,752	3,329,467
Food consumption p/c (in TZS)	299,701	201,234	25,197	1,600,864
Parents own livestock at marriage	0.340	0.474	0.000	1.000
Panel C: Rainfall Shocks				
Rainfall growing season	812.831	128.640	549.500	1,188.990
Rainfall shock, age 15	93.846	89.088	0.631	365.733
Rainfall shock, age 16	98.434	89.172	0.631	379.753
Rainfall shock, age 17	105.303	91.828	0.631	379.753
Rainfall shock, age 18	107.263	96.003	0.631	413.009
Rainfall shock, age 19	107.410	94.020	0.631	351.063
Rainfall shock, age 20	114.434	96.399	0.631	413.009
Rainfall shock, age 21	106.387	85.169	0.631	359.962
Rainfall shock, age 15-18	100.279	40.265	29.842	250.056
Rainfall shock, age 16-18	103.070	45.497	20.840	309.421
Rainfall shock, age 19-20	110.693	61.189	14.515	314.969
Rainfall shock, age 19-21	108.636	45.549	20.840	309.421
Observations		1,250		

Notes: Sample of respondents with non-missing value for the age at marriage. Rainfall shocks are computed as the absolute value of rainfall deviation (in millimetres) from the rainfall historical mean in each cluster from 1981 to 2010 in the six months of the growing seasons (March, April, May and October, November, December) at each age of the respondents. "Bride price" is equal to 1 if there was a bride price payment made for the marriage; the type of dwelling is described by the floor, the roof and the construction material of outside walls. Bad house are those with wall, floor and roof made by mud, bamboo tree or earth; good dwellings are those with wall, floor and roof made by iron, stone or cement. Source: Kagera Health Development Survey for demographic characteristics and NASA Langley Research Center for rainfall measures.

Table 2: Correlation between rainfall shocks and consumption

Dependent variable:	*Consumption p/c (log) (in TZS)*					*Food consumption p/c (log) (in TZS)*				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Rainfall deviation, t	0.024			0.027	0.027	0.025			0.029	0.029
	(0.024)			(0.024)	(0.024)	(0.027)			(0.027)	(0.027)
Rainfall deviation, t-1		-0.031**		-0.032**	-0.031**		-0.040***		-0.042***	-0.036**
		(0.014)		(0.013)	(0.014)		(0.015)		(0.015)	(0.015)
Rainfall deviation, t+1			-0.017		-0.004			-0.031		-0.016
			(0.024)		(0.023)			(0.028)		(0.026)
Controls	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Village Fixed Effects	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Year Fixed Effect	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
R2	0.829	0.829	0.829	0.829	0.829	0.802	0.802	0.802	0.802	0.802
Number of observations	8,091	8,091	8,091	8,091	8,091	8,095	8,095	8,095	8,095	8,095

Notes: OLS regression on a panel data of 8,084 households with cluster and wave fixed effects. Robust standard errors in parentheses, clustered at the village level. *** 1% , ** 5% , * 10% significance. Constant not displayed. "Consumption p/c" include all non-food expenditure (i.e. batteries, soap, umbrella, newspapers, haircuts, etc) plus expenditure in health, education, funeral and utilities and food consumption of the household divided by the household size in the past 12 months. "Food consumption" is the household food consumption divided by the household size in the past 12 months. Rainfall is the absolute value of rainfall deviation (in millimeters) from the rainfall historical mean in each cluster from 1981 to 2010 in the six months of the growing seasons (March, April, May and October, November, December). All the coefficients (standard errors) are multiplied by 100. Controls include dummies for mother and father highest level of education, an indicator for inadequate house (Bad House), a dummy indicating urban areas and dummies for the head of household ethnic group. Source: Kagera Health Development Survey.

Table 3: Probability of marriage by age 18, sample of females

Dependent variable: 1 if married before or in the year turning 18	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Rainfall shock, age 15					0.013	0.017					0.029	0.033
					(0.043)	(0.041)					(0.052)	(0.049)
Rainfall shock, age 16			0.005	-0.000	0.006	0.002			0.007	0.003	-0.000	0.001
			(0.040)	(0.038)	(0.041)	(0.039)			(0.042)	(0.041)	(0.040)	(0.037)
Rainfall shock, age 17	0.038	0.047	0.038	0.044	0.041	0.048	0.035	0.043	0.057	0.065*	0.073*	0.080*
	(0.037)	(0.038)	(0.037)	(0.037)	(0.037)	(0.037)	(0.038)	(0.038)	(0.039)	(0.039)	(0.042)	(0.042)
Rainfall shock, age 18	0.073**	0.077**	0.081**	0.086**	0.088**	0.093**	0.085**	0.088**	0.110***	0.114***	0.109***	0.110**
	(0.034)	(0.035)	(0.037)	(0.037)	(0.038)	(0.038)	(0.033)	(0.034)	(0.039)	(0.040)	(0.042)	(0.043)
Rainfall shock, age 19							-0.009	-0.007	-0.011	-0.009	0.002	-0.000
							(0.029)	(0.028)	(0.031)	(0.032)	(0.034)	(0.037)
Rainfall shock, age 20									-0.041	-0.043	-0.035	-0.033
									(0.047)	(0.045)	(0.053)	(0.050)
Rainfall shock, age 21											-0.046	-0.032
											(0.033)	(0.034)
Urban		-0.158		-0.158		-0.159		-0.138		-0.129		-0.127
		(0.100)		(0.100)		(0.098)		(0.098)		(0.093)		(0.095)
Bad House		-0.016		-0.016		-0.024		-0.015		-0.014		-0.024
		(0.048)		(0.048)		(0.047)		(0.048)		(0.048)		(0.047)
Mother Primary Educ.		-0.176		-0.176		-0.182		-0.184		-0.186		-0.188
		(0.114)		(0.114)		(0.114)		(0.115)		(0.115)		(0.119)
Mother Secondary Educ.		-0.339**		-0.339**		-0.344**		-0.370**		-0.345**		-0.347**
		(0.166)		(0.166)		(0.167)		(0.162)		(0.168)		(0.167)
Mother Tertiary Educ.		-0.488***		-0.488***		-0.484***		-0.503***		-0.493***		-0.497***
		(0.140)		(0.141)		(0.141)		(0.140)		(0.140)		(0.144)
Father Primary Educ.		0.081		0.081		0.078		0.081		0.077		0.072
		(0.090)		(0.090)		(0.090)		(0.093)		(0.095)		(0.101)
Father Secondary Educ.		0.193		0.193		0.194		0.186		0.189		0.191
		(0.120)		(0.120)		(0.121)		(0.127)		(0.126)		(0.132)
Father Tertiary Educ.		0.005		0.005		0.007		0.017		0.004		0.004
		(0.120)		(0.120)		(0.121)		(0.124)		(0.126)		(0.134)
Village FE	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Year of birth FE	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
R2	0.118	0.159	0.118	0.159	0.117	0.156	0.118	0.158	0.117	0.157	0.119	0.157
Observations	737	737	732	732	727	727	715	715	703	703	682	682

Notes: OLS regression. Robust standard errors in parentheses, clustered at the village level. *** 1% , ** 5% , * 10% significance. Constant not displayed. Rainfall is the absolute value of rainfall deviation (in millimeters) from the rainfall historical mean in each cluster from 1981 to 2010 in the six months of the growing seasons (March, April, May and October, November, December). Controls also include dummies for the head of household ethnic group. All the coefficients (standard errors) are multiplied by 100. Source: Kagera Health Development Survey.

Table 4: Probability of marriage by 18, sample of males

Dependent variable: 1 if married before or in the year turning 18						
	(1)	(2)	(3)	(4)	(5)	(6)
Rainfall shock, age 15			-0.001			-0.004
			(0.017)			(0.019)
Rainfall shock, age 16		-0.003	-0.004		0.008	0.008
		(0.014)	(0.015)		(0.012)	(0.014)
Rainfall shock, age 17	-0.025	-0.026	-0.027	-0.026	-0.019	-0.025
	(0.019)	(0.020)	(0.020)	(0.019)	(0.017)	(0.017)
Rainfall shock, age 18	-0.011	-0.012	-0.012	-0.014	-0.015	-0.015
	(0.016)	(0.017)	(0.017)	(0.017)	(0.016)	(0.017)
Rainfall shock, age 19				-0.011	-0.013	-0.019
				(0.014)	(0.014)	(0.014)
Rainfall shock, age 20					0.018	0.011
					(0.017)	(0.018)
Rainfall shock, age 21						-0.003
						(0.019)
Controls	yes	yes	yes	yes	yes	Yes
Village FE	yes	yes	yes	yes	yes	Yes
Year of birth FE	yes	yes	yes	yes	yes	Yes
R2	0.211	0.211	0.213	0.214	0.217	0.202
Observations	513	503	495	495	490	479

Notes: OLS regression. Robust standard errors in parentheses, clustered at the village level. *** 1% , ** 5% , * 10% significance. Constant not displayed. Rainfall is the absolute value of rainfall deviation (in millimeters) from the rainfall historical mean in each cluster from 1981 to 2010 in the six months of the growing seasons (March, April, May and October, November, December). All the coefficients (standard errors) are multiplied by 100. Controls, as described in table 1, ls include dummies for mother and father highest level of education, an indicator for inadequate house (Bad House), a dummy indicating urban areas and dummies for the head of household ethnic group Source: Kagera Health Development Survey.

Table 5: Probability of marriage by 18, average shocks

Dependent variable: 1 if married before or in the year turning 18								
	Females				**Males**			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Rainfall shock, age 16-18	0.134**	0.172***			-0.043	-0.028		
	(0.053)	(0.064)			(0.039)	(0.031)		
Rainfall shock, age 19-20		-0.049				0.013		
		(0.072)				(0.025)		
Rainfall shock, age 15-18			0.177**	0.229***			-0.044	-0.040
			(0.077)	(0.087)			(0.049)	(0.047)
Rainfall shock, age 19-21				-0.045				-0.010
				(0.080)				(0.041)
Controls	yes	yes	yes	yes	yes	yes	yes	yes
Village FE	yes	yes	yes	yes	yes	yes	yes	yes
Year of birth FE	yes	yes	yes	yes	yes	yes	yes	yes
R2	0.156	0.152	0.152	0.153	0.210	0.214	0.211	0.198
Observations	732	703	727	682	503	490	495	479

Notes: OLS regression. Robust standard errors in parentheses, clustered at the village level. *** 1% , ** 5% , * 10% significance. Constant not displayed. Rainfall is the absolute value of rainfall deviation (in millimeters) from the rainfall historical mean in each cluster from 1981 to 2010 in the six months of the growing seasons (March, April, May and October, November, December). All the coefficients (standard errors) are multiplied by 100. Controls, as described in table 1, include dummies for mother and father highest level of education, an indicator for inadequate house (Bad House), a dummy indicating urban areas and dummies for the head of household ethnic group Source: Kagera Health Development Survey.

Table 6: Probability of marriage by age 19-23, sample of females

Dependent variable:	*1 if married before or in the year turning 19* (1)	*1 if married before or in the year turning 20* (2)	*1 if married before or in the year turning 21* (3)	*1 if married before or in the year turning 22* (4)	*1 if married before or in the year turning 23* (5)
Rainfall shock, age 15	0.022	0.019	0.067	0.037	0.060
	(0.035)	(0.050)	(0.047)	(0.048)	(0.043)
Rainfall shock, age 16	-0.029	-0.025	-0.001	-0.015	-0.013
	(0.046)	(0.045)	(0.038)	(0.033)	(0.038)
Rainfall shock, age 17	0.023	0.055	0.037	0.053	0.049
	(0.043)	(0.043)	(0.051)	(0.047)	(0.042)
Rainfall shock, age 18	0.111***	0.149***	0.092**	0.029	0.025
	(0.040)	(0.035)	(0.039)	(0.034)	(0.032)
Rainfall shock, age 19	-0.031	-0.018	-0.015	0.004	0.004
	(0.038)	(0.038)	(0.041)	(0.038)	(0.032)
Rainfall shock, age 20		-0.050	0.005	0.010	0.002
		(0.048)	(0.055)	(0.047)	(0.042)
Rainfall shock, age 21			0.060	0.036	0.032
			(0.043)	(0.037)	(0.041)
Rainfall shock, age 22				0.000	0.014
				(0.032)	(0.029)
Rainfall shock, age 23					0.036
					(0.030)
Controls	yes	yes	yes	yes	yes
Village FE	yes	yes	yes	yes	yes
Year of birth FE	yes	yes	yes	yes	yes
R2	0.155	0.177	0.158	0.160	0.165
Number of observations	710	698	682	662	625

Notes: OLS regression. Robust standard errors in parentheses, clustered at the village level. *** 1% , ** 5% , * 10% significance. Constant not displayed. Rainfall is the absolute value of rainfall deviation (in millimeters) from the rainfall historical mean in each cluster from 1981 to 2010 in the six months of the growing seasons (March, April, May and October, November, December). All the coefficients (standard errors) are multiplied by 100. Controls, as described in table 1, .include dummies for mother and father highest level of education, an indicator for inadequate house (Bad House), a dummy indicating urban areas and dummies for the head of household ethnic group. Source: Kagera Health Development Survey.

Table 7: Bride price and probability of marriage by 18, sample of female

Dependent variable: 1 if married in the year turning 18 or before	(1)	(2)	(3)	(4)	(5)	(6)
Rainfall shock, age 15 * Brideprice's neighboring women before respondent turned 15			-0.000 (0.001)			-0.001 (0.001)
Rainfall shock, age 16 * Brideprice's neighboring women before respondent turned 16		0.000 (0.000)	0.000 (0.001)		0.000 (0.000)	0.000 (0.001)
Rainfall shock, age 17 *Brideprice's neighboring women before respondent turned 17	0.001 (0.001)	0.001* (0.001)	0.001 (0.001)	0.001 (0.001)	0.001 (0.001)	0.000 (0.001)
Rainfall shock, age 18 *Brideprice's neighboring women before respondent turned 18	0.001* (0.000)	0.001* (0.001)	0.001 (0.001)	0.001 (0.001)	0.001* (0.001)	0.001 (0.001)
Rainfall shock, age 19 *Brideprice's neighboring women before respondent turned 19				-0.000 (0.001)	0.000 (0.001)	-0.000 (0.001)
Rainfall shock, age 20 *Brideprice's neighboring women before respondent turned 20					-0.000 (0.001)	-0.002 (0.002)
Rainfall shock, age 21 *Brideprice's neighboring women before respondent turned 21						0.000 (0.001)
Rainfall shock, age 15			0.090 (0.074)			0.122 (0.089)
Rainfall shock, age 16		0.032 (0.054)	0.086 (0.092)		0.034 (0.058)	0.093 (0.099)
Rainfall shock, age 17	0.006 (0.053)	0.001 (0.062)	0.009 (0.067)	0.016 (0.054)	0.044 (0.068)	0.059 (0.087)
Rainfall shock, age 18	0.017 (0.057)	0.015 (0.084)	0.040 (0.118)	0.021 (0.063)	0.082 (0.095)	0.137 (0.138)
Rainfall shock, age 19				0.012 (0.049)	-0.068 (0.089)	-0.031 (0.079)
Rainfall shock, age 18					-0.076 (0.088)	-0.015 (0.113)
Rainfall shock, age 18						-0.063 (0.089)
Brideprice amount of women in the village married before respondent turned 17 and 18 (column 1), 16-18 (column 2), 15-18 (column 3), 17-19 (column 4), 16-20 (column 5), 15-21 (column 6)	yes	yes	yes	yes	yes	yes
Controls	yes	yes	yes	yes	yes	yes
Village Fixed Effects	yes	yes	yes	yes	yes	yes
Year of birth Fixed Effects	yes	yes	yes	yes	yes	yes
R2	0.185	0.206	0.242	0.181	0.204	0.255
Number of observations	530	473	399	521	452	367

Notes: OLS regression. Robust standard errors in parentheses, clustered at the village level. *** 1% , ** 5% , * 10% significance. Constant not displayed. Rainfall is the absolute value of rainfall deviation (in millimeters) from the rainfall historical mean in each cluster from 1981 to 2010 in the six months of the growing seasons (March, April, May and October, November, December). All the coefficients (standard errors) are multiplied by 100. Controls, as described in table 1, include dummies for mother and father highest level of education, an indicator for inadequate house (Bad House), a dummy indicating urban areas and dummies for the head of household ethnic group. The variable brideprice's neighboring women at different age is the average bride price amount received by women living in the same village as the respondent married before the respondent turned 15 to 18. Source: Kagera Health Development Survey.

Table 8: Rainfall shocks and bride price amount, sample of females

Dependent variable:	*Bride price amount (log)*								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Rainfall shock, age 15			-0.092			-0.089			0.058
			(0.157)			(0.153)			(0.086)
Rainfall shock, age 16		-0.053	-0.065		-0.034	-0.047		-0.059	-0.043
		(0.114)	(0.118)		(0.112)	(0.116)		(0.084)	(0.087)
Rainfall shock, age 17	-0.021	-0.022	-0.032	-0.024	-0.022	-0.032	0.009	-0.009	0.001
	(0.133)	(0.134)	(0.140)	(0.142)	(0.142)	(0.147)	(0.054)	(0.060)	(0.065)
Rainfall shock, age 18	-0.253	-0.224	-0.232	-0.182	-0.159	-0.167	-0.029	-0.038	-0.045
	(0.174)	(0.177)	(0.175)	(0.171)	(0.177)	(0.176)	(0.067)	(0.068)	(0.069)
Age at marriage				0.051	0.042	0.045	0.085	0.064	0.070
				(0.144)	(0.141)	(0.141)	(0.139)	(0.127)	(0.128)
Age at marriage sq.				0.001	0.001	0.001	-0.001	-0.001	-0.001
				(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Primary Educ.							0.406**	0.404**	0.408**
							(0.179)	(0.181)	(0.185)
Secondary Educ.							1.257***	1.243***	1.251***
							(0.267)	(0.265)	(0.270)
Controls	yes	yes	yes	yes	yes	yes	yes	yes	yes
Village FE	yes	yes	yes	yes	yes	yes	yes	yes	yes
Year of birth FE	yes	yes	yes	yes	yes	yes	yes	yes	yes
R2	0.238	0.241	0.241	0.273	0.274	0.274	0.319	0.318	0.319
Observations	443	442	441	443	442	441	441	440	439

Notes: OLS regression. Robust standard errors in parentheses, clustered at the village level. *** 1% , ** 5% , * 10% significance. Constant not displayed. Rainfall is the absolute value of rainfall deviation (in millimeters) from the rainfall historical mean in each cluster from 1981 to 2010 in the six months of the growing seasons (March, April, May and October, November, December). All the coefficients (standard errors) are multiplied by 100. Controls, as described in table 1, include dummies for mother and father highest level of education, an indicator for inadequate house (Bad House), a dummy indicating urban areas and dummies for the head of household ethnic group Source: Kagera Health Development Survey.

Table 9: Probability of child fertility

Dependent variable: 1 if first child before or in the year turning 18						
	(2)	(3)	(4)	(5)	(6)	(7)
Rainfall shock at age 15			0.009			0.010
			(0.040)			(0.046)
Rainfall shock at age 16		0.023	0.021		0.005	0.015
		(0.032)	(0.030)		(0.030)	(0.033)
Rainfall shock at age 17	0.054	0.056	0.055	0.055	0.069	0.064
	(0.046)	(0.047)	(0.046)	(0.044)	(0.045)	(0.047)
Rainfall shock at age 18	0.062*	0.052	0.049	0.083**	0.098**	0.093**
	(0.038)	(0.040)	(0.039)	(0.037)	(0.045)	(0.045)
Rainfall shock at age 19				0.036	0.034	0.030
				(0.033)	(0.036)	(0.036)
Rainfall shock at age 20					-0.029	-0.015
					(0.038)	(0.043)
Rainfall shock at age 21						0.030
						(0.040)
Controls	yes	yes	yes	yes	yes	yes
Village FE	yes	yes	yes	yes	yes	yes
Year of birth FE	yes	yes	yes	yes	yes	yes
R2	0.147	0.146	0.144	0.156	0.161	0.165
Observations	683	678	673	666	651	633

Notes: OLS regression. Robust standard errors in parentheses, clustered at the village level. *** 1% , ** 5% , * 10% significance. Constant not displayed. Rainfall is the absolute value of rainfall deviation (in millimeters) from the rainfall historical mean in each cluster from 1981 to 2010 in the six months of the growing seasons (March, April, May and October, November, December). All the coefficients (standard errors) are multiplied by 100. Controls, as described in table 1, include dummies for mother and father highest level of education, an indicator for inadequate house (Bad House), a dummy indicating urban areas and dummies for the head of household ethnic group. Source: Kagera Health Development Survey.

Appendix

Table A1: Correlation between probability of marriage by 18 and women's socio economic outcomes and attitudes

	Outcomes			Attitudes				
Dependent variable	*1 if secondary education and above*	*Age gap between spouses*	*First birth before or at 18*	*Little influence over the things - Agree*	*You are a failure - Agree*	*You are not good - Agree*	*Can improve your situation in life - Disagree*	*Low self-esteem - Index*
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Marriage before or in the year turning 18	-0.062***	3.106***	0.551***	0.116**	0.044	0.071	0.020	0.251***
	(0.019)	(0.421)	(0.039)	(0.055)	(0.052)	(0.049)	(0.021)	(0.080)
R2	0.011	0.056	0.301	0.012	0.002	0.007	0.005	0.017
Observations	734	649	683	262	262	262	262	262

Notes: OLS regression. Robust standard errors in parentheses, clustered at the village level. *** 1% , ** 5% , * 10% significance. Constant not displayed. Sample of ever-married women. In column 3, the age gap is in absolute value. In column 4, the dependent variable is equal to 1 if the respondent totally agrees or somewhat agrees with the sentence "Many times you feel that you have little influence over the things that happen to you"; in column 5, the dependent variable is 1 if respondent totally agrees or somewhat agrees with "All in all you are inclined to feel that you are a failure"; in column 6, the dependent variable is 1 if respondent totally agrees or somewhat agrees with "At times you think you are no good at all"; in column 7, the dependent variable is 1 if the respondent totally disagrees or somewhat disagrees with "If you try hard you can improve your situation in life". The last column include the sum of all variables reported in columns 4-7. Source: Kagera Health Development Survey.

Table A2: Age at marriage

Dependent variable: age at marriage				
	Females		**Males**	
	(1)	(2)	(3)	(4)
Rainfall shock, age 15	-0.272	-0.322	0.231	0.257
	(0.292)	(0.356)	(0.257)	(0.266)
Rainfall shock, age 16	0.350	0.249	0.021	0.011
	(0.249)	(0.282)	(0.416)	(0.464)
Rainfall shock, age 17	-0.082	-0.146	-0.001	0.105
	(0.291)	(0.331)	(0.415)	(0.400)
Rainfall shock, age 18	-0.518*	-0.571*	0.218	0.228
	(0.268)	(0.318)	(0.353)	(0.434)
Rainfall shock, age 19		0.061		0.337
		(0.279)		(0.539)
Rainfall shock, age 20		-0.020		0.112
		(0.434)		(0.389)
Rainfall shock, age 21		-0.256		-0.089
		(0.252)		(0.294)
Controls	yes	yes	yes	yes
Village FE	yes	yes	yes	yes
Year of birth FE	yes	yes	yes	yes
R2	0.206	0.198	0.312	0.316
Observations	727	682	495	479

Notes: OLS regression. Robust standard errors in parentheses, clustered at the village level. *** 1% , ** 5% , * 10% significance. Constant not displayed. Rainfall is the absolute value of rainfall deviation (in millimeters) from the rainfall historical mean in each cluster from 1981 to 2010 in the six months of the growing seasons (March, April, May and October, November, December). All the coefficients (standard errors) are multiplied by 100. Controls, as described in table 1, include dummies for mother and father highest level of education, an indicator for inadequate house (Bad House), a dummy indicating urban areas and dummies for the head of household ethnic group. Source: Kagera Health Development Survey.

Table A3: Probability of marriage by age 19-23, sample of males

Dependent variable:	*1 if married before or in the year turning 19* (1)	*1 if married before or in the year turning 20* (2)	*1 if married before or in the year turning 21* (3)	*1 if married before or in the year turning 22* (4)	*1 if married before or in the year turning 23* (5)
Rainfall shock, age 15	0.008	-0.059**	-0.056	0.033	0.035
	(0.020)	(0.027)	(0.038)	(0.044)	(0.055)
Rainfall shock, age 16	-0.007	0.001	-0.005	0.048	0.018
	(0.021)	(0.034)	(0.049)	(0.056)	(0.077)
Rainfall shock, age 17	-0.025	-0.017	-0.032	0.049	-0.004
	(0.025)	(0.035)	(0.039)	(0.052)	(0.050)
Rainfall shock, age 18	-0.048	-0.042	-0.041	-0.023	-0.004
	(0.031)	(0.047)	(0.043)	(0.055)	(0.060)
Rainfall shock, age 19	-0.012	-0.012	-0.013	0.009	-0.019
	(0.022)	(0.041)	(0.072)	(0.082)	(0.089)
Rainfall shock, age 20		0.040	0.020	0.005	-0.034
		(0.033)	(0.041)	(0.053)	(0.054)
Rainfall shock, age 21			0.062	0.063	0.062
			(0.038)	(0.042)	(0.045)
Rainfall shock, age 22				0.022	0.048
				(0.044)	(0.049)
Rainfall shock, age 23					-0.076
					(0.058)
Controls	yes	yes	yes	yes	yes
Village FE	yes	yes	yes	yes	yes
Year of birth FE	yes	yes	yes	yes	yes
R2	0.231	0.234	0.220	0.230	0.253
Number of observations	487	482	479	475	466

Notes: OLS regression. Robust standard errors in parentheses, clustered at the village level. *** 1% , ** 5% , * 10% significance. Constant not displayed. Rainfall is the absolute value of rainfall deviation (in millimeters) from the rainfall historical mean in each cluster from 1981 to 2010 in the six months of the growing seasons (March, April, May and October, November, December). All the coefficients (standard errors) are multiplied by 100. Controls, as described in table 1, include dummies for mother and father highest level of education, an indicator for inadequate house (Bad House), a dummy indicating urban areas and dummies for the head of household ethnic group Source: Kagera Health Development Survey.

Table A4: Probability of marriage in the year turning 16 and 18

Dependent variable:	*1 if married before or in the year turning 16*		*1 if married before or in the year turning 17*		*1 if married before or in the year turning 16*		*1 if married before or in the year turning 17*	
	Females				**Males**			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Rainfall shock, age 17	-0.034	-0.032			-0.011	-0.012		
	(0.025)	(0.027)			(0.012)	(0.011)		
Rainfall shock, age 18	0.006	0.007	0.018	0.020	0.001	0.001	-0.005	-0.006
	(0.022)	(0.022)	(0.029)	(0.027)	(0.011)	(0.010)	(0.013)	(0.012)
Rainfall shock, age 19			0.041	0.042			-0.013	-0.013
			(0.028)	(0.028)			(0.013)	(0.013)
Controls	no	yes	no	yes	no	yes	no	yes
Village FE	yes	yes	yes	yes	yes	yes	yes	yes
Year of birth FE	yes	yes	yes	yes	yes	yes	yes	yes
R2	0.135	0.152	0.133	0.151	0.128	0.153	0.154	0.172
Observations	737	737	720	720	513	513	505	505

Notes: OLS regression. Robust standard errors in parentheses, clustered at the village level. *** 1% , ** 5% , * 10% significance. Constant not displayed. Rainfall is the absolute value of rainfall deviation (in millimeters) from the rainfall historical mean in each cluster from 1981 to 2010 in the six months of the growing seasons (March, April, May and October, November, December). All the coefficients (standard errors) are multiplied by 100. Controls, as described in table 1, include dummies for mother and father highest level of education, an indicator for inadequate house (Bad House), a dummy indicating urban areas and dummies for the head of household ethnic group. Source: Kagera Health Development Survey.