The Effects of Drought on the Marriage Market: Forces of Delay and Forces of Acceleration

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Abstract

This study examines how climate shocks reshape the timing of women's marriage in Nigeria, treating marriage as a two-sided market in which forces of delay and acceleration coexist. While the climate–marriage literature has focused on child marriage and on the bride's side alone, we ask how growing-season drought affects adult women's first marriage when a covariate shock reaches both the bride's and the groom's families.

Using four waves of the World Bank's LSMS-ISA Nigeria Panel (2010–2019; 26,186 person-years from 6,259 women) merged with high-resolution CHIRPS precipitation data, we estimate a discrete-time hazard model with two-way (individual × year) fixed effects. On balance, drought delays marriage: an additional growing-season drought month in the previous year lowers the annual marriage hazard by about eight to nine per cent, a result robust to placebo tests and to fixed- versus random-effects specifications. Decomposing marriage-market flows locates the adjustment on the bride's side—fewer daughters leave to marry, while the rate at which households take in brides is unchanged.

The net delay masks opposing forces: a fall in the local bride price and the unaffordability of the wedding push marriage back, while bride price as a coping asset, the collapse of a daughter's own farm income, and household vulnerability pull it forward in particular subgroups. These findings suggest that delayed marriage under drought should not be read as improved opportunity or empowerment, but as a marker of household hardship and disruption in a central social institution on which women's security depends.

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1. Introduction

The United Nations Secretary-General's description of the current period as an "era of global boiling" (United Nations, 2023) rather than global warming signals that the climate crisis has moved beyond a distant warning to a direct threat to human survival. The crisis increasingly takes the form of extreme weather events, including rising sea levels, higher average temperatures, severe droughts, and catastrophic floods. These events fall heavily on agriculture, destroying arable land, causing large crop losses and hence decrease in household standard of living across Africa (Amare et al., 2018; Lobell et al., 2011; Emediegwu et al., 2022).

Responses to climate change are usually divided into mitigation and adaptation. Mitigation addresses the root causes, for example by reducing greenhouse-gas emissions, while adaptation aims to limit the damage from climate change that has already occurred. Marriage has been suggested as one such adaptation strategy, through which households cope with the effects of climate shocks they cannot control, especially where marriage involves a payment such as bride price or dowry (Corno, Hildebrandt and Voena, 2020).

A growing literature documents how climate shocks reshape the timing of marriage, and shows that the effect depends on the direction of marriage payments (Corno, Hildebrandt and Voena, 2020). Marriage payments fall into two systems. Bride price is wealth or cash transferred from the groom's family to the bride's family, and is common in sub-Saharan Africa, whereas dowry flows in the opposite direction, from the bride's family to the groom's, and is more common in South Asia, such as India and Bangladesh. Where dowry prevails, as in Bangladesh, an income shock tends to delay marriage, because the bride's family cannot meet the dowry (Corno, Hildebrandt and Voena, 2020; Trinh and Zhang, 2021; Rao, 1993). Where bride price prevails, as in much of sub-Saharan Africa, a drought-induced fall in income can instead lead families to marry daughters earlier and use the bride payment to smooth consumption. This is because marrying a daughter brings a substantial inflow of cash, livestock, and goods to her natal household during a shock (Anderson, 2007; Lowes and Nunn, 2018). A climate shock, which usually lowers agricultural income, can therefore shape the timing of women's marriage (Kumala Dewi and Dartanto, 2019; Pope et al., 2022; Otzelberger, 2014). Few studies that examine the mechanism behind point in different directions, from schooling and re-enrollment of girls (Trinh and Zhang, 2021) to the burden of a large family (Ahmed et al., 2019; Wadekar, 2020). Most are qualitative rather than quantitative in proving this mechanism.

Marriage is a largely irreversible transition in much of sub-Saharan Africa and therefore it shapes a woman's life over the whole life cycle (Shapiro and Gebreselassie, 2014). The conditions under which a woman marries, the household she joins, the husband she is matched to, and the timing of the marriage all affect her well-being and bargaining power for the rest of her life (Field and Ambrus, 2008; Lowes and Nunn, 2018).

Why, then, does the timing of marriage matter? Early marriage is widely documented to harm women, through worse matches, intimate-partner violence, and weaker bargaining power (Kidman, 2017; Tauseef and Sufian, 2024); marriages hastened under environmental stress, in particular, tend to match women to poorer and less educated husbands who are more accepting of intimate-partner violence (Carrico et al., 2020). A shock that delays marriage might therefore seem benign. Yet a delay driven by a negative income shock is not the same as a delay driven by widening opportunity, such as schooling or work. When families postpone or forgo marriages because they cannot finance a wedding, or because the local bride price has collapsed, the delay signals economic distress and a disrupted marriage market rather than empowerment. In a society where marriage is near-universal and provides much of a woman's economic and social security (Shapiro and Gebreselassie, 2014), such disruptions can prolong insecurity for women and their families and strain a central social institution. Both acceleration and delay carry social costs, which is why identifying the dominant force and its mechanism matters.

Taken together, three gaps remain in this research area. First, almost all of this literature focuses on child marriage. The marriage of adult women, where the dynamics of choice and of marriage migration differ, has been left largely unexamined. Second, the mechanism has rarely been identified in detail: the net direction of the effect is documented, but the competing forces of acceleration and delay are seldom separated. Third, and most important, heterogeneity has been studied almost entirely on the bride's side, while the groom's family is set aside, largely because of data limitations. Yet a drought is a covariate shock: when a marriage is local, it lowers the income not only of the bride's family but also of the groom's, which can also affect affordability and hence marriage demand from the groom's side.

Therefore, this study asks how drought affects the timing of women’s marriage in Nigeria, considering both the delaying and the accelerating forces and both the bride’s and the groom’s families. Specifically, it addresses three questions: (i) how does drought affect the timing of marriage; (ii) does the adjustment operate on the man’s side or the woman’s side; and (iii) which forces of acceleration and delay drive the net effect.

To answer these questions, Nigeria, a sub-Saharan African country exposed to rainfall variability, has been chosen as the area of study. This study uses the World Bank’s Living Standards Measurement Study – Integrated Surveys on Agriculture (LSMS-ISA) project in Nigeria, also known as the General Household Survey (GHS), matched with gridded rainfall data. A two-way fixed-effects model on this panel data is applied as the main analysis method.

2. Literature Review and Background

2.1 Climate shocks and the marriage market

In much of sub-Saharan Africa, marriage is understood less as a romantic union between two individuals than as a contract between two lineages and communities, especially in rural area (Esiri, 2021). Although marriage is an important passage of adulthood that can shape a woman's entire life, it is usually arranged or facilitated by the family, parents and community elders rather than chosen by the bride alone (Shapiro and Gebreselassie, 2014). This collective and economic character of marriage is what makes its timing responsive to household resources and therefore to climate shocks.

Several studies show that marrying a daughter serves as a coping strategy against economic insecurity (Jensen and Thornton, 2003; Alston et al., 2014; Ahmed et al., 2019; Kumala Dewi and Dartanto, 2019). Where bride price is paid, which is a transfer from the groom's side to the bride's side that partly compensates her family for the loss of her labour, these marriage payments work as a source of consumption smoothing (Hoogeveen, van der Klaauw and van Lomwel, 2011; Corno, Hildebrandt and Voena, 2020). An early theoretical statement is Rosenzweig and Stark (1989), who use rural Indian data to show that households enter implicit insurance arrangements by marrying daughters to spatially distant but kin-linked households, which spreads the spatial risk of agricultural income and reduces the variability of household consumption. Building on this, recent work asks how the timing of marriage is adjusted when climate-induced income shocks tighten a household's liquidity constraint.

The key empirical insight is that the marriage market response to an income shock depends on the direction of a society's marriage payments. Corno, Hildebrandt and Voena (2020), comparing large household datasets across countries, show that where bride price prevails, as across most of sub-Saharan Africa, a drought raises the annual hazard of (child) marriage by about three per cent, as families bring marriages forward to draw in the bride payment. The opposite holds only under dowry, as in India, where the same shock lowers the hazard, and this contrast underscores that it is the bride-price institution that drives the acceleration (Corno, Hildebrandt and Voena, 2020). The bride-price pattern recurs elsewhere: in Vietnam, households likewise advance daughters' marriages after adverse shocks (Trinh and Zhang, 2021).

This hastening, however, can be costly for the women involved. Using Bangladesh data, Carrico et al. (2020) find that girls and women are more likely to marry in the year of or after extreme heat, and that those who marry under environmental stress are matched to poorer and less educated husbands who are more supportive of intimate-partner violence. A related literature links early or hastened marriage to weaker female decision-making power, less schooling, and weaker property rights, with negative consequences for women's empowerment (Field and Ambrus, 2008; Lowes and Nunn, 2018). The effects are larger where households are already vulnerable, as girls in relatively poor households or in displacement settings face the greatest exposure to early marriage under climate stress (Kumala Dewi and Dartanto, 2019; Ahmed et al., 2019).

Several gaps among literature motivate this study. The strong focus on child marriage, which is understandable given its importance as a human-rights and developmental concern, leaves the marriage of adult women and the distinct dynamics of adult marriage largely unexamined. In addition, heterogeneity has been described almost entirely on the bride's side, even though a covariate climate shock is likely to reach the groom's family as well. This study addresses both gaps. Also, compared to the dowry culture in Bangladesh or India, bride price culture has not been fully explained, especially very rare in Nigerian context.

2.2 Marriage and bride price in Nigeria

Nigeria, the most populous country in Africa, has more than 250 ethnic groups and languages. Its three largest groups, the Hausa in the north, the Yoruba in the south-west and the Igbo in the south-east, each account for roughly a fifth of the population. Religion follows this geography closely: the north is mostly Muslim, while the south is mostly Christian alongside indigenous beliefs. This produces a strong regional and cultural divide within a single country (Ministry of Foreign Affairs, Nigeria, n.d.).

For this study, the important point is that the bride-price institution is not uniform across Nigeria. In the Muslim north, the Hausa keep a symbolic, low-cost payment (sadaki), in line with an Islamic preference for minimal financial barriers to marriage (Solivetti, 1994). The Yoruba likewise treat the owó orí as a largely symbolic exchange that affirms communal bonding and emphasize the ritual value of engagement gifts over cash. The Igbo, on the other hand, follow an elaborate, negotiated process with extensive bridal lists, in which the bride price is a substantial transfer of wealth and a marker of social prestige (Amadiume, 1987). This variation implies that the marriage-market response to a climate shock should also differ across groups. Where bride price is high, as in Igboland, a daughter is a valuable liquid asset whose marriage may be brought forward to raise cash during an environmental crisis, while where it is low the same incentive is weak (Corno, Hildebrandt and Voena, 2020). At the same time, a high bride price raises the cost of marrying for the groom's side, which can instead delay marriage when resources are scarce: rising bridewealth has been linked to later marriage (Isiugo-Abanihe, 1995; National Research Council, 1993). Whether a high bride price brings marriage forward or pushes it back is therefore an empirical question, and this heterogeneity is central to the mechanism analysis below.

3. Research Methodology

This study applies a two-way fixed-effects framework to identify the causal effect of growing-season drought on the timing of women's first marriage. The following sections describe the data, the sample, the measurement of drought, the decomposition of marriage by destination, and the heterogeneity analysis together with its moderators.

3.1 Data

This study bases the analysis on household panel data matched with climate data. For the household and individual data, we use the Nigeria General Household Survey (GHS), part of the World Bank's Living Standards Measurement Study – Integrated Surveys on Agriculture (LSMS-ISA) project. The survey has five waves (2010/11, 2012/13, 2015/16, 2018/19 and 2023/24), and each wave involves two visits, a post-planting visit and a post-harvest visit to capture the agricultural cycle. Given the consistency of the questions and the time lag between waves, we use only the first four waves, collected between 2010 and 2019. The dataset includes GPS coordinates for households and agricultural plots, which allow us to merge the survey with external, location-specific climate data and make this research possible.

For the climate data, this study utilized CHIRPS (Climate Hazards Group InfraRed Precipitation with Station data), a high-resolution (0.05°) satellite-station combined dataset to construct climate impact variables. Data processing was performed via the Google Earth Engine platform, with the specific procedures outlined below. First, the GPS coordinates of all households included in the Nigerian General Household Survey (GHS-Panel) were matched to the CHIRPS grid, enabling the extraction of monthly precipitation data for each household location. Second, to establish a baseline for climate variability, a 30-year long-term time series was constructed covering the period from 1991 to 2020, calculating the monthly mean and standard deviation for each location. Thirdly, based on this, a Standardized Precipitation Anomaly (Z-score) was calculated to measure how unusual the precipitation for a specific year t and month m was relative to the long-term average. The resulting Z-score was used as the key independent variable representing the intensity of the climate shock experienced by each household.

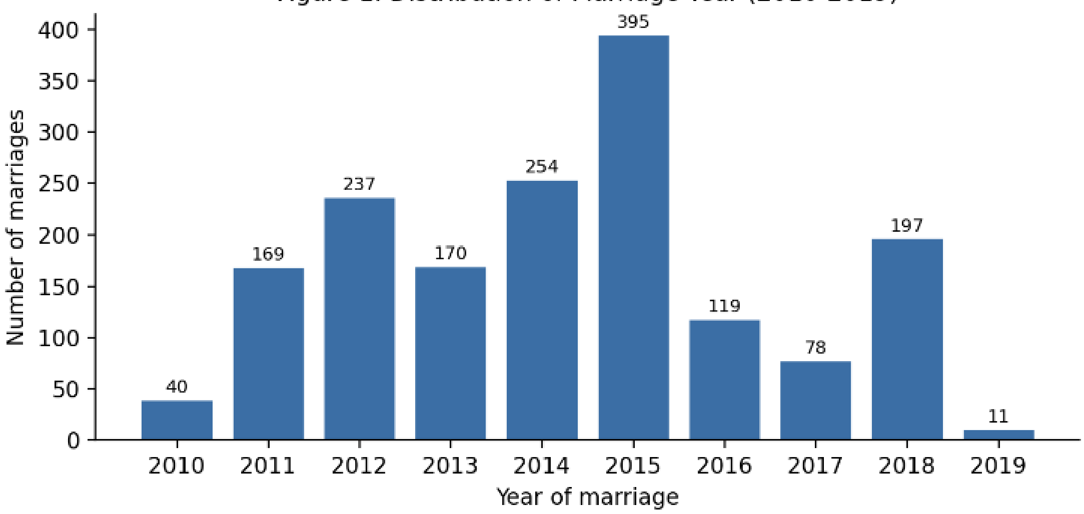
Table 1. Data sources and structure

	Climate related data	Household & Individual data
institution	Climate Hazard Center	World Bank (WB) & National Bureau of statistics (NBS)
Data source	Climate Hazards Group InfraRed Precipitation with Station data (CHIRPS)	Nigeria General Household survey (GHS) (wave 1 - 4)

3.2 Sample and targeted observation

To ensure accurate matching with geo-referenced climate data, households without precise geographical coordinates were excluded. To deal with age-reporting discrepancies across waves, we applied a two-step cleaning process: first, we excluded individuals whose reported age gap between waves exceeded 10 years, and second, we set birth years from the mode of the reported ages. When there was a tie, the first survey wave was used. This process yields a sample of 26,186 observations (person-years) from 6,259 women, with 1,619 marriage events over 2011–2018. The years 2010 and 2019 are dropped because of the survey timing: wave 1 began in 2010, so no one is recorded as leaving the household in that year, and wave 4 took place in early 2019, so only departures in January and February of 2019 are observed. The estimation window is therefore 2011–2018.

Figure 1. Distribution of Marriage Year (2010-2019)



The target age bracket of 11 to 35 was chosen based on the socio-demographic context of Nigeria. About 91% of all observed female marriages in the data occur between ages 11 and 35, so we restrict the sample to this window. Focusing on this cohort lets the model capture the most active period of life-cycle transitions.

3.3. Empirical strategies

To identify causal relationships, this study applies a two-way fixed-effects framework. By including both individual and year fixed effects, the model uses the panel structure of the data to control for unobserved, time-invariant individual and household characteristics and for year-specific shocks. This helps to reduce omitted-variable bias and to isolate the net causal effect of climate shocks from other confounding factors. This empirical strategy allows a more convincing and robust account of the causal link between environmental stress and marriage-timing decisions.

The dependent variable $Y_{i,t}$ is a discrete-time hazard indicator. It equals 1 in the year woman i first leaves her natal household to marry, and 0 in each earlier at-risk year. Marriages are identified from the roster's reason for departure code ("left to marry"). A woman who has married is removed from the risk set after that year, so the panel is a standard single-spell duration design estimated in discrete time.

3.3.1 Marriage Analysis with drought intensity

In the first step, to examine the relationship between climate intensity and marriage, the baseline empirical model is as follows:

$$Y_{i,t} = \alpha + \beta \mathrm{Drought}_{g(i),t-1} + \sum_{k} \delta_k \,\mathrm{AgeDummy}_{k,i,t} + \mu_i + \lambda_t + \varepsilon_{i,t}$$

The dependent variable $\boldsymbol{Y}_{\{i,t\}}$ is defined as a dummy variable that equals 1 if individual i leaves the original household to marry in year t, and 0 otherwise. $\boldsymbol{AgeDummy}_{\{k,ist\}}$ depicts a set of dummy variables for different age cohorts to control life-cycle effects. Unlike other socio-economic behaviors that might follow a linear trend, the propensity for marriage tends to exhibit non-linear and discrete shifts at specific life stages. To account for this 'step-like' pattern, we categorized individuals into five-year intervals from 11 to 35 years old. The youngest cohort (11–15) is the reference category, so the remaining coefficients measure the marriage hazard relative to early adolescence.

$\boldsymbol{\mu_i}$ stands for individual fixed effects which absorbs every time-invariant characteristic of women and her household, $\boldsymbol{\lambda_t}$ represents time/year fixed effects absorbing nationwide shock, such as economic growth, price inflation and any common national trend in marriage., $\epsilon_{\{i,t\}}$ is the idiosyncratic error term. Each regression contains a single climate term; drought and excess rainfall are entered in separate specifications, and the lead at t+1 is used as a placebo (a coefficient near zero rules out anticipation or reverse causality).

$\mathrm{Drought}_{g(i),t-1}$ represents the frequency or occurrence of droughts in household i's GPS grid cell during the previous year $t-1$. Given that Nigeria's agricultural sector is predominantly rain-fed, the precipitation patterns between May and October, the primary growing season, are critical for crop development and final yields (Amare et al., 2018). Consequently, the climate shock in this research only focused on this six-month period, so that it captures climate anomalies that have the most direct and significant impact on household income, food security, which might lead to changes in decision-making of the household.

$$z_{st} = \frac{Rainfall_{st} - Mean_{s,1991-2021}}{\sigma_{s,1991-2021}}$$

A drought month is a growing-season month in which rainfall falls more than a given threshold below its long-run mean, and the drought variable is the count of such months in the year (0–6). We use three thresholds of increasing severity, 1.0, 1.5 and 2.0 standard deviations ("mild", "moderate" and "extreme"), and treat ±1.5 SD as the primary specification. The shock enters with a one-year lag (t−1), because a poor growing season lowers the harvest and household resources, which then shape marriage decisions over the following year, so the relevant timing is the season before the marriage decision. As a falsification test, the t+1 lead replaces the t−1 shock; a coefficient near zero on the lead rules out anticipation effects and reverse causality.

A Hausman test comparing the fixed- and random-effects estimates of the drought coefficient rejects random effects in favour of fixed effects at the ±1.0 and ±1.5 SD thresholds, as shown in Table 12 in the appendix.

3.3.2 Analysis with two sides: bride and groom

Because a marriage moves a woman between two households, a fall in observed marriages could come from either side: the bride's family choosing to postpone, or the groom's family being unable to take a wife. Shapiro and Gebreselassie (2014) states the economic difficulties decrease the demand of marriage by males for spouses and increase the supply for potential female spouses. To separate the two, we estimate the drought effect on both flows recorded in the household roster.

The supply side is the “leave” hazard defined above, that is the annual probability that a daughter leaves her natal household to marry. The demand side is a parallel “join” hazard, built from the roster’s arrival record. We identify women who entered a household for the reason of marriage (an incoming bride) and code the outcome as 1 if any bride joined household h in year t and 0 otherwise, over the continuously observed households. The join hazard is estimated in the same way as the baseline model, with household and year fixed effects and standard errors clustered by state:

3.3.3 Analysis of accelerating and delaying factor

- **Covariate shock: same-state vs migratory marriage**

A covariate climate shock can both deter marriage and re-route it, so we decompose each first marriage into competing risks according to where the woman goes. Using the migration module, a marriage is classified as same-state (“stay”) if the woman remains within her origin state, as migratory (“mig”) if she crosses a state boundary (her recorded destination state differs from her origin household’s state), and as international if she moves abroad. International marriages (13 events) are dropped. The baseline model is then re-estimated separately with the same-state hazard and the migratory hazard as outcomes, on the same at-risk sample, so that by construction the all-marriage coefficient equals the sum of the two cause-specific coefficients:

$$Y_{i,t}^{c} = \alpha^{c} + \beta^{c}\mathrm{Drought}_{g(i),t-1} + \sum_{k} \delta_{k}^{c}\,\mathrm{AgeDummy}_{k,i,t} + \mu_{i} + \lambda_{t} + \varepsilon_{i,t}^{c}, c = \mathrm{stay}, \mathrm{mig}$$

This decomposition asks whether drought postpones marriages that stay inside the shocked local marriage market (same-state), where both the bride’s and the groom’s families are hit by the same covariate shock, while leaving climate-bridging migratory matches unaffected. This marriage cum migration patterns shows the possibility of income risks, and whether the bride’s family apply marriage as consumption smoothing strategy (Rosenzweig and Stark, 1989).

- **Heterogeneity and the moderators**

To examine the mechanism linking drought and marriage, we study heterogeneous effects through a baseline moderator M_i. Because Nigerian subpopulations differ widely in geography, ethnicity and religion, and therefore follow different time trends, a single common year effect would confound the interaction with those different trends. We therefore estimate heterogeneity in two ways: as separate subsamples, where each group carries its own full set of fixed effects, and, for binary moderators, as an interaction that adds group-specific year effects ($\lambda_t \times M_i$):

$$Y_{i,t} = \alpha + \beta_1 \text{Drought}_{g(i),t-1} + \beta_2(\text{Drought}_{g(i),t-1} \times M_i) + \sum_k \delta_k \text{ AgeDummy}_{k,i,t} + \mu_i + \lambda_t + (\lambda_t \times M_i) + \varepsilon_{i,t}$$

Every moderator is fixed at its baseline (earliest observed) value, so that it cannot be contaminated by the contemporaneous shock. Labour is taken from the earliest post-harvest waves and consumption from the wave strictly before the shock year(previous value of t-1 as proxy). The moderators are as follows:

• Tribe × religion (bride-price norms). Tribe is the woman's self-reported main language (Hausa, Igbo, Yoruba, Fulani and smaller groups grouped as "Other"), and religion is Muslim versus Christian. As a cultural norm, bride price is high among the Igbo and Yoruba and low among the Hausa, so these groups can serve as a proxy for the local bride-price institution.

• Own labour by sector. From the labour module (participation in the past seven days), we record whether the woman does household farm work, non-farm self-employment or external wage employment (each a 0/1 indicator). These capture the value of her labour at home and whether that value survives a drought.

• Household size. The baseline number of household members (split at the median), capturing the "mouths to feed" motive.

• Household headship. An indicator for a female-headed household, which in this setting marks vulnerability (typically widowhood or a missing male head) rather than empowerment.

• Education. The woman's own attainment summarized as secondary schooling or higher (=1).

• Rural residence. Whether the household is in a rural enumeration area, the setting most exposed to rainfall shocks.

• Consumption and ceremony burden. Household total consumption (the World Bank aggregate), measured at the wave strictly before the shock, as a wealth proxy (high = above median); and a ceremony-burden measure equal to the state-median wedding expenditure divided by the household's total consumption, which captures how costly a wedding is relative to the family's resources while partly netting out wealth.

Because these analyses cover many subsamples and intensity thresholds, the heterogeneity results are treated as exploratory. We treat a heterogeneous effect as credible only when its sign is consistent across the robust interaction, the subsample estimates and the drought thresholds.

3.4. descriptive statistics

Table 2. Sample and marriage events by year (2010–2019)

Year	Person-years	Leave events	same-state	migratory	In analysis window
2010	40	40	34	6	— excluded
2011	3,463	169	136	32	Yes
2012	3,533	237	193	42	Yes
2013	4,006	170	146	23	Yes
2014	3,963	254	208	40	Yes
2015	4,112	395	332	61	Yes
2016	4,346	119	94	25	Yes
2017	1,322	78	53	24	Yes
2018	1,441	197	150	47	Yes
2019	3,467	11	11	0	— excluded

Notes: Full 2010–2019 distribution of woman-years (women aged 11–35) and first-marriage ("leave") events; same-state vs migratory by whether the bride crosses a state boundary (international omitted from the split). The estimation window is 2011–2018; the edge years 2010 and 2019 are excluded.

Table 3. Drought exposure (growing-season months, person-year)

Drought intensity	Mean	Std. Dev.	N
Months ≥ ±1.0 SD	1.22	1.16	25,922
Months ≥ ±1.5 SD	0.47	0.82	25,922
Months ≥ ±2.0 SD	0.16	0.46	25,922
Annual rainfall (standardized z)	-0.23	0.51	25,922

Notes: Counts of growing-season months (May–October) at the household GPS grid cell with rainfall below the indicated threshold, at the person-year level (2011–2018).

Table 4. Descriptive statistics

	Mean	Std. Dev.	N
Individual characteristics (woman level)			
Age (years)	15.53	5.71	6,259
Education (highest attained)			
No / non-formal schooling (=1)	1.8%		5,575
Primary education (=1)	31.4%		5,575
Junior secondary (=1)	17.4%		5,575
Senior secondary (=1)	34.7%		5,575

Tertiary education (=1)	9.6%		5,575
Quranic schooling (=1)	5.1%		5,575
Ever married during panel (=1)	25.9%		6,259
Age at first marriage (married only)	20.96	5.89	1,619
Household characteristics (woman level)			
Female-headed household (=1)	13.6%		6,259
Household size (persons)	7.33	3.24	6,259
Religion			
Muslim (=1)	43.2%		6,256
Christian (=1)	56.2%		6,256
Traditional / other (=1)	0.6%		6,256
Ethnicity (main language)			
Hausa (=1)	30.7%		5,928
Fulani (=1)	3.6%		5,928
Yoruba (=1)	15.7%		5,928
Igbo (=1)	14.4%		5,928
Tiv (=1)	1.7%		5,928
Ijaw (=1)	1.7%		5,928
Kanuri (=1)	1.0%		5,928
Edo (=1)	1.1%		5,928
Other (=1)	30.1%		5,928
Rural residence (=1)	66.4%		6,259
Own labour (past 7 days)			
Household farm work (=1)	12.3%		5,641
Non-farm self-employment (=1)	8.4%		5,641
External wage employment (=1)	3.7%		5,641
Economic resources			
Total consumption (naira, pre-shock)	87969.20	175748.41	5,852
Ceremony burden (state cost / consumption)	0.22	0.46	5,852
Married this year (=1)	6.2%		26,186

Notes: Sample = women aged 11–35, 2011–2018. Individual and household statistics are at the woman level (N≈6,259; first observed year); climate and outcome at the person-year level (N≈26,186). For binary variables (1/0) the mean is the sample proportion. Tribe is the self-reported main language. Consumption is the WB aggregate at the wave strictly preceding the shock; ceremony burden is the state-median wedding cost over household consumption. Unweighted;

Table 5. Marriage-market flows (leave vs join) and group composition

	Count	Note
Leave events (bride departs) — total	1619	*supply side; the dependent variable*
same-state	1312	
migratory (cross-state)	294	
international (excluded)	13	
Join events (bride arrives) — total	695	*demand side; brides joining a household, 2011–2018*
Join regression person-years	31,432	*continuous households*

Notes: "Leave" (supply) is the analysis dependent variable; "join" (demand) counts brides entering continuous households over 2011–2018.

4 Results & Discussion

4.1 Drought delays the timing of marriage

Drought reduces the number of marriages, which we read as a delay in the timing of marriage (Table 6). For mild drought (±1.0 SD), an additional drought month lowers the marriage hazard by 0.0050*, which is about 8.4% of the mean marriage for unmarried women aged 11 to 35. For moderate drought, one additional drought month lowers the hazard by 0.0051* (about 8.5% of the mean). The effect for extreme drought is in the same direction (−0.0060, about 10% of the mean) but is not statistically significant, because severe droughts are rare and the number of cases is small. The result is not driven by anticipation or reverse causality: the t+1 placebo lead is small and insignificant at every threshold. The coefficients look small, but marriage is not a frequent multiple events for most Nigerian women (Shapiro and Gebreselassie, 2014;), so a change of this size is economically meaningful. Taken together, and given the context, drought does delay the timing of marriage for women in Nigeria.

Table 6. Effect of Climate Shocks on the Hazard of Marriage

Discrete-time hazard, two-way (individual × year) fixed effects

Drought intensity	(causal) t−1	(placebo) t+1	Implied % Δ hazard
±1.0 SD	-0.0050*	+0.0023	-8.4%
	(0.0027)	*(0.0021)*	
±1.5 SD	-0.0051*	+0.0020	-8.5%
	(0.0031)	*(0.0024)*	
±2.0 SD	-0.0060	+0.0050	-10.1%
	(0.0048)	*(0.0041)*	

*Notes: Each cell from a separate regression of first marriage on the drought month-count at the indicated threshold. Mean of the dependent variable = 0.0596; N = 25,841 person-years (6,259 women, 1,539 marriages). A near-zero t+1 placebo lead supports a causal reading. *** p<0.01, ** p<0.05, * p<0.1; SE in parentheses.*

4.2 Which side of the market adjusts: the woman's family

Because a marriage moves a woman between two households, this net delay could come mainly from either side: the bride's family choosing to postpone, or the groom's family being unable to afford a wife. In other words, in the marriage market, the demand from groom's family and supply of bride's family meet together to decide the equilibrium. To locate the adjustment, we use two flows recorded in the household roster. The "leave" hazard is the dependent variable above, the annual probability that a daughter leaves her natal household to marry, which is the supply side. The "join" hazard is its mirror image, the annual probability that a bride enters a household, which is the demand side. As Table 7 shows, drought lowers the leave hazard (−0.0050* and −0.0051* at the mild and moderate thresholds, about 8.4% and 8.5% of the mean leave hazard), but leaves the join hazard essentially unchanged and insignificant. The adjustment therefore runs through the bride's side: when drought strikes, fewer daughters leave to marry, while the rate at which households take in brides is unaffected. The two hazards are measured on different, non-overlapping household samples, and the results are similar after including various controls. This points the mechanism analysis that follows to the decisions of the bride's family, and it already weighs against a groom-affordability story.

Table 7. Which side of the market adjusts: leave vs join

Drought intensity	Leave (bride departs)	Join (bride arrives)
±1.0 SD	-0.0050*	+0.0008
	(0.0027)	*(0.0009)*
±1.5 SD	-0.0051*	+0.0013
	(0.0031)	*(0.0014)*

*Notes: "Leave" is the woman-year hazard that a daughter departs to marry (supply); "join" is the household-year hazard that a bride enters a continuous household (demand). Drought reduces leaving but not arriving, locating the adjustment on the bride side. *** p<0.01, ** p<0.05, * p<0.1.*

4.3 What drives the delay, and what drives the acceleration

Having shown that the adjustment falls mainly on the bride's side, we now turn to why drought delays marriage on balance and which forces offset that delay. The net effect reflects two opposing forces, some that postpone marriage and others that bring it forward, and we organize the evidence accordingly.

Two cautions apply when reading these results. First, because marriage is not a frequent multiple events for each woman, splitting the sample into many subgroups reduces statistical precision relative to the average effect. The heterogeneity analysis should therefore be read as exploratory, and we regard a pattern as credible only when its sign is stable across the interaction specification, the subsample estimates and the three intensity thresholds. Second, because neither bride-price payments nor wedding expenditures are directly observed, the proposed mechanisms are inferred from the pattern of marriage responses rather than from observed prices.

4.3.1 Delaying factor

Two forces hold marriage back. The first is a possible fall in the local bride price. When we split marriages by whether the bride stays in her origin state or crosses a state border, the delay is concentrated entirely among same-state marriages. The same-state hazard falls by 0.0052* at the moderate threshold and 0.0072* at the extreme threshold (about 9% and 12% of the mean marriage hazard), while the migratory hazard stays close to zero, and together the two margins account for the overall effect (Table 8). This pattern is consistent with a shock to the local bride price. A drought lowers the resources of prospective grooms as well as those of the brides' families (Corno, Hildebrandt and Voena, 2020), which can lower the bride price that local grooms can offer. Rather than accept a lower bride price, families may postpone their daughters' marriages. Marriages that cross state borders are less exposed to this mechanism, because the groom's household is in a different and often unaffected local marriage market. Although bride prices are not directly observed, the contrast between same-state and migratory marriages closely matches the pattern implied by a local bride-price channel.

Table 8. Forces of delay (1): marriage-cum-migration decomposition (cause-specific hazards)

Drought intensity	(1) All	(2) Same-state	(3) Migration
±1.0 SD	-0.0052*	-0.0042	-0.0010
	(0.0027)	*(0.0027)*	*(0.0009)*
±1.5 SD	-0.0052*	-0.0052*	-0.0000
	(0.0031)	*(0.0029)*	*(0.0012)*
±2.0 SD	-0.0070	-0.0072*	+0.0002
	(0.0047)	*(0.0041)*	*(0.0020)*

Notes: Same risk set, international excluded; column (1)=(2)+(3). The delay is borne by same-state marriages; migration ~0. ‡ marks a same-state coefficient whose t+1 placebo lead is itself significant (none here at the credible ±1.5/±2.0 thresholds).

The second delaying force is the cost of the wedding. Although the bride price flows to the bride's family, the wedding itself is a costly celebration. The bride's family also bears part of its expense, hosting the traditional ceremony and feeding guests (Fadipe, 1970), while the groom's side likewise faces large and rising marriage costs (Smith, 2017). Where this cost is large relative to a family's resources, a drought makes it harder to meet. To capture this channel, we build a ceremony-burden measure equal to the state-median wedding expenditure divided by the household's own consumption. Its interaction with drought is negative and significant (β_2 = −0.0090 at the mild threshold and −0.0202 at the extreme threshold, about −15% and −34% of the mean hazard), so households facing a heavier burden postpone marriage by more (Table 9). Wealth itself does not moderate the effect: neither total nor per-capita consumption is significant. The binding constraint therefore seems to be not poverty as such, but the cost of the wedding relative to available resources. This burden is especially high in the poorer, agriculture-dependent North-West, which is one reason why drought-induced marriage delays are strongest there, a pattern we return to in the regional analysis below.

Table 9. Forces of delay (2): the cost of the wedding (drought × moderator, robust group × year FE)

Moderator (β_2)	±1.0 SD	±1.5 SD	±2.0 SD
Total consumption (high)	+0.0009	+0.0004	+0.0038
	(0.0055)	*(0.0076)*	*(0.0126)*
Ceremony burden: local cost / consumption (high)	-0.0090*	-0.0089	-0.0202*
	(0.0050)	*(0.0055)*	*(0.0105)*

*Notes: β_2 on Drought × moderator with group-specific year effects; both measured at baseline (consumption at the wave strictly preceding the shock). Wealth alone does not moderate the effect; the ceremony burden does. EXPLORATORY. *** p<0.01, ** p<0.05, * p<0.1.*

4.3.2 Accelerating factor

Three forces pull the other way. The first is bride price working as a coping asset, and it appears where bride price is high. By ethnographic account, bride price is high among the Igbo and Yoruba of the south and low among the Hausa of the north (Solivetti, 1994; Amadiume, 1987; Isiugo-Abanihe, 1995), and the estimates follow this gradient. The high-bride-price groups turn positive: Yoruba Muslims accelerate significantly (+0.0181 at the moderate threshold) and the Igbo are positive though imprecise, while the low-bride-price Hausa Muslims delay (−0.0101** at the mild threshold).

A geographic cut by zone and religion tells the same story: the delay sits with Northern Muslims, the South-East Igbo Christians accelerate, and within a zone religion separates the sign more sharply than region. The two faces of the bride price are not a contradiction but two responses to one shock. A drought lowers the local price everywhere, but where bride price is high a daughter is still a valuable, liquid asset worth marrying off to raise cash, similar to the logic of literature review (Hoogeveen, van der Klaauw and van Lomwel, 2011; Corno, Hildebrandt and Voena, 2020), where it is low the lowered price is not worth taking and the delaying forces win. These factors are exploratory, and the Igbo acceleration is significant only in the geographic cut, so we do not lean on any single one; but the overall gradient fits bride price acting as a coping strategy where the custom makes a daughter most valuable.

Table 10. Bride-price norms — tribe × religion (subsample drought coefficients)

Tribe × religion	N (PY)	β (±1.0 SD)	β (±1.5 SD)
Igbo × Christian	3,786	-0.0007	+0.0057
		(0.0036)	*(0.0040)*
Yoruba × Muslim	1,677	+0.0137*	+0.0181**
		(0.0070)	*(0.0075)*
Yoruba × Christian	2,486	-0.0029	+0.0041
		(0.0092)	*(0.0064)*
Hausa × Muslim	5,765	-0.0101**	-0.0130
		(0.0051)	*(0.0093)*
Hausa × Christian	1,368	+0.0064	+0.0047
		(0.0063)	*(0.0062)*
Other (incl. Fulani)	10,405	-0.0049*	-0.0017
		(0.0027)	*(0.0023)*

Notes: Bride price is high among Igbo and Yoruba, low among Hausa. High-bride-price groups accelerate (Corno-type coping), the low-bride-price Hausa delay. EXPLORATORY; threshold-fragile.

The second accelerating force is the collapse of the bride's own income. Of the three kinds of work, only household farm work changes the effect. Under mild drought, a woman who did farm work before the drought (t−1) is more likely to marry (β_2 = +0.0129, significant at the 5% level, about +22% of the mean hazard), and the direction is the same for moderate and severe drought. The reason is that drought hits agricultural rural areas hardest, because it directly damages crops and so causes an income shock (Tsaneva, 2020). A drought destroys the very crop a farming daughter would have produced, so the value of keeping her at home falls just as the shock lands, and the family is more willing to send her to marriage (Rosenzweig and Stark, 1989).

The third force is acute vulnerability. A female-headed household here signals hardship, usually widowhood or an absent male head, rather than empowerment (Buvinić and Gupta, 1997), and such households accelerate marriage under drought (β_2 = +0.0098* at the mild and +0.0176* at the extreme threshold, about +16% and +30% of the mean hazard), because they have the least access to other forms of insurance. Household size and the woman's own education show nothing stable, so the simple 'one less mouth to feed' and schooling stories from literature review find little support (Castañeda Camey et al., 2020).

Table 11. Forces of acceleration (2–3): the bride's own labour and household (drought × moderator, robust group × year FE)

Moderator (β_2)	±1.0 SD	±1.5 SD	±2.0 SD
Own farm work	+0.0129**	+0.0036	+0.0077
	(0.0061)	*(0.0095)*	*(0.0114)*
Own self-employment	+0.0021	+0.0095	+0.0243
	(0.0103)	*(0.0115)*	*(0.0190)*
Own wage employment	-0.0052	+0.0216	-0.0052
	(0.0135)	*(0.0168)*	*(0.0301)*
Female-headed household	+0.0098*	+0.0070	+0.0176*
	(0.0059)	*(0.0066)*	*(0.0094)*
Large household	+0.0027	-0.0021	-0.0133*
	(0.0041)	*(0.0048)*	*(0.0081)*
Rural	-0.0014	-0.0041	-0.0151*
	(0.0042)	*(0.0042)*	*(0.0082)*
Secondary+ education	-0.0020	+0.0040	+0.0081
	(0.0046)	*(0.0058)*	*(0.0087)*

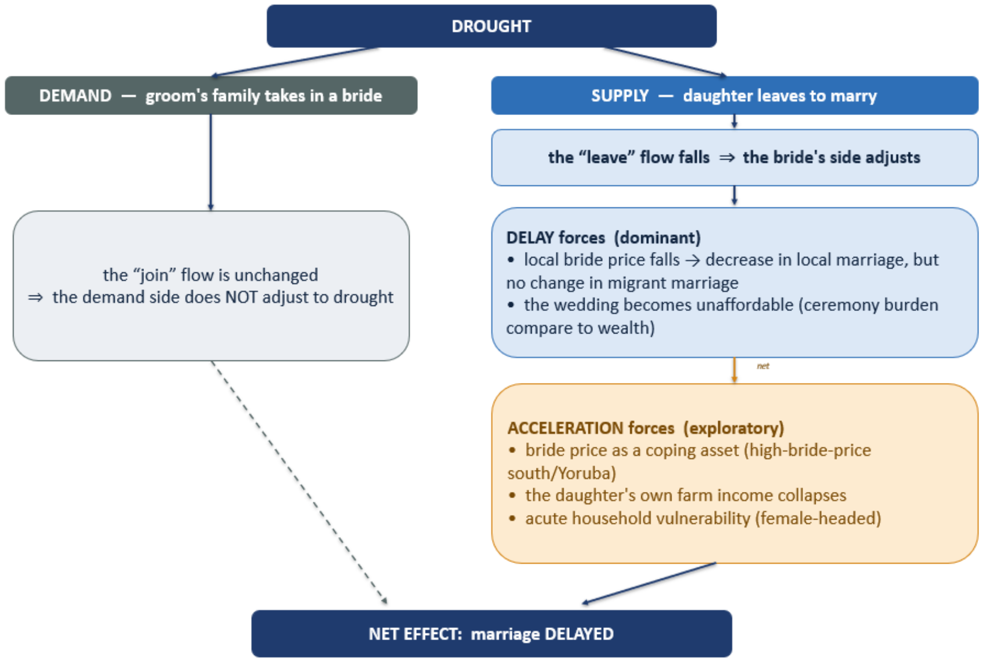
*Notes: β_2 on Drought × moderator with group-specific year effects; baseline moderators (all bride-side; labour from the earliest post-harvest waves). Own farm work moves toward acceleration; female-headship likewise; the remaining characteristics show no stable effect. EXPLORATORY. *** p<0.01, ** p<0.05, * p<0.1.*

Taken together, the evidence describes a marriage market pulled in two directions. The forces of delay, a fall in the local bride price and the unaffordability of the wedding, operate broadly and are concentrated in the poor, agricultural, low-bride-price North. The forces of acceleration, bride price as a coping asset in the high-bride-price south, the collapse of a daughter's own farm income, and acute household vulnerability, appear in particular subgroups but do not overturn the average. On net the delaying forces win: in Nigeria, drought delays marriage, and it does so by changing the economic calculus of the bride's family.

5 Conclusion

This study has examined how growing-season drought affects the timing of women's first marriage in Nigeria. Unlike a literature that has mostly studied child marriage on the bride's side alone, it treats marriage as a two-sided market in which forces of delay and acceleration coexist, and in which a covariate climate shock can affect both the bride's and the groom's families.

Figure 2. Drought and the timing of marriage: a two-sided market



Three findings stand out. First, on balance drought delays marriage. An additional month of drought in the previous year lowers the annual marriage hazard by about eight to nine per cent, a result that survives placebo tests and the choice between fixed- and random-effects specifications. This contrasts with the sub-Saharan finding that, under bride price, drought accelerates child marriage (Corno, Hildebrandt and Voena, 2020), and it shows that for adult women in Nigeria the delaying forces dominate on net.

Second, the adjustment runs through the bride's side of the market. Drought lowers the rate at which daughters leave to marry, but leaves unchanged the rate at which households take in brides, which locates the response in the decisions of the woman's family rather than in groom demand.

Third, the net delay is the result of opposing forces: a fall in the locally determined bride price and the unaffordability of the wedding on the delaying side, and bride price as a coping strategy, the collapse of a daughter's own farm income, and household vulnerability on the accelerating side. A single 'bride price accelerates marriage' summary is therefore too simple for a country as internally varied as Nigeria.

The study has limitations that point to directions for future work. The bride price and the cost of the wedding are not directly observed, so the mechanisms are identified from the pattern of responses and proxy rather than from measured prices. The heterogeneity estimates are exploratory and at times fragile across thresholds. And the groom's side is observed only indirectly, through the contrast between local and migratory marriages. Linking marriage-payment data directly to climate shocks and extending the two-sided analysis with better measures of the groom’s circumstances would sharpen the mechanisms identified.

Because this delay is driven by economic distress rather than by widening opportunity, it should be read as a marker of household hardship and marriage-market disruption, not as a sign of improving conditions for women. Even so, the main message is clear: in Nigeria, drought delays marriage, and it does so by changing the economic calculus of the bride’s family.

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Appendix. Robustness Checks

Table 12. Hausman test — fixed vs random effects (drought, single term)

H0: random effects consistent. Rejection favors fixed effects.

Drought intensity	β (FE)	β (RE)	Hausman $\chi^2(1)$	p-value	Preferred
±1.0 SD	-0.0050	-0.0076	34.10	0.000	FE
±1.5 SD	-0.0051	-0.0065	4.93	0.026	FE
±2.0 SD	-0.0060	-0.0076	1.99	0.158	FE (retained)

Notes: Fixed-effects (individual × year) vs random-effects estimates of the drought coefficient, with classical (non-robust) variances for the Hausman statistic. Random effects are rejected at ±1.0 and ±1.5 SD; at ±2.0 SD the test lacks power (extreme droughts are rare), but fixed effects are retained throughout because the design requires within-individual identification and the time-invariant moderators cannot be estimated under random effects.