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The gender education gap in developing countries: Roles of income shocks and culture*

Sylvain Dessy† Luca Tiberti‡ David Zoundi§

Abstract

When exposed to an adverse income shock, cash-constrained households may lean on culture to select the gender of offspring whose outcomes will be sacrificed to enhance survival. We test this by studying how culture mediates the impact of drought on the gender education gap in two separate settings: Malawi and Indonesia. In so doing, we proxy culture with kinship traditions (matrilocality and patrilocality) and exploit drought episodes' spatial and temporal randomness as a source of exogenous variation in rural households' exposure to adverse income shocks. After accounting for the grid and year-fixed effects, we find that patrilocal households, but not matrilocal ones, sacrifice their daughters' schooling in favor of sons' when they experience droughts and schooling requires payment of fees. These results survive numerous robustness checks and are driven by disparities in women's empowerment and the extent of son preference between matrilocal and patrilocal groups.

Keywords: Drought; Kinship traditions; Matrilocality; Patrilocality; Gender education gap.

JEL codes: I24, I25, I28, O12, O57.

Running title: Shocks, Culture, and Gender Gap

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1 Introduction

Gender disparities disadvantaging girls in primary and secondary education have disappeared in the developed world[1], but persist in developing countries[2]. As most developing countries are prone to adverse income shocks, such as drought, pandemics, and floods, the resulting income volatility may impose difficult choices on cash-constrained low-income households. This paper provides evidence on whether culture interrelates with adverse income shocks to explain the gender education gap favoring boys in developing countries.

We focus on the gender education gap for two important reasons. First, girls' education enhances the quality of the labor force, the fertility transition, and maternal health (Bloom et al., 2009), which makes it a lever of economic development (Wodon et al., 2018). However, despite this, girls continue to trail boys in educational attainment globally. Only 49% of countries have achieved gender parity in primary education, 42% in lower secondary education, and a mere 24% in upper secondary education. Moreover, in the developing world, the difference in boys' and girls' enrollment rates — an indicator of the gender education gap— remains significant.[3] To the extent that girls' education is a lever of development, as the literature finds, the persistence of this gender gap in developing countries is a serious threat to the timely completion of the UN's sustainable development goals (SDGs).

Second, the literature examining the causes of the persistence of gender disparities in educational attainment in low-income countries points to the lack of development itself as the main culprit (Alderman et al., 1996; Klasing and Milionis, 2020). For example, poor maternal health— the result of inadequate health infrastructure— may induce households to invest less in girls' education relative to boys because girls are not expected to live past their childbearing years (Jayachandran, 2015). Moreover, the cost of a girl's education relative to a boy of the same age tends to rise with age, resulting in school

[1]See OECD, 2015. Gender Equality, available online at https://www.oecd.org/gender/data/gender-gap-in-education.htm

[2]See UNICEF, 2022. Gender and Education, available online at https://data.unicef.org/topic/gender/gender-disparities-in-education/

[3]See UNICEF, 2021. Available at https://www.unicef.org/education/girls-education

environments that are inhospitable to adolescent girls (Goldin and Katz, 2000; Kazianga et al., 2013; Birungi et al., 2015). What is more, adolescent girls may not have access to contraceptives or other means of birth control (Goldin and Katz, 2000), implying that unintended pregnancies may end their education prematurely compared to boys. These three facts suggest that external factors, such as differential (opportunity) costs of education based on gender (Goldin and Katz, 2000; Kazianga et al., 2013; Birungi et al., 2015) and differential life expectancy at birth (Jayachandran, 2015) can open up a gender education gap, without gender discrimination Björkman-Nyqvist (2013). However, while these facts explain why developed countries have eliminated the gender education gap but not less developed ones, they do not necessarily account for disparities in the size of this gap among the latter countries themselves.[4]

Yet, accounting for such disparities is important if the driving forces of this undesirable phenomenon are to become well-understood.

To analyze the interrelation between adverse income shocks and culture, we draw from Bau (2021) by using customs of post-marriage residence for couples as proxies for culture: matrilocality and patrilocality. These marriage customs prescribe whether daughters (matrilocality) or sons (patrilocality) co-reside with their parents after marriage, eventually becoming their source of old-age support (Bau, 2021). However, they also differ in two other respects. First, patrilocality prohibits women from inheriting the wealth of their parents (Berge et al., 2014), whereas women can inherit their parents' wealth in matrilocal communities (Peters, 2010). Second, in matrilocal groups, children are public goods only to their mother's kin who have a vested interest in their well-being (Lowes, 2020). We hypothesize that these differences between the two customs affect how low-income parents allocate their scarce resources across offspring based on gender.

Moreover, we follow the literature by exploiting the spatial and temporal randomness

[4]To illustrate our point, consider two low-income countries of sub-Saharan Africa: Malawi and Guinea. Of the two, Malawi is the poorest with a GDP per capita of 642.7 *US*$ (2021 est.), and a poverty ratio of 70.1 at 2.15 PPP$ a day (2019 est.; % of population). Corresponding figures for Guinea are 1,174 *US*$ (2021 est.) and 13.8 (2018 est.). GDP per capita and poverty figures are taken from the World Bank at https://data.worldbank.org/country. Yet, as of 2021, Malawi has a gender education gap of only 8.5%, while the relative richer Guinea has a larger gap at 32.5%, nearly four times the level of Malawi. Note: The gender gap figures are from *The Global Gender Gap Report 2021*, produced by the World Economic Forum and retrieved online at https://www.weforum.org/reports/ab6795a1-960c-42b2-b3d5-587eccda6023.

of drought episodes, which are well-documented adverse income shocks (Jayachandran, 2006; Björkman-Nyqvist, 2013; Corno et al., 2020). In so doing, we draw from Harari and Ferrara (2018), Miao and Popp (2014), and Vicente-Serrano et al. (2010) by measuring drought based on the Standardized Precipitation-Evapotranspiration Index (SPEI). The SPEI combines the effects of precipitation, potential evaporation, and temperature. Indeed, unlike drought measures based on precipitation alone, the SPEI accounts for how the soil retains water. This multiscalar drought index allows us to account for a possible spatial correlation from omitted weather variables. We focus on the rainy season because it coincides with the start of the cropping season. Therefore, by drought, we mean drought occurring in the rainy (or agricultural) season, making it an adverse income shock in rural communities dependent on rainfed agriculture for livelihoods.

Additionally, we use representative individual panel data from rural Malawi and rural Indonesia, respectively. The common denominator between these two countries is the co-existence in their territories of two different customs of post-marriage residence for couples: matrilocality and patrilocality. In addition, both have been the sites of extreme weather shocks, including droughts and floods, and are heavily reliant on agriculture (Menon et al., 2007; Pauw et al., 2010; Syaukat et al., 2011). However, despite these similarities, the two countries have disparities encompassing the economic and social spheres. First, Malawi is a landlocked low-income country ranked among the 11th poorest worldwide *World Bank National Accounts*. By contrast, Indonesia is an upper-middle-income South-East Asian country accessible by sea, with a GDP per capita six times the level of Malawi. Second, the two countries differ in the number of years of compulsory schooling in the education sector. Whereas in Malawi, primary education is free but not compulsory, and school fees are imposed for enrollment in secondary education, in Indonesia, as of 1994, compulsory education covers nine grades, which is primary education plus three years of secondary education. Estimating the interrelation of adverse aggregate income shocks and culture in these two different socioeconomic contexts thus also provides a test of the external validity of our findings.

Finally, we estimate a linear fixed-effects probability model in which a child's school dropout probability each year, conditional on being enrolled the year before, is the outcome of interest. Thus, we proxy the gender education gap with the gender gap in school

dropout –defined as the gap between a girl's dropout probability and that of a boy of the same age. The higher this gap, the bigger the gender education gap favoring boys. We account for grid-cell and year-fixed effects. We follow Manning and Swaffield (2008); Tembon and Fort (2008); Blau and Kahn (2017); Björkman-Nyqvist (2013); Reichelt et al. (2021) in specifying this linear fixed-effects model for each gender. This split-sample regression approach reflects the more realistic assumption that boys and girls have different attitudes towards schooling. For example, girls are often reported to have different psychological attributes than boys (Heckman and Kautz, 2012), while relative to girls, boys may be keener to conform to patriarchal gender norms because such norms empower them at the expense of girls (Van Hoorn and Maseland, 2010; Bisin et al., 2016; van Hoorn, 2016). Both these cases would violate the assumption of homoscedastic residual errors underlying the pooled-sample approach based on interacting terms.

Our primary analysis samples comprise children aged 8˘18 for Malawi and 6˘18 for Indonesia, respectively. When schooling is not free of charge, estimation results show that drought increases the gender education gap in patrilocal communities but not in matrilocal ones. Indeed, results show that a mediating effect of culture exists only for schoolchildren aged $15-18$ in Malawi and $16-18$ In Indonesia. These are children whose schooling requires payments of fees by households. By contrast, such a mediating effect does not exist for younger schoolchildren—those aged $8-14$ in Malawi and $6-15$ in (relatively more affluent) Indonesia. These are children whose education is free of charge according their respective school systems.

To increase confidence in the validity of these findings, we demonstrate that they pass various robustness checks in both empirical settings, depending on the availability of relevant data. First, we show that in Malawi and Indonesia, our main results are robust to controlling for potential correlates of kinship traditions and household fixed effects. These results also hold when we account for spatial correlation and replace our baseline split-sample analysis with a pooled-sample approach using interacting terms. Second, in Malawi, our results also hold when replacing prevailing customs of post-marriage residence for couples with prevailing lineage systems as proxies for culture.[5]

[5]Data availability constraint did not allow for a comparable check to be performed in Indonesia.

Finally, exploring the mechanisms underlying this interrelation between drought and prevailing customs of post-marriage residence for couples, we consider son preference and measures of women's empowerment. Indeed, if women in patrilocal marriages traditionally lack decision-making authority, they are unlikely to take action or make choices to support their parents' well-being in old age. Anticipating this, low-income parents in patrilocal communities may prefer having sons instead of daughters. This idea is consistent with evidence showing that gender inequality favoring boys later in life starts early through parents' preference for having and investing in sons (Edlund, 1999; Choi and Hwang, 2015; Lambert and Rossi, 2016; Jayachandran, 2015; Jayachandran and Pande, 2017). In Malawi—the only one of the two settings for which relevant data is available—, we find that, relative to women in matrilocal marriages, women in patrilocal marriages want more sons than daughters and have less decision-making power in their families. These findings support the hypothesis that son preference is integral to mechanisms through which patrilocality combines with economic hardship to drive up the gender education gap in developing countries.

There are three takeaways from our study. First, when exposed to adverse income shocks, low-income households in developing countries lean on culture to give them rules for selecting the gender of offspring whose outcomes — in this case, schooling— they will sacrifice to enhance survival. Second, culture may explain why gender education gaps vary across low-income countries. This finding is important because it indicates that economic growth is insufficient to eliminate these countries' gaps. Third, public policies that induce cultural change are integral to public efforts to enhance development outcomes, such as gender parity in educational attainment. These facts are consistent with evidence showing that Western democracies did not eliminate their gender education gaps until they adopted policies to induce cultural change. An example is the adoption of equal opportunity policies that persuaded parents to invest equally in sons' and daughters' education (Beveridge et al., 2000; Cheung and Chan, 2007; De Paola et al., 2010).

This paper contributes to the broad literature on gender inequality in education. Contributions to this literature point to poor economic conditions either at the aggregate level (Alderman et al., 1996; Alderman and Gertler, 1997) or at the household level (Björkman-

Nyqvist, 2013) as the primary driver of gender inequality in education. Alderman et al. (1996) find evidence in rural Pakistan that local school shortages account for about a third to two-fifths of the gender gap in schooling outcomes. Björkman-Nyqvist (2013) uses random variation in rainfall across districts in Uganda to identify the causal effect of poor household economic conditions on the gender gap favoring boys in primary education attainment and achievements. The common denominator of this literature is that this positive effect of financial hardship is obtained in settings that are home to predominantly patrilocal cultures. Indeed, both Pakistan (Khan, 1998; Taj et al., 2004) and Uganda (Obbo, 1989; Katabarwa et al., 2000) are the settings of strictly patrilineal systems of kinship in which the practice of patrilocality to assign post-marriage living arrangements to couples is near universal. We contribute to this literature by showing that removing barriers to the supply of education, and improving the school environment for girls, although desirable from a public policy perspective, may not eliminate the gender education gap. Instead, countries prone to covariate income shocks should combine such policies with those that induce cultural change to achieve this goal.

This paper also contributes to the broader literature on adverse aggregate income shocks and individual outcomes (Jayachandran, 2006; Burke et al., 2015; Dinkelman, 2017; Corno et al., 2020; Kaur, 2019). Both Dinkelman (2017) and Corno et al. (2020) study the effects of drought on youth outcomes. Dinkelman (2017) studies the long-term effect of drought on children's human capital. In contrast, Corno et al. (2020) focus on its effect on girls' child marriage probabilities conditional on the marriage custom (bride price vs. dowry). We complement this literature by analyzing the effects of drought on the probabilities of school dropout of children living in rural Malawi and rural Indonesia, conditional on gender and culture.

Finally, we contribute to the nascent literature in economics building on anthropologists' recognition of the impact of traditional systems of kinship on economic outcomes in developing countries (Jayachandran, 2015; La Ferrara and Milazzo, 2017; Lowes, 2020; Bau, 2021). For example, Bau (2021) finds that culture directly affects the gender education gap because of parents' concern for their old-age security. We differ from Bau (2021) in that we test whether adverse aggregate income shocks interrelate with culture to drive this gap in low-income countries.

The rest of this paper is structured as follows. Section 2 presents the study context and data. Our empirical strategy follows in Section 3. Section 4 reports the main empirical results. Section 5 presents robustness checks. We discuss the mechanisms underlying our main results in Section 6. Finally, Section 7 offers concluding remarks.

2 Background, data and measurement of key variables

In this section, we present our data, the context of our study, how we measure our main variables, as well as descriptive statistics and stylized facts for Malawi and Indonesia.

2.1 Data sources

As mentioned in the introductory section, Malawi and Indonesia are separate settings for our empirical analysis. In this subsection, we describe the primary data used in this analysis.

Malawi data

Our data on school dropouts, kinship traditions, and various individual, household, and community characteristics come from Malawi's longitudinal Integrated Household Panel Survey (IHPS) 2010, 2013, and 2016. This nationally representative survey contains various longitudinal information on individuals, which allows us to construct an annual panel dataset over seven years (2010 to 2016). We can control for grid-cell and year fixed effects and potential individual heterogeneity. Furthermore, on top of this advantage, the survey contains, for each individual, information about the exact year school dropout occurs, as well as the time and district to which they eventually migrated. Hence, our data allow us to consistently match our drought variable with the district where the individual effectively lived.

Our analysis sample consists of primary and secondary school-age children, which in Malawi refers to children aged $8-14$ and $15-18$, respectively. The descriptive statistics of the variables used in the econometric analyses are reported in Table 1. With most developing countries nearing universal primary education, enrolment in secondary ed-

ucation remains a significant challenge, as these countries still lack the means to enforce compulsory enrolment at this level. Indeed, a UNICEF-sponsored survey published in 2019 finds that in rural Malawi, unaffordable school fees are the main reason respondents ended their school participation at the secondary level (Makwemba et al., 2019). Furthermore, in addition to direct costs, education may also entail an opportunity cost to households, for example, in terms of foregone income from child labor or child marriage in bride price communities. In other words, in rural Malawi, keeping children in school following a negative income shock is a decision that places a heavy financial burden on parents. In the context of incomplete markets, the occurrence of droughts thus may lead these parents to make difficult choices in terms of which children will be kept in school and which will be pulled out.

Indonesia data

To conduct our core analysis in Indonesia, we use the Indonesian Family Life Survey (IFLS5) collected in 2014/2015. The IFLS5 is a multipurpose georeferenced survey, including modules on individual characteristics such as ethnicity, religion, gender, age, migration episodes, and education. IFLS also provides village-level information on post-marriage residence norms, as communicated by *Adat* experts. The longitudinal nature of the education module allowed us to construct an individual panel measure of school dropouts, as in the case of Malawi. For our analysis, we retain rural individuals aged between 6 and 18. We set the starting age at 6 because, according to our data, the school entry age is 6 for about 35% of individuals, although the official entry age is 7. The ending age for our analysis is 18, that corresponds to the last year of high school (12th grade). Our final sample is of $9,054$ individuals, or $92,669$ observations-year, distributed as follow: $35,940$ and $31,882$ girls and boys aged $6-15$, respectively, and $12,978$ and $11,869$ girls and boys aged $16-18$, respectively. The second group consists of children who are not in compulsory school and are most likely to fall victim to child marriage- a marriage involving a child aged 17 or less. The summary statistics of the outcome and explanatory variables used in the regression analyses are reported in Table 2.

2.2 Background on kinship traditions in Malawi and Indonesia

As stated above, Malawi and Indonesia are similar in that their social fabric features the co-existence of two customs of post-marriage residence for couples: matrilocality and patrilocality. In what follows, we give a brief overview of the socioeconomic characteristics of the countries, highlighting similarities and differences.

Kinship traditions in Malawi

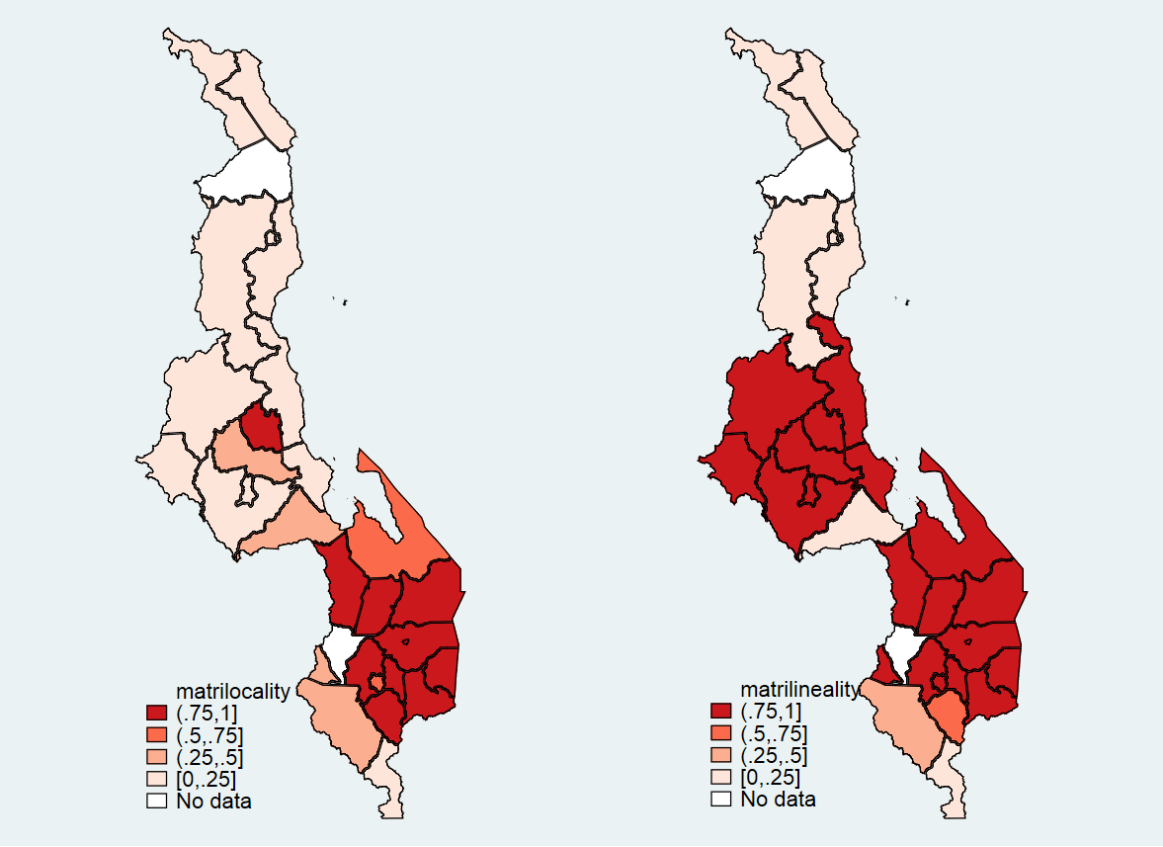
Malawi is a landlocked, low-agricultural yield country in southern Africa. Recently, it has become the epicenter of recurring climate shocks such as droughts and floods. It is estimated that the country loses on average 1.7 percent of its annual GDP due to a combined effect of drought and floods (Pauw et al., 2010). Notably, 90 percent of the country's population derives livelihoods from subsistence agriculture, an activity that is predominantly rainfed (Menon et al., 2007; Pauw et al., 2010). This widespread dependence on rainfed agriculture enables us to interpret droughts as adverse income shocks in the context of Malawi. As negative income shocks, droughts are an exogenous source of spatial and temporal variation in income volatility across households- our study's independent variable of interest.

Our interest in Malawi is also based on its cultural diversity. Although located on the matrilineal belt, Malawi is a culturally diverse country where kinship and matrilineal systems operate side by side. In Malawi, each kinship system prescribes inheritance norms and regulates marriage practices, including the age at first marriage, decision making on when and to whom to marry, and post-marriage living arrangements (Mtika and Doctor, 2002; Makwemba et al., 2019). From this perspective, customs and traditions vary depending on the prevailing kinship system, matrilineal or patrilineal. For example, in patrilineal systems of descent, upon marriage, the wife moves to the man's village and lives among his relatives to create a lineage for her husband. Anthropologists refer to this type of marriage as patrilocality. Thus, children in patrilocal marriages belong to the man's line.

In contrast to patrilineal kinship systems, a family in matrilineal systems is an integral part of the wife's lineage (Mtika and Doctor, 2002; Makwemba et al., 2019). How-

ever, unlike patrilineal ethnic groups, which all practice patrilocality, matrilineal cultures in Malawi come in two different types, depending on the prevailing custom of post-marriage residence. Some matrilineal ethnic groups are matrilocal— e.g., the Ngoni—, while others are patrilocal—e.g., the Chewa— (Berge et al., 2014). Matrilineal ethnic groups that practice patrilocal marriage are primarily found in the central region, while those that practice matrilocality are predominantly from the southern part. Figure 1 describes the relative prevalence of matrilineal kinship systems (right panel) and the matrilocal custom (left panel) in rural Malawi by district.

Figure 1: *Distribution of Matrilocality and Matrilineality in Malawi, by district*



Source: Authors' elaboration based on IHPS 2010-2016

As shown in Figure 1, matrilineal kinship systems and the matrilocal custom are predominantly phenomena of southern Malawi. In contrast, patrilineal systems and the associated patrilocal marriage custom are predominantly cultural endowments of the populations of rural northern Malawi. However, it is also clear from Figure 1 that matrilineal groups do not necessarily practice matrilocal marriages. This fact is particularly notable in the central part of the country, where some matrilineal groups have adopted the custom of patrilocality traditionally associated with patrilineal kinship systems. This

fact proves that matrilineal and patrilineal systems of kinship are not symmetric (Lowes, 2020).

Notwithstanding the above, the coexistence of different kinship systems in rural Malawi, combined with the fact that 84% of the population lives in rural areas (NSO, 2019), creates conditions for a natural experiment to investigate whether culture mediates the effect of adverse aggregate income shocks on the gender education gap.

Kinship traditions in Indonesia

According to the Cultural Atlas,[6] most of Indonesian society is still patriarchal, with only a few indigenous populations (around 8 'groups') still practicing a matriarchal system within their culture. However, despite the prevalence of patriarchy, many Indonesian ethnic groups trace descent either through the mother (matrilineality) or through the father (patrilineality). Similar to Malawi, some matrilineal ethnic groups practice the marriage custom of matrilocality, while others practice patrilocality.

Unlike Malawi, however, Indonesia is accessible by sea and has a GDP per capita of $3,869.6$ *US*$ in 2019— six times the level of Malawi. Disparities between the two countries also encompass the public sphere. For example, the two countries differ in the years of compulsory education in the education sector. In Malawi, primary education is free but not compulsory, and school fees are imposed for enrollment in secondary education. By contrast, in Indonesia, as of 1994, compulsory education covers nine grades, which is primary education plus three years of secondary education (children aged 7 - 15).

Importantly, in addition to the expansion of compulsory education, the government of Indonesia also implemented numerous reforms and policies over time, explicitly aimed at addressing gender disparities in education. An example is Presidential Decree No. 9/2000 on Gender Mainstreaming in the National Development Planning and Programming (Afkar et al., 2020). This reform, and others before and after it, triggered progress towards gender parity in education participation. As a result, although significant regional disparities remain, at the national level, by 2019, the country achieved a Gender Parity Index (GPI) of 1.00 for school enrollment rates of 7-12-year-olds. Interestingly, for

[6] Available at https://culturalatlas.sbs.com.au/

children aged $13-15$ and $16-18$, the figures have shifted to a slight female advantage, with GPIs of 1.02 and 1.03, respectively (Afkar et al., 2020).

2.3 Measuring culture

Kinship remains a central system of the social organization of production and household decision-making in rural Malawi and Indonesia (Mtika and Doctor, 2002; Sear, 2008; Bargain et al., 2022; Bau, 2021). The two main kinship systems in rural Malawi and Indonesia are matrilineality and patrilineality (Lowes, 2020; Bargain et al., 2022). These two kinship systems differ based on inheritance and descent principles, marital practices, and work organization. However, as shown in Figure 1, for Malawi, matrilineal and patrilineal kinship systems are not symmetric, as both are patriarchal systems (Lowes, 2020).

The primary source of asymmetry between matrilineal and patrilineal systems, as shown in Figure 1, is the prevailing custom of post-marriage residence for married couples: matrilocality and patrilocality. These marriage customs differ in three important ways. First, these customs prescribe whether daughters (matrilocality) or sons (patrilocality) co-reside with their parents after marriage, eventually becoming their source of old-age support (Bau, 2021). Second, patrilocality prohibits women from inheriting the wealth of their parents (Berge et al., 2014), whereas women can inherit their parents' wealth in matrilocal communities (Peters, 2010). Finally, in matrilocal groups, husbands are less able to mistreat their spouses, wives have greater autonomy in decision-making relative to patrilocal women, and children are public goods only to their mother's kin who have a vested interest in their well-being (Lowes, 2020). Therefore, to best emphasize cultural differences between individuals in our analysis sample, we measure culture based on the prevailing custom of post-marriage residence for couples.

To match each schoolchild to the culture governing parental decisions on child schooling in the household in which they live, we need data on the type of marriage that led to the formation of that household. In other words, we need to know whether that marriage was patrilocal or matrilocal. In the IHPS for Malawi, each community leader is asked the following question: "what is the dominant form of marriage in your community?" We use the answer to this question to match schoolchildren to their respective cultures

of affiliation. For example, In Malawi, a school-age child is said to live in a matrilocal household if matrilocality is the prevalent custom of post-marriage residence in the rural community in which they live.

In the case of Indonesia, for each village, the prevailing custom of post-marriage residence based on traditional law is obtained from the *Adat* questionnaire in the 1997 IFLS data. However, unlike the IHPS for Malawi, the IFLS for Indonesia does not provide information on prevalent inheritance norms like matrilineage/patrilineage. We could have considered using the prevailing lineage norms from the Murdock (1967) 's Atlas, but this refers to ancestral, and not current, norms. For these reasons, we could not use lineage (i.e., matrilineal/patrilineal tradition) as an alternative measure of culture to the post-marriage residence customs (i.e., matrilocal/patrilocal) for Indonesia.

2.4 Measuring school dropout

School dropout is a suitable educational outcome in our study because it is sensitive to short-term negative shocks like droughts. In addition, it is related to chronic disengagement from school, which leads to gender inequality later in life. However, one of the problems encountered in dropout studies is the lack of a uniform definition, with many terms being used as synonyms for the term (Chávez et al., 1991). Therefore, we use the UNESCO definition in our study. A dropout is an individual who leaves school permanently in a given school year. This definition implies that the individual has been in school, and when they leave school, they no longer return.

School dropout in Malawi

The IHPS for Malawi provides socioeconomic (age, gender, expenditure, education), demographic, and geographic (distance, GPS) information. In addition, its education module includes detailed information on schooling, such as the level of education, type of education, qualifications acquired, dropout dates, etc. Therefore, we use the year of dropout from the questionnaire to construct our annual dropout variable.

We focus on the school dropout probabilities of children between the ages of 8 and 18, which corresponds to primary and secondary education ages in Malawi. Therefore,

our school dropout variable thus takes the value 1 if, in the current year, a rural child aged $8-18$ is not enrolled in school, conditional on being enrolled the year before and never returning to school in the future. Table 17 presents school dropout rates and mean completed years of schooling by gender. In our analysis sample, matrilocal girls aged $8-14$ have higher school dropout rates (8.15%) than matrilocal boys of the same age group (6.52%). This rate is also roughly twice as high as that of corresponding girls living in patrilocal communities (3.92%). Despite this, matrilocal girls aged $8-14$ still have nearly the same mean years of school (3.91) as their patrilocal counterparts (4.2), implying the former tend to drop out later than the latter. Surprisingly, patrilocal girls also have lower school dropout rates for this age group than their male counterparts (5.8%).

For the age group $15-18$, school dropout rates are much higher than for the age group $8-14$. However, in this age group, matrilocal girls have lower school dropout rates (20.27%) than their patrilocal counterparts (23.24%) but have lower mean years of schooling completed (6.81%) compared to patrilocal girls (7.32%). One possible explanation might be that those who stay longer in school more than compensate (in terms of completed years of schooling) for those who dropped out, while those who dropped out did so later. This argument can be supported by Ashraf et al. (2020), who find that bride price (prevalent in patrilocal communities) would push girls to stay longer in school. Still, matrilocal and patrilocal girls have higher school dropout rates than their respective male counterparts, implying that factors other than culture and drought impede girls' education.

School dropout in Indonesia

For Indonesia, we construct an individual panel measure of school dropouts using the IFLS5 (relying on the combination of the year of birth, school entry age and total years of schooling – unfortunately, the year of dropout variable contains several missing values). Our analysis consists of rural individuals aged between 6 and 18. Our school dropout variable thus takes the value 1 if, in the current year, a rural child aged $6-18$ is not enrolled in school, conditional on being enrolled the year before and never returning to school in the future. Children aged $6-15$ years - corresponding to primary and junior

secondary education- are covered by the 1994 free compulsory education mandate. By contrast, those aged $16-18$ are not. Therefore, poverty and insufficient public expenditures in education at the municipality level are seen as the main reasons for dropping out of school among children aged $6-15$ (Muttaqin et al., 2017). For those aged $16-18$, poverty combined with school fees is the main reason for dropping out.

The summary statistics of the outcome and explanatory variables used in the regression analyses are reported in Table 2. In particular, school dropout in our sample is significantly higher in matrilocal groups than in patrilocal ones (25.5% Vs. 19.2%).[7]

2.5 Measuring drought

We follow the existing literature (e.g., Harari and Ferrara (2018); Miao and Popp (2014); Vicente-Serrano et al. (2010)) in measuring drought based on the Standardized Precipitation-Evapotranspiration Index (SPEI). This index combines the effects of precipitation, potential evaporation, and temperature. Unlike drought measures based on precipitation only, the SPEI accounts for the extent to which the soil retains water.

The SPEI is based on precipitation and temperature data and has the advantage of combining a multiscalar character with the ability to include the effects of temperature variability on drought assessment (Vicente-Serrano et al., 2010). Our SPEI data are from the SPEI Global Drought Monitor. The SPEI Global Drought Monitor provides information on drought on a global scale. The SPEI time scales offered a range from 1 to 48 months, and the SPEI calibration period for our data is from January 1950 to December 2019.

For Malawi, a drought at year t is measured through the average SPEI value observed in grid cell g between November of year $t-1$ (corresponding to the onset of the cropping season in Malawi) and April t (the end of the cropping season). Similarly, we used the SPEI value reported between April and December for Indonesia. Grids are subnational cells of 1 degree of latitude 1 degree of longitude (approximately 110 km). Consistently with Vicente-Serrano et al. (2010), we shall say that drought occurred at time t in grid

[7]However, we should interpret these figures with caution for the following reason. Most individuals are covered over 13 years (between 6 and 18), whereas, in Malawi, we have a shorter span; this implies that we have more dropouts in Indonesia because individuals are followed over a longer period.

cell g if and only if the SPEI value is below -1, indicating the occurrence of moderate to extreme droughts. Knowing the latitude and longitude of each grid cell in Malawi and Indonesia, we can easily match the individual's location with the corresponding drought variables. In the rural Malawi (cfr. Indonesia) areas covered by our dataset, we have 38 (156) grids (22 (44) grids in both matrilocal and patrilocal samples – see Tables 1 and 2), which yields up to 266 (4,056) grid-year observations.

Figure 2 and 3 report the spatial and temporal frequency of drought occurrence in Malawi and Indonesia based on the SPEI. First, except for 2014, Figure 2 shows that every year from 2009 to 2016, a drought occurred in at least 5% of Malawi's grid cells. The year 2009 represents the lagged year in the first period of our analysis.

In 2012, 2015, and 2016, more than 25% of grid cells experienced drought yearly. 2015 was the worst year, as over 60% of grid cells in Malawi experienced a drought that year. The spatial dimension of drought was lowest in 2009, 2010, 2011, and 2013, with less than 10% of the grid cells experiencing drought. Indonesia shows an even higher frequency of drought occurrence over the (long) period of analysis (1990-2015). Except for 1995, in all the years considered, we find grids hit by a drought episode, with 1994, 1997, 2002, 2006, 2009, and 2015 showing the highest (50% or more) share of grids affected.

Based on the above discussion, our drought variables, denoted $Drought_{gt}$ and $Drought_{gt-1}$, are an indicator function equal to one if and only the SPEI value fell below -1 at the grid cell g in time t and $t-1$ respectively, and zero otherwise.

3 Empirical strategy

In this section, we describe our empirical strategy for analyzing the effect of an adverse aggregate income shock on the gender education gap, conditional on culture.

3.1 Estimating the effect of drought conditional on the prevailing kinship tradition

Here, we study how drought affects the gender education gap, conditional on the prevailing custom of post-marriage residence: either matrilocality or patrilocality. As explained in the introductory section, the theoretical argument underlying this test is that economic hardship alone does not explain how household resources are allocated between children based on gender. Instead, other factors may inform this decision. For example, gender-based differences in education costs can determine which children, girls or boys, are pulled out of school due to low income, leading to gender disparities in schooling outcomes. However, when there are no gender differences in education costs—direct costs and opportunity costs —, parental differential valuation of children based on gender may influence how households faced with economic hardship invest in their offspring's education based on gender. Because kinship traditions drive this differential valuation (Ebenstein, 2010; Zhang, 2019), as discussed above, we hypothesize that they influence the effect of drought on the gender gap in school dropout probabilities in rural communities dependent on rainfed agriculture.

To test this hypothesis, we estimate separate equations of school dropout probabilities for boys and girls, conditional on the prevailing custom of post-marriage residence for married/cohabitating coupled in the community in which they live. This split-sample approach allows for heteroscedastic residual variance. We follow Jayachandran (2006), Björkman-Nyqvist (2013) and Corno et al. (2020) in exploiting the quasi-random variation in drought events over space and time to estimate the following fixed effects linear probability model:

$$D_{ijgt} = \beta_1 Drought_{gt} + \beta_2 Drought_{gt-1} + \beta_3 X_{ijgt} + \beta_4 E_{ijg} + \beta_5 W_{jt} + \gamma_t + \theta_i + \gamma_g + \epsilon_{ijgt}, \quad (1)$$

on a sample of rural schoolchildren aged $8-18$ for Malawi and $6-18$ for Indonesia. These children are followed up to the year they eventually drop out of school. The dependent variable, D_{ijgt}, is an indicator function equal to unity if a child i living in community j located in grid g drops out of school in year t, and zero otherwise; $Drought_{gt}$ and $Drought_{gt-1}$ are time-varying indicator variables measuring whether drought occurred

at grid g in year t or $t-1$.

X_{ijgt} are time-varying covariates. For Malawi, the vector X_{ijgt} includes controls such as if the father or the mother died; distance to primary and secondary school; the number of teachers in primary and secondary school; and the quintile of the household's wealth index.[8] E_{ijg} identifies the father's and mother's education.

For Indonesia, the vector X_{ijgt} only includes the household's religion and whether it had previously migrated.[9] In addition, we include grid fixed effects, γ_g, to control for time-invariant local unobservable characteristics, such as geographic and social factors that may affect dropout in a given grid. ϵ_{ijgt} is the error term.

We also follow Manning and Swaffield (2008); Tembon and Fort (2008); Björkman-Nyqvist (2013); Blau and Kahn (2017); Reichelt et al. (2021) by specifying our regression model in 1 separately for each gender. Unlike the pooled-sample approach based on interacting terms, which relies on the assumption of homoscedastic residual variance, this gender-specific regression model allows for the residual variances for the boys' and girls' models to be substantially different. This modeling strategy is particularly desirable if boys and girls have different attitudes towards schooling. For example, girls are often reported to have different psychological attributes than boys (Heckman and Kautz, 2012), which may be the case if their gender informs children's academic identity formation, as the literature finds (Akerlof and Kranton, 2002). In other words, some unobservables affect girls' regression but not boys', in which case gender-based differences in schooling performance may arise without parental discrimination. Not accounting for these gender differences in schooling attitudes may confound the effect of drought on the gender education gap.

For drought to drive the gender education gap, the estimated coefficients of interest β_1 and β_2 must differ between boys and girls. This difference is expected to be positive. We cluster standard errors at the grid level and apply Wald's Test for the equality of

[8]The household's wealth index is estimated by using the Principal Component Analysis method. It uses information from the survey's year and, for the years not covered by the survey (i.e., 2011, 2012, 2014, and 2015), linear interpolations based on the values observed in 2010, 2013, and 2016 are used.

[9]In the Indonesia data, there are no additional longitudinal time-varying control variables. Hence we had to rely on a more parsimonious specification.

coefficients to gauge the effect of drought on the gender education gap.

Hence, for each cultural community (matrilocal or patrilocal), we estimate equation 1 for boys and girls. For each of the four regression equations, the coefficients β_1 and β_2, the relative effects of Drought occurring respectively in the current year (year t) and previous year (year $t-1$), are the main coefficients of interest. The literature suggests that these coefficients are nonnegative for girls and non-positive for boys (Björkman-Nyqvist, 2013).

Since the starting period of our study is 2010 for Malawi and 1990 for Indonesia, our respective samples consist only of individuals who were in school in 2010 (Malawi) and 1990 (Indonesia). We removed from our samples all those who dropped out of school before 2010 (Malawi) and 1990 (Indonesia).

The fundamental assumption of our analysis is that current and past droughts are exogenous to other confounding factors; in other words, $Drought_{gt}$ and $Drought_{gt-1}$ are not correlated to ϵ_{ijgt}. The exogeneity hypothesis of rainfall shock is secured by controlling for grid-year fixed effects. Such a hypothesis is crucial in our analysis because unobserved variables could influence the school dropout of children. For example, grids with high average rainfall may also be those with more households. These households may have different characteristics to those in grids with less average rainfall (e.g., higher income, more progressive view towards women). These characteristics may, in turn, influence the educational choice of boys and girls (Björkman-Nyqvist, 2013).

Robust standard errors are clustered at the grid level, as in Shah and Steinberg (2017), to account for the potential serial correlation in droughts. In addition, given the tendency of droughts and customs of post-marriage residence may be clustered in space, as a robustness check, we use the method developed by Conley (1999) to correct standard errors allowing for both spatial correlation across the EAs within a radius of 55 (22) km (the median distance across EAs) and infinite serial correlation.

3.2 Identification assumptions

One may argue that cultural factors governing household behavior are not entirely exogenous. Indeed, a household's selection into matrilocality or patrilocality might be influenced by the same unobservables determining the relationship between drought and school dropout. For example, individuals from matrilineal ethnic groups that practice matrilocality and who prefer to trace descent through the paternal (instead of the maternal) line can strategically self-select (through marriage) into matrilineal groups that practice patrilocality, a move designed to free them from the constraint of having to pass their inheritance to their sisters' children instead of their own. To the extent that inter-ethnic marriages are common in rural Malawi and Indonesia, this potential nonrandom selection into a matrilineal group that practices patrilocality can bias estimates of the causal effect of drought on the gender gap in school dropout probabilities.

Furthermore, to the extent that decisions on where to build a school and what quality of infrastructure it should be equipped with are controlled predominantly by individuals who prefer to trace descent through the paternal line, school quality and distance to school may differ in patrilocal and in matrilocal communities. In addition, the differential impact of these post-marriage residence customs may actually capture their potential correlates.

We address this potential threat to identification as follows. First, we introduce grid cell (geographic) fixed effects controls to account for time-invariant historical differences between matrilocal and patrilocal groups. Second, we introduce controls for time-varying school quality variables to account for any difference in school infrastructure quality across various kinship groups that could have affected the relationship between drought and school dropout probability during our period. In addition, we interact potential correlates of kinship groups with drought. Third, the relatively low mobility across rural communities and – for Malawi – the relatively short analysis period also limit the possible nonrandom selection into kinship groups with a given custom of post-marriage residence.

4 Results

In this section, we report the results of our inference procedures for identifying the effect of adverse aggregate income shocks on the gender education gap, conditional on the community-level custom of post-marriage residence.

4.1 Full-sample results

Here, we report estimation results of the effect of drought on the gender education gap by kinship tradition and gender. Table 3 reports the result for Malawi and Table 4 for Indonesia.

In table 3, results are obtained over a sample of children aged $8-18$. They show evidence of an interrelation between (lagged) drought (i.e., $Drought_{t-1}$) and the prevailing custom of post-marriage residence in explaining the gender education gap. First, in matrilocal groups, (lagged) drought reduces the school dropout probabilities of girls by roughly 3.6 percentage points but has no statistically significant effect on boys. However, Wald's test indicates no statistically significant difference between the estimated coefficients for boys and girls in matrilocal groups (Table 3, column 3). Second, in patrilocal groups, (lagged) drought increases the school dropout probabilities of girls by roughly 6.8 percentage points but has no statistically significant effect on boys. Here, Wald's test does indicate that the estimated coefficients for boys and girls in patrilocal groups are statistically different (Column 6). These results indicate drought increases the gender education gap in patrilocal communities but not in matrilocal groups.

Table 4 is Indonesia's analog for 3. In the case of Indonesia, the analysis sample includes rural school children aged $6-18$. Wald's test (Table 4, Columns 3 and 6) indicates that, unlike in Malawi, culture in (richer) Indonesia does not mediate the effect of drought on the gender education gap. We explain this apparent disparity in the next subsection below.

4.2 Child's age as a source of heterogeneity

Here we test whether children's age introduce an heterogeneity in the interrelated effect of drought and the custom of post-marriage residence. Tables 5 for Malawi and 6 for Indonesia explore age-based heterogeneity in this interrelation. Recall that we use split-sample regressions for boys and girls and matrilocal and patrilocal communities, as explained in the section on empirical strategy. Therefore, we rely on Wald's test results to determine whether kinship traditions and drought interrelate in explaining the gender education gap.

In the case of Malawi, Table 5, Wald's test results (see Columns 3, 6, 9, and 12) read as follows. First, the interrelation between the prevailing custom of post-marriage residence (matrilocality or patrilocality) and (lagged) drought has no statistically significant impact on the gender gap in school dropout among children of primary school age— those aged $8-14$ (Columns 3 and 9). Second, among secondary education children—those aged $15-18$—, Wald's test results (Columns 6 and 12) indicate that drought increases school dropout in patrilocal communities (Column 12) but has no statistically significant impact in matrilocal groups (Column 6). These two contrasting results show that the interrelated effect of (lagged) drought and prevailing customs of the post-marriage residence uncovered in Table 3 is driven essentially by secondary education children (Columns 6 and 12)–those for which schooling involves the payment of fees and is no longer compulsory.

In Indonesia, Table 6 shows nearly identical results to Table 5 for Malawi. A mediating effect of culture exists only for schoolchildren aged $16-18$— those whose education is no longer free of charge. Indeed, Wald's test results (Columns 3 and 9) show that similar to Malawi, the interrelation of drought and the prevailing custom of post-marital residence for couples is not statistically significant among schoolchildren aged $6-15$— those whose schooling is free and compulsory. It is only statistically significant among schoolchildren aged $16-18$ (see Column 12). For these schoolchildren, (lagged) drought increases the gender gap in school dropout in patrilocal groups (Columns 10, 11, and 12) but not in matrilocal communities (Columns 7, 8, and 9). This result is qualitatively similar to the one obtained in the case of Malawi.

Overall, results reported in Tables 5 and 6 show, in different contexts, that when chil-

dren's schooling entails the payment of fees, low-income cash-constrained households lean on culture to select the gender of children whose schooling will be sacrificed to enhance survival. In our study, patrilocal households, but not matrilocal ones, sacrifice their daughters' schooling in favor of sons' when they experience an adverse income shock and schooling requires payment of fees. This result obtains in both Malawi and Indonesia.

5 Robustness checks

In what follows, we demonstrate that our findings from the previous section survive various robustness checks. In particular, we perform six alternative specifications of our baseline regression equations: (i) whether correlates of kinship traditions drive results; whether our baseline results are robust to (ii) replacing EA fixed effects with household fixed effects, (iii) accounting for spatial correlation of drought and kinship traditions, (iv) replacing the split-sample with the pooled-sample approach based on interacting terms, (v) excluding migrants from the sample, and (vi) using an alternative measurement of culture. We ran checks (i) - (iv) for both Malawi and Indonesia. However, due to a lack of meaningful migration rate (for (v)) or comparable data (for (vi)), we only performed the last two using Malawi data.

(i) Are results driven by correlates of kinship traditions?

Here, we account for potential correlates of the customs of post-marriage residence in rural communities. Indeed, one may argue that the differential effect on the gender gap in education between matrilocal and patrilocal groups may reflect the impact of their correlates. To address this issue, we follow Bau (2021) in controlling for the interaction between drought and likely correlates of kinship traditions. For both Malawi and Indonesia, our list of correlates for the prevailing customs of post-marriage residence includes dummies for ethnic groups, whether a child is a member of an ethnic group that practices the bride price custom, and whether polygyny and the Muslim religion are prevalent in this ethnic group. As is well-known, household ethnicity is a predictor of cultural values (Desmet et al., 2017). For Malawi, data on ethnic groups come from the IHPS, while for

Indonesia, it comes from the IFLS. The other indicators are taken from Murdock (1967)'s Atlas and are potential correlates of customs of post-marriage residence (Bau, 2021).

Results of this estimation are reported in Table 7 for Malawi and 8 for Indonesia. These tables are the replica of Table 3 (Malawi) and 4 (Indonesia), in which we introduce an interacting term between drought and correlates of prevailing customs of post-marriage residence. As shown in these tables, results confirm that, in Malawi, the interrelation between these customs and drought increases the gender gap in school dropout among patrilocal groups but has no statistically significant effect on this gender gap among matrilocal ones, whereas in Indonesia no statistical significant effects are found globally.

(ii) Robustness to household fixed effects

The results of this test are reported in Tables 9 for Malawi and 10 for Indonesia. These results are nearly identical to those reported in Tables 3 and 4, albeit with a slightly higher magnitude. Hence the robustness of our results to the alternative specification with household fixed effects.

(iii) Correcting for Spatial Correlation

One may argue that our results are confounded by the tendency of drought occurrences to be correlated across space. Here, we follow Conley (1999) in accounting for spatial correlation across the grid within a radius of 55 and 22 km (the median distance across the EAs in Malawi and Indonesia respectively). Estimation results are reported in Tables 11 for Malawi and 12 for Indonesia. They are replicas of those of Tables 3 and 4 respectively, where we did not control for spatial correlation. For Malawi and Indonesia, the two sets of results are almost identical, thus confirming our findings' robustness to an alternative specification that controls for spatial correlation of drought occurrences.

(iv) Robustness to an alternative regression specification

Our baseline specification estimates separate regression equations for each gender and each kinship tradition. We argued above that this split-sample approach allows us to account for the potential heteroscedasticity of residual variances. Indeed, the Levene

test of homogeneous residual variance (available upon request) rejects the null hypothesis of equal residual variances for boys' and girls' regressions and matrilocal and patrilocal regressions, thus confirming that our separate regressions' specification is correct. Nevertheless, for robustness, we present results of the estimation of a triple difference specification, in which we interact drought with gender and kinship tradition.

Results of this estimation are reported in Tables 13 for Malawi and 14. In both tables, Column 1 reports results obtained using the entire sample of children, Column 2 for primary education children, and Column 3 for secondary education children. In Malawi, current drought (i.e., $drought_t$) decreases the gender gap in school dropout among secondary education children (those aged $15-18$) relative to children of the same age living in patrilocal communities but has no statistically significant effect among primary education children—those aged $8-14$. Furthermore, lagged drought (i.e., $drought_{t-1}$) decreases the gender gap in school dropout among primary education children living in matrilocal communities relative to those of the same age living in patrilocal communities. Still, it has no statistically significant effect on this gap among secondary education children.

For Indonesia (see Table 14), we find that results are consistent with those obtained using the split-sample regression approach. In particular, (lagged) drought reduces the gender gap in school dropout among schoolchildren aged $16-18$ living in matrilocal communities relative to children of the same age group living in patrilocal communities.

Although these estimations results are not a perfect replica of those obtained using the split-sample approach, they confirm that culture mediates the effect of adverse aggregate income shocks on the gender education gap for schoolchildren whose schooling is no longer free of charge.

(v) Taking migrants out of our sample

Here we report the results of a specification without migrants only for Malawi, for reasons stated above. These results are reported in Table 15 and are similar to those obtained in Table 3, albeit with weaker magnitudes. Results show that lagged drought decreases school dropout among girls living in matrilocal households but not boys' (see

Column 1 of Table 15). Moreover, the differential between the estimated coefficients of lagged drought for boys and girls is not statistically significant. Once again, this result implies that, in matrilocal communities, drought has no statistically significant effect on the gender education gap. By contrast, in patrilocal communities, lagged drought increases school dropout among girls but not boys (see Column 3 of Table 15). Notably, the differential between the coefficients of lagged drought for boys and girls is statistically significant at the 5% level, indicating that, in patrilocal communities, drought increases the gender education gap favoring boys.

These findings establish the robustness of our main results when the potential effect of migration is ruled out.

(vi) Robustness to an alternative measurement of culture

In our baseline specifications, kinship tradition is measured based on the custom of post-marital living arrangements, distinguishing between matrilocality and patrilocality.

Here we present the results of an alternative specification by replacing prevailing customs of post-marriage residence for married couples with the lineage customs, distinguishing between matrilineality —tracing descent through the paternal line (see Webster Dictionary)— and patrilineality —tracing descent through the maternal line. Table 16 is a replica of Table 3, in which we replace matrilocality/patrilocality with matrilineality/patrilineality. Qualitatively the results are similar to those reported in Table 3. In particular, Wald's test results indicate statistically different estimated coefficients of (lagged) drought for boys and girls. As a result, drought increases the gender education gap in patrilineal groups but not matrilineal ones. This finding establishes the robustness of our main result that culture mediates the effect of adverse aggregate income shocks on the gender education gap in a developing country.

6 Mechanisms

Our findings in Section 4 suggest that culture mediates how adverse aggregate income shocks, such as drought, impact the gender education gap favoring boys in developing countries. Indeed, results show, in different contexts, that when children's schooling entails the payment of fees, low-income cash-constrained households lean on culture to select the gender of children whose schooling will be sacrificed to enhance survival. In our study, patrilocal households, but not matrilocal ones, sacrifice their daughters' schooling in favor of sons'. A compelling question, therefore, is: what mechanism drives this mediating effect of culture? To address this question, we consider whether gender discrimination could be the driving mechanism of the impact of culture on gender inequality. Indeed, if patrilocality is gender-biased toward women, this might increase gender inequality favoring boys' education only in patrilocal communities.

In this section, we test this hypothesis in the context of Malawi, using various proxies of gender bias toward women.[10]

6.1 Empirical strategy

To test our hypothesis that patrilocality induces gender bias against women, we draw from Jayachandran (2015), Bau (2021), and Lambert and Rossi (2016) in building proxies for gender bias against women.

(i) Measuring within-household gender inequality

We measure within-household gender inequality by a married woman's decision-making power relative to her husband. We draw from Jayachandran (2015) and Bau (2021) in building our indicator of a married woman's decision-making power within the household. We use the 2015 Demographic and Health Survey (DHS) data from Malawi, which contain answers to the following questions addressed to women respondents, and which we associate with the presence or absence of within-household gender inequality

[10]Unfortunately, the lack of comparable data does not allow us to replicate this analysis in Indonesia. Nonetheless, findings from Bargain et al. (2022) show that matrilocality strongly improves women's well-being and empowerment in Indonesia.

or discrimination against women: Who has the final say on (i) making large household purchases; (ii) visits family or relatives; who usually decides on (i) how to spend your earnings, (ii) what to do with the money your husband earns, and (iii) your health care. From the answers to these questions, we create five indicator functions, respectively, for a woman's decision-making on (i) her earnings, (ii) large household purchases, (iii) her husband's earnings, (iv) household visit, and (v) her healthcare. Each indicator function equals one if the girl respondent indicated her husband is alone or someone else makes the decision; it equals 0 if she responded that she is alone or she and her husband/partner make the decision.

(ii) Desire for sons

Another measure of household preference for sons is captured by the strength of its desire for sons. DHS data contain women's answers to (i) the ideal number of children they would like to have and (ii) the number of children of either sex they would ideally like within this number. We only kept women who gave consistent answers to these questions in our sample. Based upon women's answers to these questions, we build an indicator function equal to 1 if the ideal number of boys is strictly greater than the ideal number of girls, which indicates a preference for sons, and 0 otherwise.

We regress these gender inequality outcomes separately on whether a woman's marriage was patrilocal, using the same controls as in our primary regression. To match each woman to the type of marriage she has (either matrilocal or patrilocal), we merged the DHS data with our IHPS 2010-2016 database through the communities' GPS coordinates available in both surveys. For Indonesia, unfortunately, the latest DHS data do not provide GPS coordinates. Alternatively, we could have matched data on marriage customs through ethnicity, but Indonesian DHSs do not have that information.

6.2 Estimation results

Table 18 shows the results of this series of regressions. Results show that being in a patrilocal marriage increases the probability that a woman surrenders the decision-making power on how her income is spent to her husband by roughly 6 percentage points when compared to a similar woman who is in a matrilocal marriage (Column 1, Table 18). Be-

ing in a patrilocal marriage also increases the probability that she does not participate in the decision-making process on the purchase of household durable goods by roughly 5 percentage points when compared to a similar woman who is in a matrilocal marriage (Column 2, Table 18). Likewise, being in a patrilocal marriage increases the probability that a woman does not participate in the decision-making about how her husband's income is used by nearly 10 percentage points when compared to a similar woman who is in a matrilocal marriage (Column 3, Table 18). Columns 4 and 5 of Table 18 also report positive effects of patrilocality on the probability that a woman does not participate in the decision-making process about who visits their household (5 percentage points) and her healthcare (roughly 2.5 percentage points).

Finally, we also find that traditional patrilocality increases the probability that a woman prefers to have a son by nearly 3 percentage points compared to a similar woman in traditional matrilocality (Column 6, Table 18). The results in Table 18 support the hypothesis that patrilocality induces a gender bias toward women and girls.

7 Conclusion

This paper provides evidence that adverse aggregate income shocks (e.g., drought) induce parents in affected low-income countries to lean on culture to give them rules for investing in their children's education when such investment entails cost, such as the payment of school fees. We study whether drought– an exogenous source of adverse aggregate income shock– interrelates with the prevailing custom of post-marriage residence– matrilocality or patrilocality– to explain the gender education gap favoring boys in developing countries. Overall, results show that when children's schooling entails the payment of fees, low-income cash-constrained households lean on culture to select the gender of children whose schooling will be sacrificed to enhance survival. In our study, patrilocal households, but not matrilocal ones, sacrifice their daughters' schooling in favor of sons' when they experience an adverse income shock and schooling requires payment of fees. We obtain these results in two separate settings: Malawi, a poorer landlocked East-African country, and Indonesia, an upper-middle-income country in South-

East Asia.

Our results are credible for four important reasons. First, we rely on spatial and temporal randomness of drought episodes to obtain an exogenous variation in household economic conditions. Second, we follow the literature using kinship traditions as proxies for culture. In so doing, we account for potential correlates of matrilocal and patrilocal customs such as ethnic groups, whether a child belongs to an ethnic group that practices the bride price custom or lives in a community where polygyny and Islam are prevalent, in addition to controlling for grid-cell and year fixed effects. Third, we demonstrate that our main results pass various robustness checks, including replacing our favored split-sample analysis with a pooled-sample approach based on interacting terms. Finally, we also demonstrate that son preference and low female empowerment in patrilocal societies open a path of influence for the interrelated impact of culture and adverse aggregate income shocks.

We derive three important implications from our study's results. First, when exposed to an adverse income shock, low-income households in developing countries lean on culture to give them rules for selecting the gender of offspring whose outcomes — in this case, schooling— they will sacrifice to enhance survival. Second, culture may explain why gender education gaps vary across low-income countries. This finding is important because it indicates that economic growth is insufficient to eliminate these countries' gaps. Third, public policies that induce cultural change are integral to public efforts to enhance development outcomes, such as gender parity in educational attainment.

References

Afkar, R., N. Yarrow, S. Surbakti, and R. Cooper (2020). *Inclusion in Indonesia's education sector: A subnational review of gender gaps and children with disabilities*. The World Bank.

Akerlof, G. A. and R. E. Kranton (2002). Identity and schooling: Some lessons for the economics of education. *Journal of Economic Literature 40*(4), 1167–1201.

Alderman, H., J. R. Behrman, D. R. Ross, and R. Sabot (1996). Decomposing the gender gap in cognitive skills in a poor rural economy. *Journal of Human Resources*, 229–254.

Alderman, H. and P. Gertler (1997). Family resources and gender differences in human capital investments: The demand for children's medical care in pakistan. *Intrahousehold Resource Allocation in Developing Countries*, 231–48.

Ashraf, N., N. Bau, N. Nunn, and A. Voena (2020). Bride price and female education. *Journal of Political Economy 128*(2), 591–641.

Bargain, O., J. Loper, and R. Ziparo (2022). Traditional norms, access to divorce and women's empowerment. *IZA Discussion Paper 15374*.

Bau, N. (2021). Can policy change culture? government pension plans and traditional kinship practices. *American Economic Review 111*(6), 1880–1917.

Berge, E., D. Kambewa, A. Munthali, and H. Wiig (2014). Lineage and land reforms in malawi: Do matrilineal and patrilineal landholding systems represent a problem for land reforms in malawi? *Land Use Policy 41*, 61–69.

Beveridge, F., S. Nott, and K. Stephen (2000). Mainstreaming and the engendering of policy-making: a means to an end? *Journal of European public policy 7*(3), 385–405.

Birungi, H., C.-C. Undie, I. MacKenzie, A. Katahoire, F. Obare, and P. Machawira (2015). Education sector response to early and unintended pregnancy: A review of country experiences in sub-saharan africa.

Bisin, A., E. Patacchini, T. Verdier, and Y. Zenou (2016). Bend it like beckham: Ethnic identity and integration. *European Economic Review 90*, 146–164.

Björkman-Nyqvist, M. (2013). Income shocks and gender gaps in education: Evidence from uganda. *Journal of Development Economics 105*, 237–253.

Blau, F. D. and L. M. Kahn (2017). The gender wage gap: Extent, trends, and explanations. *Journal of Economic Literature 55*(3), 789–865.

Bloom, D. E., D. Canning, G. Fink, and J. E. Finlay (2009). Fertility, female labor force participation, and the demographic dividend. *Journal of Economic Growth 14*(2), 79–101.

Burke, M., E. Gong, and K. Jones (2015). Income shocks and hiv in africa. *The Economic Journal 125*(585), 1157–1189.

Chávez, R. C., L. D. Belkin, J. G. Hornback, and K. Adams (1991). Dropping out of school: Issues affecting culturally, ethnically, and linguistically distinct student groups. *The Journal of Educational Issues of Language Minority Students 8*(1), 1–13.

Cheung, H. Y. and A. W. Chan (2007). How culture affects female inequality across countries: An empirical study. *Journal of Studies in International Education 11*(2), 157–179.

Choi, E. J. and J. Hwang (2015). Child gender and parental inputs: No more son preference in korea? *American Economic Review 105*(5), 638–43.

Conley, T. G. (1999). Gmm estimation with cross sectional dependence. *Journal of econometrics 92*(1), 1–45.

Corno, L., N. Hildebrandt, and A. Voena (2020). Age of marriage, weather shocks, and the direction of marriage payments. *Econometrica 88*(3), 879–915.

De Paola, M., V. Scoppa, and R. Lombardo (2010). Can gender quotas break down negative stereotypes? evidence from changes in electoral rules. *Journal of Public Economics 94*(5-6), 344–353.

Desmet, K., I. Ortuño-Ortín, and R. Wacziarg (2017). Culture, ethnicity, and diversity. *American Economic Review 107*(9), 2479–2513.

Dinkelman, T. (2017). Long-run health repercussions of drought shocks: Evidence from south african homelands. *The Economic Journal 127*(604), 1906–1939.

Ebenstein, A. (2010). The "missing girls" of china and the unintended consequences of the one child policy. *Journal of Human resources 45*(1), 87–115.

Edlund, L. (1999). Son preference, sex ratios, and marriage patterns. *Journal of Political Economy 107*(6), 1275–1304.

Goldin, C. and L. F. Katz (2000). Career and marriage in the age of the pill. *American Economic Review 90*(2), 461–465.

Harari, M. and E. L. Ferrara (2018). Conflict, climate, and cells: a disaggregated analysis. *Review of Economics and Statistics 100*(4), 594–608.

Heckman, J. J. and T. Kautz (2012). Hard evidence on soft skills. *Labour economics 19*(4), 451–464.

Jayachandran, S. (2006). Selling labor low: Wage responses to productivity shocks in developing countries. *Journal of Political Economy 114*(3), 538–575.

Jayachandran, S. (2015). The roots of gender inequality in developing countries. *Annual Review of Economics 7*(1), 63–88.

Jayachandran, S. and R. Pande (2017). Why are indian children so short? the role of birth order and son preference. *American Economic Review 107*(9), 2600–2629.

Katabarwa, N., F. Richards Jr, and R. Ndyomugyenyi (2000). In rural ugandan communities the traditional kinship/clan system is vital to the success and sustainment of the african programme for onchocerciasis control. *Annals of Tropical Medicine & Parasitology 94*(5), 485–495.

Kaur, S. (2019). Nominal wage rigidity in village labor markets. *American Economic Review 109*(10), 3585–3616.

Kazianga, H., D. Levy, L. L. Linden, and M. Sloan (2013). The effects of" girl-friendly" schools: Evidence from the bright school construction program in burkina faso. *American Economic Journal: Applied Economics 5*(3), 41–62.

Khan, D. (1998). Mixed marriages in islam: An anthropological perspective on pakistan. *Journal of the anthropological society of Oxford 29*(1), 5–28.

Klasing, M. J. and P. Milionis (2020). The international epidemiological transition and the education gender gap. *Journal of Economic Growth 25*(1), 37–86.

La Ferrara, E. and A. Milazzo (2017). Customary norms, inheritance, and human capital: evidence from a reform of the matrilineal system in ghana. *American Economic Journal: Applied Economics 9*(4), 166–85.

Lambert, S. and P. Rossi (2016). Sons as widowhood insurance: Evidence from senegal. *Journal of Development Economics 120*, 113–127.

Lowes, S. (2020). Matrilineal kinship and spousal cooperation: evidence from the matrilineal belt. *Unpublished manuscript. URL: https://scholar. harvard. edu/files/slowes/files/lowes_matrilineal. pdf*.

Makwemba, M., B. Chinsinga, C. T. Kantukule, A. Munthali, M. Woldegorgis, S. Haenni, and Q. Lin (2019). Survey report: Traditional practices in malawi. Survey report, Center for Child Wellbeing and Development at the University of Zurich, the National Statistical Office of Malawi, the Centre for Social Research at the University of Malawi, and UNICEF Malawi.

Manning, A. and J. Swaffield (2008). The gender gap in early-career wage growth. *The Economic Journal 118*(530), 983–1024.

Menon, R. et al. (2007). Famine in malawi: Causes and consequences. *Occassion Paper. Human Development Report Office. http://hdr. undp. org/en/reports/global/hdr2007-2008/papers/menon_roshni_2007a_malawi. pdf. Accessed on 17*, 02–10.

Miao, Q. and D. Popp (2014). Necessity as the mother of invention: Innovative responses to natural disasters. *Journal of Environmental Economics and Management 68*(2), 280–295.

Mtika, M. M. and H. V. Doctor (2002). Matriliny, patriliny, and wealth flow variations in rural malawi. *African Sociological Review/Revue Africaine de Sociologie 6*(2), 71–97.

Murdock, G. P. (1967). *Ethnographic Atlas*. Pittsburgh: University of Pittsburgh Press.

Muttaqin, T., R. Wittek, L. Heyse, and M. Van Duijn (2017). Why do children stay out of school in indonesia? *Jurnal Perencanaan Pembangunan: The Indonesian Journal of Development Planning 1*(2), 93–108.

NSO (2019). Malawi 2018 population and housing census main report. Technical report, National Statistical Office of Malawi.

Obbo, C. (1989). Sexuality and economic domination in uganda. In *Woman-nation-state*, pp. 79–91. Springer.

Pauw, K., J. Thurlow, D. van Seventer, et al. (2010). Droughts and floods in malawi. *International Food Policy Research Institute, Washington, DC*.

Peters, P. E. (2010). "our daughters inherit our land, but our sons use their wives' fields": matrilineal-matrilocal land tenure and the new land policy in malawi. *Journal of Eastern African Studies 4*(1), 179–199.

Reichelt, M., K. Makovi, and A. Sargsyan (2021). The impact of covid-19 on gender inequality in the labor market and gender-role attitudes. *European Societies 23*(sup1), S228–S245.

Sear, R. (2008). Kin and child survival in rural malawi. *Human Nature 19*(3), 277.

Shah, M. and B. M. Steinberg (2017). Drought of opportunities: Contemporaneous and long-term impacts of rainfall shocks on human capital. *Journal of Political Economy 125*(2), 527–561.

Syaukat, Y. et al. (2011). The impact of climate change on food production and security and its adaptation programs in indonesia. *J. ISSAAS 17*(1), 40–51.

Taj, S., A. Majid, A. H. Mirza, M. Abbas, B. ICARDA, and R.-P. ABAD (2004). Assessment of rural and urban women's participation in the decision making in family matters. *Pak. J. Life and Soc. Sci 2*(1), 28–32.

Tembon, M. M. and L. Fort (2008). *Girl's education in the 21st century: Gender equality, empowerment and growth*. The World Bank.

van Hoorn, A. (2016). The cultural roots of human capital accumulation. *Available at SSRN 2850868*.

Van Hoorn, A. and R. Maseland (2010). Cultural differences between east and west germany after 1991: Communist values versus economic performance? *Journal of Economic Behavior & Organization 76*(3), 791–804.

Vicente-Serrano, S. M., S. Beguería, and J. I. López-Moreno (2010). A multiscalar drought index sensitive to global warming: the standardized precipitation evapotranspiration index. *Journal of climate 23*(7), 1696–1718.

Vicente-Serrano, S. M., S. Beguería, J. I. López-Moreno, M. Angulo, and A. El Kenawy (2010). A new global 0.5 gridded dataset (1901–2006) of a multiscalar drought index: comparison with current drought index datasets based on the palmer drought severity index. *Journal of Hydrometeorology 11*(4), 1033–1043.

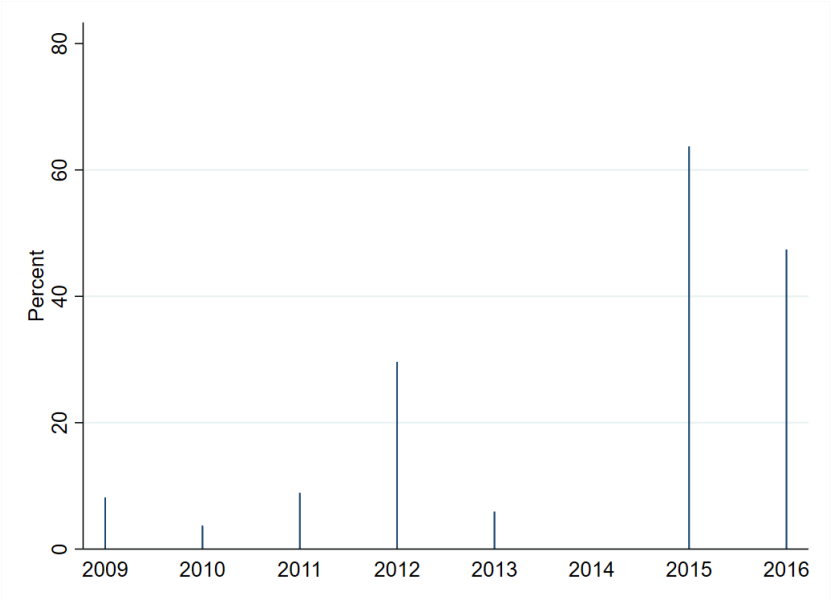
Wodon, Q., C. E. Montenegro, H. Nguyen, and A. Onagoruwa (2018). Missed oportunities: The high cost of not educating girls.

Zhang, C. (2019). Family support or social support? the role of clan culture. *Journal of Population Economics 32*(2), 529–549.

8 Appendix

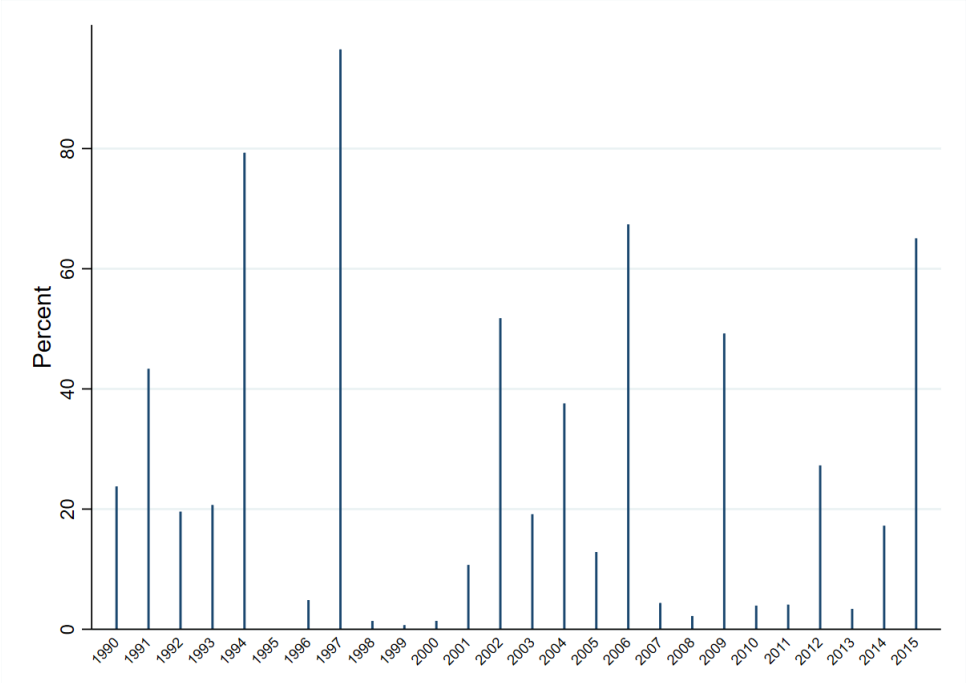
i. Descriptive evidence

Figure 2: *Percentage of grid points with drought experiences by year in* ***Malawi***



Source: Authors' elaboration from the SPEI Global Drought Monitor data (https://www.spei.csic.es)

Figure 3: *Percentage of grid points with drought experiences by year in* ***Indonesia***



Source: Authors' elaboration from the SPEI Global Drought Monitor data (https://www.spei.csic.es)

Table 1: *Descriptive Statistics of the variables used in the regression estimates, whole sample and by kinship group, rural individuals aged* $8-18$*—rural* ***Malawi***

	Full Sample (1)	Matrilocal (2)	Patrilocal (3)	Difference (4) [(2)-(3)]	p-value (5)
School dropout	0.1340	0.1360	0.1286	0.0074	0.6450
	(0.3408)	(0.3430)	(0.3349)	(0.0162)	
Age	11.7594	11.6391	12.0176	-0.3785	0.0058
	(2.9437)	(2.9026)	(3.0205)	(0.1370)	
Female	0.4902	0.4931	0.4838	0.0093	0.6909
	(0.5000)	(0.5002)	(0.5000)	(0.0233)	
Father has no education	0.7606	0.7987	0.7124	0.0863	0.0000
	(0.4268)	(0.4011)	(0.4529)	(0.0196)	
Father has primary education	0.1019	0.0794	0.1204	-0.0409	0.0026
	(0.3026)	(0.2705)	(0.3256)	(0.0136)	
Father has secondary education	0.1235	0.1189	0.1304	-0.0115	0.4514
	(0.3291)	(0.3238)	(0.3369)	(0.0153)	
Father has tertiary education	0.0140	0.0030	0.0369	-0.0339	0.0000
	(0.1175)	(0.0547)	(0.1885)	(0.0057)	
Mother has no education	0.8649	0.8552	0.8567	-0.0014	0.9297
	(0.3419)	(0.3520)	(0.3506)	(0.0163)	
Mother has primary education	0.0772	0.0899	0.0689	0.0210	0.1001
	(0.2670)	(0.2861)	(0.2534)	(0.0128)	
Mother has secondary education	0.0564	0.0549	0.0698	-0.0149	0.1784
	(0.2307)	(0.2279)	(0.2550)	(0.0111)	
Mother has tertiary education	0.0015	0.0000	0.0047	-0.0047	0.0150
	(0.0386)	0.0000	(0.0682)	(0.0019)	
Father is dead	0.1308	0.1330	0.1372	-0.0042	0.7896
	(0.3373)	(0.3397)	(0.3443)	(0.0159)	
Mother is dead	0.0613	0.0673	0.0612	0.0061	0.5941
	(0.2400)	(0.2506)	(0.2398)	(0.0115)	
Wealth index	-0.2616	-0.3534	-0.0434	-0.3100	0.0000
	(1.4229)	(1.3772)	(1.5435)	(0.0673)	
Internal migration	0.0807	0.0818	0.0913	-0.0095	0.4651
	(0.2724)	(0.2742)	(0.2882)	(0.0130)	
Distance to primary school (km)	5.3956	4.6104	7.8413	-3.2308	0.0069
	(24.0309)	(13.0407)	(38.4819)	(1.1954)	
Distance to secondary school (km)	23.4529	21.4334	24.6179	-3.1845	0.0002
	(18.2393)	(17.5646)	(18.6882)	(0.8463)	
# teachers in primary school	14.5795	15.6308	15.1019	0.5289	0.1811
	(8.4542)	(7.4690)	(9.9831)	(0.3953)	
# of teachers in secondary school	22.3331	24.2394	18.7885	5.4509	0.0001
	(28.0570)	(37.0347)	(5.2281)	(1.3958)	
# Individuals	2,117	1,100	796	-	-
# Grids	38	22	22	-	-

Source: Authors' elaboration based on IHPS 2010-2016, rural areas.

Notes: *** p<0.01, ** p<0.05, * p<0.1. The full sample includes 'Matrilineal and neolocal', 'Patrilineal and neolocal' and 'Other' kinship types. As reported in the last row, both matrilocal and patrilocal groups are in 22 grids, of which 8 are the same.

Table 2: *Descriptive Statistics of the variables used in the regression estimates, whole sample and by kinship group, rural individuals aged* $6-18$*—rural* ***Indonesia***

	Full Sample (1)	Matrilocal (2)	Patrilocal (3)	Difference (4) [(2)-(3)]	p-value (5)
School dropout	0.6748	0.6828	0.6638	0.0190	0.1407
	(0.4685)	(0.4654)	(0.4725)	(0.0129)	
Internal migration	0.0006	0.0000	0.0009	-0.0009	0.0428
	(0.0235)	0.0000	(0.0295)	(0.0004)	
Female	0.5184	0.5221	0.5022	0.0200	0.1172
	(0.4997)	(0.4996)	(0.5001)	(0.0127)	
Muslim	0.8939	0.9623	0.6983	0.2641	0.0000
	(0.3080)	(0.1904)	(0.4591)	(0.0078)	
Christian	0.0546	0.0160	0.1507	-0.1347	0.0000
	(0.2271)	(0.1254)	(0.3578)	(0.0058)	
Other	0.0516	0.0217	0.1511	-0.1294	0.0000
	(0.2212)	(0.1458)	(0.3582)	(0.0060)	
# Individuals	7,687	3,966	1,960	-	-
# Grids	156	145	55	-	-

Source: Authors' elaboration based on the 2014/2015 Indonesian Family Life Survey (IFLS), rural areas.

Notes: *** p<0.01, ** p<0.05, * p<0.1. The full sample includes 'Matrilineal and neolocal', 'Patrilineal and neolocal' and 'Other' kinship types. The panel period spans between 1990 and 2015. Dropout takes one if, during the observed period, an individual reported having dropped out of school.

ii. Baseline results

Table 3: *Effect of drought on school dropout, by kinship tradition, and gender (8-18 years old)—rural* ***Malawi***

	Matrilocal			**Patrilocal**		
Dropout (0/1)	(1) Girl	(2) Boy	(3) p-value of (1)-(2)	(4) Girl	(5) Boy	(6) p-value of (4)-(5)
$Drought_t$	-0.0018	0.0029	0.7576	0.0154	0.0022	0.4555
	(0.0148)	(0.0143)		(0.0145)	(0.0111)	
$Drought_{t-1}$	-0.0363**	-0.0222	0.3716	0.0675***	-0.0140	0.0000
	(0.0143)	(0.0162)		(0.0194)	(0.0150)	
Additional controls	Y	Y		Y	Y	
Year FE	Y	Y		Y	Y	
Age FE	Y	Y		Y	Y	
Grid FE	Y	Y		Y	Y	
Observations	2,089	2,321		1,630	1,616	
R^2	0.1177	0.0633		0.1109	0.0696	

Source: Authors' elaboration based on IHPS 2010-2016, rural areas.

Notes: FE = fixed effects. Y=yes; *** p<0.01, ** p<0.05, * p<0.1. Standard errors are clustered at the grid level. Additional controls are: quintile of household's wealth index (for 2011, 2012, 2014 and 2015, linear interpolations based on the values observed in 2010, 2013 and 2016 are used); if father died; if mother died; father's education level; mother's education level; distance to primary and secondary school and number of teachers in primary and secondary school. The Wald test was used to test the equality of coefficients; results are reported in columns (3) and (6).

Table 4: *Effect of drought on school dropout, by kinship tradition, and gender (6-18 years old)—rural* ***Indonesia***

	Matrilocal			**Patrilocal**		
Dropout (0/1)	(1) Girl	(2) Boy	(3) p-value of (1)-(2)	(4) Girl	(5) Boy	(6) p-value of (4)-(5)
$Drought_t$	-0.0037	-0.0005	0.7366	-0.0089	-0.0129	0.8616
	(0.0073)	(0.0068)		(0.0105)	(0.0082)	
$Drought_{t-1}$	-0.0020	-0.0069	0.6561	-0.0017	-0.0105	0.5268
	(0.0072)	(0.0061)		(0.0098)	(0.0080)	
Additional controls	Y	Y		Y	Y	
Year FE	Y	Y		Y	Y	
Age FE	Y	Y		Y	Y	
Grid FE	Y	Y		Y	Y	
Observations	16,871	13,965		8,413	7,632	
R^2	0.1367	0.1384		0.1468	0.1357	

Source: Authors' elaboration based on the 2014/2015 Indonesian Family Life Survey (IFLS), rural areas.

Notes: FE = fixed effects. Y=yes; N=no; *** p<0.01, ** p<0.05, * p<0.1. Standard errors are clustered at the grid level. Additional controls are: religion, if migrated. The panel period spans between 1990 and 2015. The Wald test was used to test the equality of coefficients; results are reported in columns (3) and (6).

iii. Age heterogeneity results

Table 5: *Effect of drought on school dropout, by kinship tradition, gender, and age group (8-14 and 15-18 years old)—rural* ***Malawi***

	Matrilocal						**Patrilocal**					
Dropout (0/1)	(1) Girl 8-14	(2) Boy 8-14	(3) p-value of (1)-(2)	(4) Girl 15-18	(5) Boy 15-18	(6) p-value of (4)-(5)	(7) Girl 8-14	(8) Boy 8-14	(9) p-value of (7)-(8)	(10) Girl 15-18	(11) Boy 15-18	(12) p-value of (10)-(11)
$Drought_t$	0.0003	-0.0103	0.4132	-0.0492	0.0397	0.1211	0.0096	0.0129	0.8141	0.0104	-0.0333	0.5762
	(0.0141)	(0.0118)		(0.0535)	(0.0475)		(0.0083)	(0.0134)		(0.0625)	(0.0411)	
$Drought_{t-1}$	-0.0219	-0.0190	0.8711	-0.1640**	-0.0410	0.1682	0.0302*	0.0074	0.1698	0.2257***	-0.0900*	0.0001
	(0.0163)	(0.0165)		(0.0732)	(0.0611)		(0.0129)	(0.0195)		(0.0534)	(0.0523)	
Additional controls	Y	Y		Y	Y		Y	Y		Y	Y	
Year FE	Y	Y		Y	Y		Y	Y		Y	Y	
Age FE	Y	Y		Y	Y		Y	Y		Y	Y	
Grid FE	Y	Y		Y	Y		Y	Y		Y	Y	
Observations	1,695	1,751		392	570		1,222	1,209		406	407	
R^2	0.0568	0.0475		0.2085	0.1079		0.0574	0.0648		0.1669	0.0894	

Source: Authors' elaboration based on IHPS 2010-2016, rural areas.

Notes: FE = fixed effects. Y=yes; *** p<0.01, ** p<0.05, * p<0.1. Standard errors are clustered at the grid level. Additional controls are: quintile of household's wealth index (for 2011, 2012, 2014 and 2015, linear interpolations based on the values observed in 2010, 2013 and 2016 are used); if father died; if mother died; father's education level; mother's education level; distance to primary and secondary school and number of teachers in primary and secondary school. The Wald test was used to test the equality of coefficients; results are reported in columns (3), (6), (9) and (12).

Table 6: *Effect of drought on school dropout, by kinship tradition, gender, and age group (6-15 and 16-18 years old)—rural* ***Indonesia***

	Matrilocal						Patrilocal					
Dropout (0/1)	(1) Girl 6-15	(2) Boy 6-15	(3) p-value of (1)-(2)	(4) Girl 16-18	(5) Boy 16-18	(6) p-value of (4)-(5)	(7) Girl 6-15	(8) Boy 6-15	(9) p-value of (7)-(8)	(10) Girl 16-18	(11) Boy 16-18	(12) p-value of (10)-(11)
$Drought_t$	0.0019	-0.0008	0.9291	-0.0099	-0.0151**	0.7582	-0.0265	0.0057	0.5765	0.0168	-0.0012	0.9317
	(0.0077)	(0.0060)		(0.0101)	(0.0070)		(0.0221)	(0.0277)		(0.0263)	(0.0332)	
$Drought_{t-1}$	-0.0046	-0.0124**	0.5354	-0.0082	-0.0017	0.5654	0.0104	0.0223	0.9895	0.0628**	-0.0426	0.0088
	(0.0055)	(0.0059)		(0.0098)	(0.0064)		(0.0261)	(0.0208)		(0.0237)	(0.0299)	
Additional controls	Y	Y		Y	Y		Y	Y		Y	Y	
Year FE	Y	Y		Y	Y		Y	Y		Y	Y	
Age FE	Y	Y		Y	Y		Y	Y		Y	Y	
Grid FE	Y	Y		Y	Y		Y	Y		Y	Y	
Observations	14,190	11,499		7,005	6,290		2,681	2,466		1,408	1,342	
R^2	0.1156	0.1084		0.1216	0.1030		0.1769	0.1879		0.2028	0.1997	

Source: Authors' elaboration based on the 2014/2015 Indonesian Family Life Survey (IFLS), rural areas.
Notes: FE = fixed effects. Y=yes; N=no; *** p<0.01, ** p<0.05, * p<0.1. Standard errors are clustered at the grid level. Additional controls are: religion, if migrated. The panel period spans between 1990 and 2015. The Wald test was used to test the equality of coefficients; results are reported in columns (3), (6), (9) and (12).

iv. Robustness checks

Table 7: *Effect of drought on school dropout, by kinship tradition, with interaction between drought and correlates of kinship, 8-18 years old—rural* ***Malawi***

	Matrilocal			Patrilocal		
Dropout (0/1)	(1) Girl	(2) Boy	(3) p-value of (1)-(2)	(4) Girl	(5) Boy	(6) p-value of (4)-(5)
$Drought_t$	-0.0346	0.0033	0.3139	0.0257	0.0215	0.8916
	(0.0370)	(0.0151)		(0.0327)	(0.0190)	
$Drought_{t-1}$	-0.0688**	-0.0104	0.1299	0.0978***	0.0282	0.0389
	(0.0304)	(0.0267)		(0.0240)	(0.0223)	
Additional controls	Y	Y		Y	Y	
Correlates of kinship × droughts	Y	Y		Y	Y	
Year FE	Y	Y		Y	Y	
Age FE	Y	Y		Y	Y	
Grid FE	Y	Y		Y	Y	
Observations	2,086	2,321		1,627	1,614	
R^2	0.1184	0.0649		0.1140	0.0732	

Source: Authors' elaboration based on IHPS 2010-2016, rural areas.

Notes: FE = fixed effects. Y=yes; *** p<0.01, ** p<0.05, * p<0.1. Standard errors are clustered at the grid level. Additional controls are: quintile of household's wealth index (for 2011, 2012, 2014 and 2015, linear interpolations based on the values observed in 2010, 2013 and 2016 are used); if the household head is Muslim; if father died; if mother died; father's education level; mother's education level; distance to primary and secondary school and number of teachers in primary and secondary school. Correlates of kinship include: household ethnic group, if a child belongs to an ethnicity with a bride price custom and where polygamy and belonging to the Muslim religion are prevalent. The Wald test was used to test the equality of coefficients; results are reported in columns (3) and (6).

Table 8: *Effect of drought on school dropout, by kinship tradition, with interaction between drought and correlates of kinship, 6-18 years old—rural* ***Indonesia***

	Matrilocal			Patrilocal		
Dropout (0/1)	(1) Girl	(2) Boy	(3) p-value of (1)-(2)	(4) Girl	(5) Boy	(6) p-value of (4)-(5)
$Drought_t$	0.0001	0.0021	0.6575	-0.0056	-0.0072	0.8450
	(0.0010)	(0.0098)		(0.0118)	(0.0119)	
$Drought_{t-1}$	-0.0022	-0.0020	0.7185	0.0049	-0.0036	0.7369
	(0.0075)	(0.0093)		(0.0138)	(0.0101)	
Additional controls	Y	Y		Y	Y	
Correlates of kinship × droughts	Y	Y		Y	Y	
Year FE	Y	Y		Y	Y	
Age FE	Y	Y		Y	Y	
Grid FE	Y	Y		Y	Y	
Observations	11,538	9,501		6,935	6,350	
R^2	0.1508	0.1650		0.1397	0.1423	

Source: Authors' elaboration based on the 2014/2015 Indonesian Family Life Survey (IFLS), rural areas.

Notes: FE = fixed effects. Y=yes; *** p<0.01, ** p<0.05, * p<0.1. Standard errors are clustered at the grid level. Additional controls are: religion, if migrated. The panel period spans between 1990 and 2015. Correlates of kinship include: if a child belongs to an ethnicity with a bride price custom and where polygamy is prevalent. The Wald test was used to test the equality of coefficients; results are reported in columns (3) and (6).

Table 9: *Effect of drought on school dropout, by kinship tradition and gender (8-18 years old), with household fixed effects—rural* ***Malawi***

	Matrilocal		**Patrilocal**	
Dropout (0/1)	Girl	Boy	Girl	Boy
$Drought_t$	0.0109	0.0114	0.0246	0.0092
	(0.0187)	(0.0207)	(0.0216)	(0.0164)
$Drought_{t-1}$	-0.0614*	-0.0224	0.0841***	-0.0373
	(0.0365)	(0.0151)	(0.0254)	(0.0213)
Additional controls	Y	Y	Y	Y
Year FE	Y	Y	Y	Y
Age FE	Y	Y	Y	Y
Household FE	Y	Y	Y	Y
Observations	1,896	2,138	1,480	1,485
R^2	0.2881	0.2646	0.2825	0.2375

Source: Authors' elaboration based on IHPS 2010-2016, rural areas.

Notes: FE = fixed effects. Standard errors are clustered at the grid level; Y=yes; *** p<0.01, ** p<0.05, * p<0.1. Standard errors are clustered at the grid level. Additional controls are: quintile of household's wealth index (for 2011, 2012, 2014 and 2015, linear interpolations based on the values observed in 2010, 2013 and 2016 are used); if father died; if mother died; father's education level; mother's education level; distance to primary and secondary school and number of teachers in primary and secondary school.

Table 10: *Effect of drought on school dropout, by kinship tradition and gender (6-18 years old), with household fixed effects—rural* ***Indonesia***

	Matrilocal		**Patrilocal**	
Dropout (0/1)	Girl	Boy	Girl	Boy
$Drought_t$	0.0038	0.0004	0.0070	0.0004
	(0.0048)	(0.0038)	(0.0068)	(0.0043)
$Drought_{t-1}$	0.0054	-0.0010	0.0033	0.0075
	(0.0047)	(0.0034)	(0.0055)	(0.0050)
Additional controls	Y	Y	Y	Y
Year FE	Y	Y	Y	Y
Age FE	Y	Y	Y	Y
Household FE	Y	Y	Y	Y
Observations	19,558	17,827	9,712	9,332
R^2	0.2276	0.2265	0.2311	0.2508

Source: Authors' elaboration based on the 2014/2015 Indonesian Family Life Survey (IFLS), rural areas.

Notes: FE = fixed effects. Standard errors are clustered at the grid level; Y=yes; *** p<0.01, ** p<0.05, * p<0.1. Standard errors are clustered at the grid level. Additional controls are: religion, if migrated. The panel period spans between 1990 and 2015.

Table 11: *Effect of drought on school dropout, by kinship tradition, and gender (8-18 years old), corrected for spatial correlation—rural* ***Malawi***

	Matrilocal		**Patrilocal**	
Dropout (0/1)	Girl	Boy	Girl	Boy
$Drought_t$	-0.0018	0.0029	0.0154	0.0022
	(0.0128)	(0.0119)	(0.0134)	(0.0101)
$Drought_{t-1}$	-0.0363***	-0.0222	0.0675***	-0.0140
	(0.0123)	(0.0136)	(0.0143)	(0.0120)
Additional controls	Y	Y	Y	Y
Year FE	Y	Y	Y	Y
Age FE	Y	Y	Y	Y
Grid FE	Y	Y	Y	Y
Observations	2,089	2,321	1,630	1,616
R^2	0.1177	0.0633	0.1109	0.0696

Source: Authors' elaboration based on IHPS 2010-2016, rural areas.
Notes: FE = fixed effects. Y=yes; *** p<0.01, ** p<0.05, * p<0.1. Standard errors are clustered at the grid level. Additional controls are: quintile of household's wealth index (for 2011, 2012, 2014 and 2015, linear interpolations based on the values observed in 2010, 2013 and 2016 are used); if father died; if mother died; father's education level; mother's education level; distance to primary and secondary school and number of teachers in primary and secondary school. We account for spatial correlation across the grid within a radius of 55 km (the median distance across the EAs) by following Conley (1999).

Table 12: *Effect of drought on school dropout, by kinship tradition, and gender (6-18 years old), corrected for spatial correlation—rural* ***Indonesia***

	Matrilocal		**Patrilocal**	
Dropout (0/1)	Girl	Boy	Girl	Boy
$Drought_t$	-0.0037	-0.0005	-0.0089	-0.0129
	(0.0073)	(0.0067)	(0.0103)	(0.0074)
$Drought_{t-1}$	-0.0020	-0.0069	-0.0017	-0.0105
	(0.0072)	(0.0061)	(0.0098)	(0.0079)
Additional controls	Y	Y	Y	Y
Year FE	Y	Y	Y	Y
Age FE	Y	Y	Y	Y
Grid FE	Y	Y	Y	Y
Observations	16,871	13,965	8,413	7,632
R^2	0.1367	0.1384	0.1468	0.1357

Source: Authors' elaboration based on the 2014/2015 Indonesian Family Life Survey (IFLS), rural areas.
Notes: FE = fixed effects. Y=yes; *** p<0.01, ** p<0.05, * p<0.1. Standard errors are clustered at the grid level. Additional controls are: religion, if migrated. The panel period spans between 1990 and 2015. We account for spatial correlation across the grid within a radius of 22 km by following Conley (1999).

Table 13: *Effect of drought on school dropout, by kinship tradition and gender, and age group (8-14 and 15-18 years old), triple difference approach—rural* ***Malawi***

	(1)	(2)	(3)
Dropout (0/1)	8-18	8-14	15-18
$Drought_t$	0.0091	0.0059	0.0322
	(0.0082)	(0.0092)	(0.0265)
$Drought_t \times girl \times matrilocality$	-0.0189	0.0064	-0.1314**
	(0.0129)	(0.0094)	(0.0510)
$Drought_{t-1}$	0.0047	-0.0037	0.0304
	(0.0095)	(0.0110)	(0.0314)
$Drought_{t-1} \times girl \times matrilocality$	-0.0334*	-0.0370**	-0.0527
	(0.0165)	(0.0143)	(0.0675)
Additional controls	Y	Y	Y
Year FE	Y	Y	Y
Age FE	Y	Y	Y
Grid FE	Y	Y	Y
Observations	7,657	5,878	1,779
R^2	0.0741	0.0353	0.1031

Source: Authors' elaboration based on IHPS 2010-2016, rural areas.
Notes: FE = fixed effects. Y=yes; *** p<0.01, ** p<0.05, * p<0.1. Standard errors are clustered at the grid level. Additional controls are: quintile of household's wealth index (for 2011, 2012, 2014 and 2015, linear interpolations based on the values observed in 2010, 2013 and 2016 are used); if father died; if mother died; father's education level; mother's education level; distance to primary and secondary school and number of teachers in primary and secondary school.

Table 14: *Effect of drought on school dropout, by kinship tradition and gender, and age group (6-18 years old), triple difference approach—rural* ***Indonesia***

	(1)	(2)	(3)
Dropout (0/1)	6-18	6-15	16-18
$Drought_t$	-0.0127**	-0.0095	0.0006
	(0.0061)	(0.0074)	(0.0221)
$Drought_t \times girl \times matrilocality$	-0.0003	0.0035	-0.0391
	(0.0114)	(0.0114)	(0.0397)
$Drought_{t-1}$	-0.0091	-0.0043	-0.0146
	(0.0065)	(0.0062)	(0.0267)
$Drought_{t-1} \times girl \times matrilocality$	-0.0088	0.0035	-0.0899**
	(0.0140)	(0.0121)	(0.0398)
Additional controls	Y	Y	Y
Year FE	Y	Y	Y
Age FE	Y	Y	Y
Grid FE	Y	Y	Y
Observations	46,881	39,984	7,897
R^2	0.0943	0.0987	0.1380

Source: Authors' elaboration based on the 2014/2015 Indonesian Family Life Survey (IFLS), rural areas.
Notes: FE = fixed effects. Y=yes; N=no; *** p<0.01, ** p<0.05, * p<0.1. Standard errors are clustered at the grid level. Additional controls are: religion, if migrated. The panel period spans between 1990 and 2015.

Table 15: *Effect of drought on school dropout, by kinship tradition, and gender (8-18 years old), without migrants—rural **Malawi***

	Matrilocal			Patrilocal		
Dropout (0/1)	(1) Girl	(2) Boy	(3) p-value of (1)-(2)	(4) Girl	(5) Boy	(6) p-value of (4)-(5)
$Drought_t$	0.0104	0.0021	0.5654	0.0193	0.0029	0.2423
	(0.0149)	(0.0151)		(0.0141)	(0.0126)	
$Drought_{t-1}$	-0.0359**	-0.0184	0.8529	0.0589***	-0.0132	0.0000
	(0.0168)	(0.0161)		(0.0171)	(0.0154)	
Additional controls	Y	Y		Y	Y	
Year FE	Y	Y		Y	Y	
Age FE	Y	Y		Y	Y	
Grid FE	Y	Y		Y	Y	
Observations	1,888	2,098		1,454	1,484	
R^2	0.1236	0.0626		0.1146	0.0748	

Source: Authors' elaboration based on IHPS 2010-2016, rural areas.

Notes: FE = fixed effects. Standard errors are clustered at the grid level; Y=yes; *** p<0.01, ** p<0.05, * p<0.1. Standard errors are clustered at the grid level. Additional controls are: quintile of household's wealth index (for 2011, 2012, 2014 and 2015, linear interpolations based on the values observed in 2010, 2013 and 2016 are used); if father died; if mother died; father's education level; mother's education level; distance to primary and secondary school and number of teachers in primary and secondary school.

Table 16: *Effect of drought on school dropout, by type of lineage system, and gender (8-18 years old)—rural **Malawi***

	Matrilineal			Patrilineal		
Dropout (0/1)	(1) Girl	(2) Boy	(3) p-value of (1)-(2)	(4) Girl	(5) Boy	(6) p-value of (4)-(5)
$Drought_t$	0.0021	0.0066	0.7086	0.0171	0.0002	0.3921
	(0.0116)	(0.0094)		(0.0171)	(0.0102)	
$Drought_{t-1}$	0.0073	-0.0154	0.3195	0.0508**	-0.0156	0.0025
	(0.0187)	(0.0121)		(0.0218)	(0.0146)	
Additional controls	Y	Y		Y	Y	
Year FE	Y	Y		Y	Y	
Age FE	Y	Y		Y	Y	
Grid FE	Y	Y		Y	Y	
Observations	3,441	3,511		646	722	
R^2	0.0923	0.0618		0.1669	0.0898	

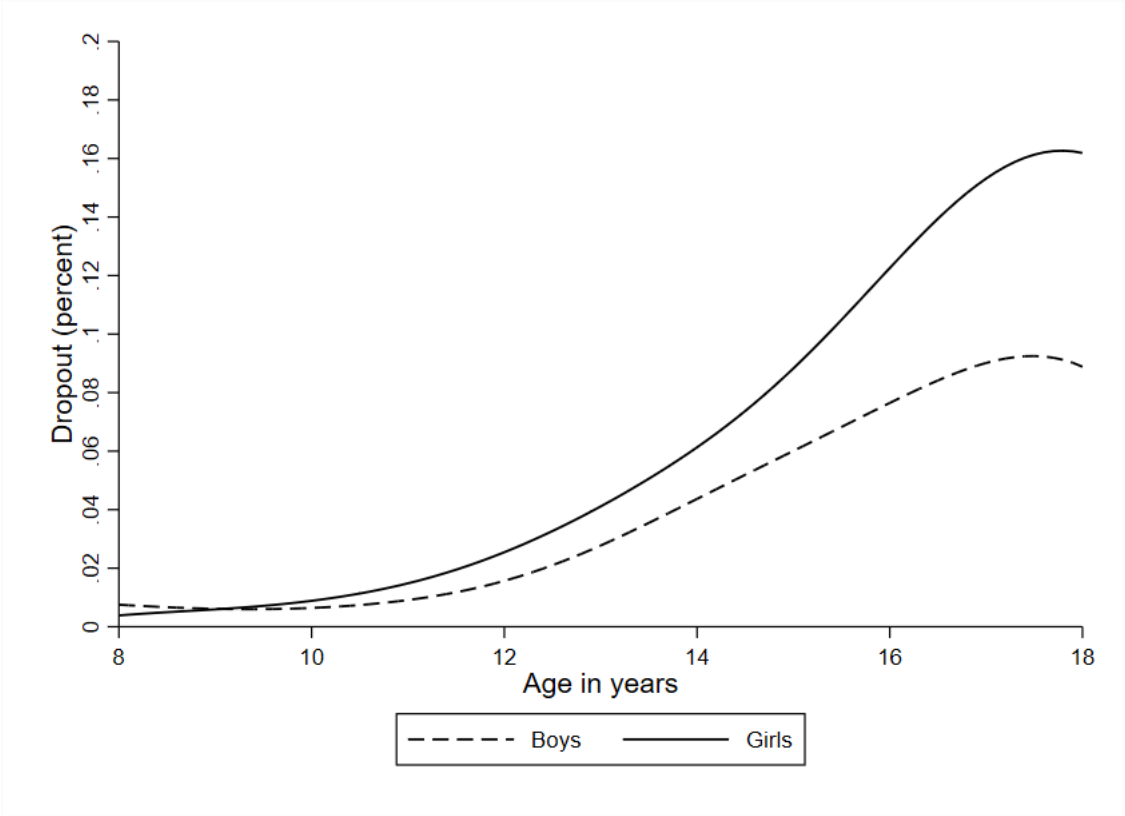
Source: Authors' elaboration based on IHPS 2010-2016, rural areas.

Notes: FE = fixed effects. Y=yes; *** p<0.01, ** p<0.05, * p<0.1. Standard errors are clustered at the grid level. Additional controls are: quintile of household's wealth index (for 2011, 2012, 2014 and 2015, linear interpolations based on the values observed in 2010, 2013 and 2016 are used); if father died; if mother died; father's education level; mother's education level; distance to primary and secondary school and number of teachers in primary and secondary school. The Wald test was used to test the equality of coefficients; results are reported in columns (3) and (6).

9 Online appendix

i. Additional results

Figure 4: *School dropout rate by age and by gender*



Source: Authors' elaboration based on IHPS 2010-2016

Table 17: *Descriptive Statistics: Average School Dropout rate and Total years of schooling by gender, age group and kinship—rural **Malawi** and **Indonesia***

	Malawi			
	Girls		**Boys**	
	8-14	15-18	8-14	15-18
	(1)	(2)	(3)	(4)
Dropout in (kinship)				
Matrilocal	0.0815	0.2027	0.0652	0.1489
	(0.2739)	(0.4030)	(0.2470)	(0.3567)
Patrilocal	0.0392	0.2324	0.0582	0.1286
	(0.1944)	(0.4235)	(0.2345)	(0.3357)
Total years of education in (kinship)				
Matrilocal	3.9079	6.8152	3.5388	6.2653
	(1.7812)	(2.4080)	(1.6389)	(2.3545)
Patrilocal	4.1988	7.3218	3.9209	6.6604
	(1.8479)	(2.5850)	(1.8243)	(2.4351)
	Indonesia			
	Girls		**Boys**	
	6-15	16-18	6-15	16-18
	(1)	(2)	(3)	(4)
Dropout in (kinship)				
Matrilocal	0.2248	0.2007	0.1517	0.1461
	(0.4175)	(0.4007)	(0.3588)	(0.3533)
Patrilocal	0.1916	0.1519	0.1434	0.1204
	(0.3938)	(0.3592)	(0.3507)	(0.3256)
Total years of education in (kinship)				
Matrilocal	8.8198	8.6705	8.7181	8.6748
	(3.3361)	(4.4035)	(3.4127)	(3.4480)
Patrilocal	8.9212	8.8512	8.9771	8.9107
	(3.5126)	(3.5599)	(3.5371)	(3.6133)

Source: Authors' elaboration based on IHPS 2010-2016 (Malawi) and IFLS 2014/2015 (Indonesia), rural areas.

Notes: Columns are divided by the age groups used in the regression analyses, 8-14 and 15-18 years old (Malawi), and 6-15 and 16-18 (Indonesia), respectively. The panel periods span between 2010 and 2016 (Malawi), and 1990 and 2015 (Indonesia), respectively.

Table 18: *Effect of Patrilocality on women's decision-making power and desire for sons—rural* ***Malawi***

	Woman's husband or someone else making decision about:					Desire for sons
	(1)	(2)	(3)	(4)	(5)	(6)
	Her earnings	Large HH purchases	husband earnings	HH visits	Her health care	
Patrilocal	0.0620***	0.0542***	0.0998***	0.0501***	0.0246**	0.0272***
	(0.0208)	(0.0112)	(0.0115)	(0.0097)	(0.0107)	(0.0068)
Additional controls	Y	Y	Y	Y	Y	Y
Observations	2,641	11,718	11,316	11,718	11,718	17,572
R^2	0.0355	0.0299	0.0196	0.0259	0.0162	0.0033

Source: Authors' elaboration based on DHS 2015, rural areas and women only.

Notes: Robust standard errors in parentheses; Y=yes; *** p<0.01, ** p<0.05, * p<0.1. Additional controls are: Age; region; education; religion and wealth index.

Table 19: *Correlation between Lagged Drought and Welfare—rural **Malawi***

Welfare (in log)	coef
$Drought_{t-1}$	-0.2412***
	(0.0472)
Year FE	Y
Grid FE	Y
Observations	5,691
R^2	0.2376

Source: Authors' elaboration based on IHPS 2010 and 2013, rural areas.

Notes: Welfare is observed in 2010 and 2013, is defined as per adult equivalent household expenditure, and accounts for temporal (base year = 2010) and spatial (across regions) price differences. FE = fixed effects. Standard errors are clustered at the grid level. Y=yes; *** p<0.01, ** p<0.05, * p<0.1.