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The Impact of Household Shocks on Domestic Violence: Evidence from Tanzania

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THE IMPACT OF HOUSEHOLD SHOCKS ON DOMESTIC VIOLENCE: EVIDENCE FROM TANZANIA

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Abstract

In this paper, we study the effects of household shocks on the incidence of domestic violence (DV) using a unique set of microdata from the World Bank's Living Standard Measurement Survey for Tanzania. We use idiosyncratic variation in rainfall as an exogenous shock to Tanzanian households and control for a large set of potential confounding variables on the individual, household and community levels, while exploiting intra-and inter-community rainfall variation for identification. We find that rainfall shocks substantially increase the likelihood of the DV incidence in the household. A one standard deviation negative rainfall shock increases the incidence of domestic violence by about 18.8 percentage points compared to baseline for wives. We furthermore show that rainfall shocks have an effect on physical violence, while we do not find an effect on severe physical or sexual abuse, which is consistent with the strategic use of violence. Estimates from non-linear specifications reveal that the overall effects are driven by droughts rather than floods. We furthermore show that effects are more pronounced for poorer households. In addition, we also provide evidence that female empowerment mitigates the impact of rainfall shocks on violence.

JEL classifications: D13, I10, J12, J16

Keywords: Domestic violence, household shocks, rainfall, Tanzania.

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1. Introduction

Violence against women – in particular intimate partner violence – is a major public health issue which has attracted increased attention in economics lately.[1] A recent analysis of the WHO, based on existing data from over 80 countries, found that 35% of women worldwide have experienced either physical intimate partner violence or non-partner physical violence in the past (WHO 2014), with the majority of these incidences being related to intimate partner violence. Besides the direct welfare concerns for victims of domestic violence (DV), the costs of violence against women related to policing, health expenditure, lower intra-household productivity and distorted investment incentives are substantial (Walby 2004, Doepke *et al.* 2012; Duflo 2012). Walby (2009) estimates the cost of DV at approximately 6 billion pounds a year for the United Kingdom. This figure includes estimates for lost economic output due to time off work related to injury and cost estimates for public services used including criminal justice, social services, housing and health care. Health care costs associated with DV account for approximately 1.5 percent of public health expenditure in the UK in 2008.[2] In Chile, women's lost earnings as a result of DV cost US$1.56 billion which is above 2 percent of the country's GDP in 1996 while in Nicaragua an estimate of US$29.5 million which translates to 1.6 percent of the national GDP in 1997 was reported (Morrison and Orlando 1999). More recent cost estimates for other countries, in particular developing countries, are very rare, probably because of limited information on the incidence of DV.

In addition to the cost borne by the victim, the negative externalities of DV extend to children in households of victims and the unborn children of victims. Aizer (2011) documents the cost of exposure to DV in utero on newborn health in the US and finds that hospitalization for DV leads to a reduction in birth weight of about 160 grams. Rawlings and Siddique (2014) find that children exposed to DV in utero across 30 low- and middle-income countries have worse health at birth and an increased child mortality rate.

A second strand in the literature focuses on examining possible socioeconomic characteristic and their intrahousehold distribution as determinants for intimate partner violence. Early work by Gelles (1976) uses a simple household bargaining model to explain the intra household use of violence.[3] In bargaining models, women with better outside options have higher threat points and lower reference points for abuse leading to lower incidence of DV in these households. A number of empirical papers have demonstrated how income or relative income between partners influence prevalence of DV incidence through shifting bargaining powers (Tauchen *et al.*1991; Tauchen and Witte 1995; Farmer and Tiefenthaler 1997; Bowlus and Seitz 2006; Srinivasan and Bedi 2007;

[1] Recent examples include Aizer 2010; Carrell and Hoekstra 2010; Card and Dahl 2011; van den Berg and Tertilt 2012; Bobonis et al. 2013; Hidrobo and Fernald 2013, Sekhri and Storeygard 2014; Anderberg et al. 2015.

[2] Own calculation based on estimates on health care costs from Walby (2009) and official health care expenditure data from the Office for National Statistics (2011).

[3] Subsequent household bargaining models include Manser and Brown (1980), McElroy and Horney (1981), Bloch and Rao (2002), Srinivasan and Bedi (2007), Anderson and Eswaran (2009), Aizer (2010), Eswaran and Malhotra (2011) and Bobonis *et al.* (2013).

Chin 2012). In a recent paper by Aizer (2010) using exogenous changes in the demand for labour in female-dominated industries, she estimates the effect of the male-female wage gap on the incidence of DV and provides evidence consistent with a household bargaining model. Anderberg *et al.* (2015) show for the UK how a shift in male and female unemployment have opposite-signed effects on domestic abuse, where female unemployment leads to a weakening in the bargaining position of females and to an increase in DV.

Rather than focusing on the relative bargaining position of females in high-income countries, we are interested in the effect of exogenous shocks to the economic position of a household in a resource-scarce environment, namely Tanzania, one of the poorest countries in the world. To learn about the effect of these shocks on DV we make use of a unique dataset that provides very detailed information about the incidence and the severity of domestic abuse, including categories of physical, severe physical and sexual abuse, for 2,606 households. We then combine this information with household level information on exogenous rainfall shocks for households whose main income depends on agricultural production to estimate causal effects of household resource shocks have on domestic abuse.

Our paper is closest to two recent papers by Sekhri and Storeygard (2014) and Cools *et al.* (2015). Sekhri and Storeygard (2014) study the effect of rainfall shocks on dowry deaths in India. Using district level data from 583 Indian districts, they find that a one standard deviation decline in annual rainfall from the local mean increases reported dowry death by 8 percent explaining their results with the use of dowry to smooth consumption during negative rainfall shocks. Cools *et al.* (2015) investigate how weather shocks affect violence against women using rainfall variation across selected African countries. They find that droughts lead to an increase in the risk for first abuse in relationships where only the woman and not her husband works in agriculture.

We contribute to this literature with estimates of rainfall shocks on DV using household level variation in precipitation and making use of an extraordinarily rich dataset providing a rich set of controls and a unique set of measures of DV not available in other datasets. We provide evidence that rainfall shocks have a significant effect on the incidence of DV in Tanzania. A one standard deviation negative rainfall shock (approximately 15% decrease in precipitation from the long-run mean) increases the probability of DV by 3.2 percent. These effects translate to approximately 18.8 percentage point increase in DV compared to the mean incidence for wives. We furthermore show that rainfall shocks have an effect on physical violence (with a magnitude similar to the combined DV specification), we do not find an effect on severe physical or sexual abuse, findings consistent with the strategic use of violence in a household bargaining models. Estimates from non-linear specifications reveal that the overall effects are driven by dry shocks (droughts) rather than wet shocks (floods). We also show that effects are much stronger for poorer households (as measured by quartiles of the non-agricultural assets in the household). We also provide evidence that female empowerment mitigates the impact of rainfall shocks.

The remainder of this paper is organized as follows. In section 2, we describe the data and the variables used in the analysis. Section 3 discusses the rainfall shock measures. Section 4 introduces the identification strategy. Section 5 presents and discusses the main results. In section 6, we explore possible underlying mechanisms and we conclude in section 7.

2. Data

We use data from the Tanzanian Household Panel Survey, which is part of the World Bank's Living Standards Measurement Study-Integrated Surveys on Agriculture (LSMS-ISA) for this paper. The LSMS-ISAs are collaborative initiatives between the World Bank and national bureaus of statistics (or similar) in selected developing countries providing researchers with nationally representative high quality micro data for agricultural-dominant economies. Tanzania first participated in the survey in 2008/2009 and there are now three completed waves in total with waves two and three being conducted in 2010/2011 and 2012/2013 respectively. Individual and household level data is complemented by extensive community level data drawing on a variety of sources. For households engaged in agricultural practices additional very detailed plot-level information about agricultural inputs and outputs are also collected. The Tanzanian LSMS follows 3,265 households over the three waves including information on 16,711 household members. Attrition rates are low due to the extraordinary effort being made to track households and individuals moving households or villages etc. Figure 1 shows a map of the 386 randomly selected enumeration areas (EA) for which data has been collected, where red dots denote the randomised settlements.

We restrict the data on households for which the agricultural questionnaire has been completed and for which data on rainfall on the HH level is available, restricting the sample to 2,606 households.

Household summary statistics are reported in table 1**.** Average household size is just above seven, 82 percent households have a male household head with 69 percent of these households being located in the rural areas. Individuals are on average 21 years old reflecting high fertility rates in Tanzania. The sample comprises of 47 percent males and 53 percent adults are married. Educational attainment is generally low among adults, with the vast majority reporting primary education as the highest attainment (80 percent), 19 percent have a junior or senior high school qualification with only 0.6 percent having a college degree. The large majority of the adults work either in agriculture or in mining sector (67 percent), while sizeable adults are self-employed (15 percent) with a smaller fraction having employment in the private sector or in NGOs (7 percent). The remainder either works as civil servant in local or regional government (5 percent) or as domestic worker or unemployed (6 percent).

Information on violence towards female household members is available only in the 2008/2009 Tanzanian LSMS-ISA wave. DV questions were administered to women within 15 – 50 years of age and great care has been taken when collecting this information. Women were interviewed for these questions in separate rooms ensuring that the conversation could not be overheard by anyone else. The questions were administered by specially trained female interviewers and interviewees were instructed that the interview could be ended at any point at their request. Out of 3,182 women eligible for the DV section, 2,933 individuals answered these questions, so the response rate is 92.2 percent.

Questions on DV were repeated for two timescales, reporting the incidence over the past 12-month period and over the entire life of the interviewees. Eight separate questions were asked about the incidence of domestic abuse for these timescales and their frequency was recorded including whether the respondent was subjected to either hitting, pushing, beating, slapping, choking, burning, the use or the threat to use a weapon, and forceful and unwanted sexual intercourse. As is standard in the literature we categorized these questions into physical abuse including the first four questions, severe-physical abuse comprising of choking, burning and the use of a weapon, and a category including sexual violence. From these categories, we created dummies for the incidence of physical, severe physical and sexual violence, as well as indices using the frequency of occurrence available in the questionnaire, each for the 12-month and lifetime exposure.

In addition, females were asked about their perception of the acceptability of violent acts by their partner. The question asked whether a husband would be justified in hitting or beating his wife in a range of scenarios.[4] The survey also included questions on whether victims have ever sought help after physical violence with either family, hospital or health centre, village or community leaders, an NGO, religious leaders or the police, which provides very helpful information on the reliability of statistics of DV incidences based on reported incidences with any of these agencies.

While twenty-three percent of women in the sample report having experienced at least one form of physical or sexual violence over their lifetime, twelve percent report to being victimized in the last twelve months (Table 2, Chart A) indicating that a proportion of females suffer from repeat incidences of domestic violence. Within the previous twelve months, roughly 10 percent report having experienced some form of physical violence, 1 percent of severe-physical violence, and 5 percent sexual violence. The figures are slightly higher for wives within the household. 31 percent have experienced abuse in their entire life while 17 percent have been abused in the last twelve months. These figures are 8 percentage points and 5 percentage points higher than general reports of female-targeted DV respectively for lifetime and twelve months. Chart B Table 2 reports the findings on the perception of the acceptability of violence for female respondents. Going out without permission, child neglect, argument with male partner and refusal of sex are named equally frequently as acceptable justification of violence by a husband with on average just above 30

[4] These include ‘if she goes out without telling him’, ‘if she neglects the children’, ‘if she argues with him’, ‘if she refuses to have sex with him’, ‘if there are problems with his or her family’, ‘if there are money problems’, ‘if there is no food at home’, ‘other’.

percent of women accepting these as justification. Problems with the families of either the respondent or their partner, financial problems and lack of food are much less frequently being accepted as justification, with 3, 2, and 6 percent respectively.

Chart C of table 2 shows that 7 percent of respondents have ever been to hospital or to a health clinic as result of domestic violence; 5 percent ever reported an incident to the police and 1 percent state that they turned to an NGO, demonstrating the likely degree of underreporting of DV using official data from health institutions or the police and explaining the discrepancy when comparing the incidence of DV across such datasets. In combination with the attention by the trained survey teams to ensuring privacy the information on DV is likely among the most reliable data on the incidence of DV minimizing potential measurement error, in particular when comparing to official statistics based on reporting to public services.

3. Measuring rainfall shocks

We use annual and seasonal rainfall shocks to investigate the effect of these economic shocks on the incidence of DV for households where agricultural income is a major component. To create measures of household rainfall shocks we use the data provided in the LSMS-ISA for Tanzania using information from the georeferenced agricultural plot locations on the household level. After information on precipitation has been merged by household ID, georeferenced data is removed to preserve the confidentiality of the households. Different to many other datasets though, the precipitation is available on the household level rather than at the enumeration area or regional level, so that we have available variation in precipitation not only across regions or villages, but even within the village as individual plots are often spread out over a larger area[5]. This also helps us to reduce measurement error in precipitation compared to weather shocks based on regional precipitation data. In the same vein, this helps with concerns more recently raised about spatial correlation of rainfall data (Lind 2015). One way to address these concerns is the link to the units of observation. Because of the absence of georeferenced household data in many studies precipitation data is observed only at the district level though.

When constructing rainfall shocks we follow closely the previous literature (Macinni and Yang 2009; Björkman-Nyqvist 2013; Rocha and Soares 2015[6]), and we adopt the conventional measure of shocks as a deviation of a given year's rainfall from historical averages for the same locality. The relevant year's rainfall in our case relates to the total yearly rainfall from July 2007 till June 2008 to capture the relevant rainfall for the main planting season for the 2008/2009 LSMS-ISA, while the historical rainfall average is the mean value of the yearly rainfall for the period 2001 to

[5] See details of World Banks' formation of plot level geo-referenced precipitation estimates from both weather stations and multiple meteorological satellites in the appendix.
[6] Although, Rocha and Soares (2015) has alternative shock specification in terms of drought dummy, estimates from the rainfall shock specification adopted by our study is the focus for the general interpretation of their paper.

2008 as measured for the July to June periods. Hence, we construct the rainfall shock variable as log-deviation from historical average as follows[7]:

$$\text{rainfall shock}_{\text{h}} = ln\, R_{ht-1} - ln\, \overline{R_h} \qquad (1)$$

where R_{ht-1} indicates the yearly rainfall in household h for 2007/2008 planting season, $\overline{R_h}$ is the average historical yearly rainfall in household h. Thus, rainfall shock_{h} is defined as the deviation between the natural logarithm of the total rainfall in the 12 months prior to the 2008/2009 survey and the natural logarithm of the average yearly historical rainfall in household h. The rainfall deviation implies a percentage deviation from mean rainfall (Macinni and Yang 2009). Rainfall shock summary statistics in Table 1 indicates an average of 0.3 percent decrease in household (and community) precipitation from the mean for the 2007/2008 agricultural season. In addition to the household level rainfall measures, we construct village level long-term rainfall shock measures. We use the GPS information provided for each village in the Tanzania LSMS to access the University of Delaware's rainfall repository by matching each village to the four closest weather stations for historical rainfall data between 1978 and 2007. The data which is compiled and made available by Matsuura and Willmott (2012) has been used in many empirical studies in economics.

4. Identification strategy

The difficulty of estimating the effect that the household socioeconomic background or a shock to household income has on the incidence of DV in a household arises from the fact that confounding factors that are related to these socioeconomic conditions and to the propensity to using violence or being the victim of violence may be unobservable to the econometrician and their omission may then lead to biased estimates.

To circumvent this problem we propose to use plausibly exogenous variation in rainfall on the household level to estimate the effect of economic shocks on the incidence of DV. In line with a rich literature using rainfall variation in place of socioeconomic shocks, we estimate the following reduced form model:

$$DV_{ih} = \alpha + \beta \text{rainfall shock}_h + X_{ih}'\nu_x + Z_c'\upsilon_z + \varepsilon_{ih} \qquad (2)$$

where DV_{ih} is the domestic violence measure for an individual respondent i (measured as a dummy variable or severity index within 12 months of abuse) in household h. β is the parameter on the variable of interest rainfall shock_h. $\boldsymbol{X}$ and $\boldsymbol{Z}$ are vectors of controls to enhance the precision of our estimation. $\boldsymbol{X}$ is an array of individual and household level covariates including household demographic characteristics such as household size, number of children, gender of household head dummy, average household age, an indicator for rural households, proxies for household wealth, indicators for household savings group membership and whether the household has taken out a

[7] We repeat the same exercise for wet season (agricultural season) rainfall shocks and dry season (out-of-planting season) shocks respectively.

loan previously. Individual controls mainly consist of individual demographic characteristics including individual's age, gender, education, occupation categories and marital status. $\boldsymbol{Z}$ is a vector of relevant community level controls including community level infrastructure facilities such as bank, birth and death registration centre, court, government health facilities and hospitals, government primary and secondary schools, daily and weekly market facilities, police station, post office, nursery care facility, savings and credit cooperative (SACCO), private health facilities and hospitals, private primary and secondary schools and veterinary clinics. In addition, community level controls include the proximity of community of residence to district or regional headquarters. We also include annual community level temperature because an existing literature argues that high temperature contributes to the propensity for violence (Anderson 2001; Burke *et al.* 2013). The error is ε_{ih} are assumed to be iid between households but correlated within households so that the standard errors are clustered at the household level.

To further investigate the differential role of negative and positive rainfall shocks namely dry shock and wet shock respectively we propose to separate these effects following practice in the literature (Sekhri and Storeygard 2014) and we modify equation 2 to accommodate the two potential categories of shocks non-linearly as follows:

$$DV_{ih} = \alpha + \beta_1 \text{dry shock}_h + \beta_2 \text{wet shock}_h + X_{ih}'\nu_x + Z_c'\upsilon_z + \varepsilon_{ih} \quad (3)$$

where dry shock_h connotes negative rainfall shocks and is constructed as absolute value if the deviation of the previous season's rainfall from historical average is negative; zero otherwise. Analogously, wet shock_h connotes a positive rainfall shock and constructed as actual value if the deviation of the previous season's rainfall from historical average is positive; zero otherwise.

Because rainfall shocks are constructed in a manner that reflects previous agricultural season's farm harvest, they determine the economic circumstances over the period reflected in the 12 month prior to the survey date. We also repeat the estimation procedure of eq. (2) for the planting season and out-of-season using the seasonal breakdown data to shed more light on the precise relationship between rainfall shocks and DV incidence.

5. Results

5.1 Main results

Table 3 presents the main estimates of eq. (2) by reporting marginal effects from probit estimates for a binary outcome model. We find that a negative rainfall shock (drought) leads to an increase in the incidence of DV. The inclusion of controls reduces the estimates significantly, while remaining statistically significant (Columns 2 and 3). Focusing on the model including community and individual/ household level controls, estimates in column 3 indicate that a one standard deviation[8] positive (negative) rainfall shock reduces (increases) the likelihood of DV targeted

[8] Summary statistics of rainfall shock in Table 2 indicates that a standard deviation shock indicates a 15% movement in actual rainfall measure.

towards female in a typical household by a probability of 0.10 statistically significant at the 5 percent level[9]. The impact of rainfall shock on DV is 1.5% inverse response of DV incidence to a one standard deviation movement in rainfall. This effect corresponds to a 12.1 percentage point movements in DV incidence given the baseline. Results are very similar in magnitude to linear probability model estimates of the impact of rainfall shock on DV incidence (see Table A8).

Shifting our attention to the different categories of DV, results from table 4 indicate that the overall effect is driven by the effect on physical violence, while we do not find any effect for severe physical or sexual violence. A one standard deviation negative rainfall shock increases the likelihood of physical abuse by 0.097 (Column 1) – a very similar magnitude to the main overall effect. On the contrary, the estimate from severe-physical DV (Column 2) indicates a negligible response (β = 0.005) to rainfall shocks, while the coefficient for sexual abuse (Column 3) is -0.031 and not statistically significant. We estimate eq. (2) for the crude DV categories in the questionnaire. Estimates reported in Table A9[10] show that rainfall shock estimates for categories of DV under physical DV – which includes slapping, pushing, hitting and beating – all reveal a very similar effect to the main categories, while the individual variables for severe physical abuse are very small and not significant, except the estimate for forceful sex.

Not surprisingly, the effect is driven by violence towards spouses of the household head (Table A1). We find no effect on children in the household and a much smaller effect on other females in the household who are not spouses (Table 9). Interpreting the rainfall shock estimate of -0.21 from table A1, results in 3.2% inverse response of DV incidence to a standard deviation rainfall shock. Given the sample average 0.17 DV incidence for wives, the effect implies approximately 18.8 percentage point impact for wives.

We then turn our attention to the severity of DV using the information on the frequency of abuse. This exercise follows the literature for consistency check for results obtained from the use of binary variable, as an indicator for victim of DV (see Hidrobo and Fernald 2013). Tables 5 and A2 report rainfall shock estimates for general and abuse against wives respectively for DV severity measures.

Results on table 5 show that there is a similar inverse relationship between rainfall shock and DV intensity/severity. Using the marginal effects on table 5 in column 2, the physical abuse reports a more predominant rainfall shock estimate among other categories with a magnitude similar to that of the overall abuse reported in column 1 (-0.031 and -0.035 respectively for physical and overall abuse outcomes[11]). While the magnitude for the sexual abuse is considerably smaller, the severe-physical abuse reports a small estimate, indicating that severe-physical and sexual assaults

[9] Table A10 presents similar community level rainfall shock estimate.
[10] Section I of the 2008 Tanzanian LSMS Questionnaire for the Domestic Violence is presented in the Appendix section.
[11] While the marginal estimates for rainfall shocks in DV index specifications do not directly replicate marginal estimates for DV incidence, the DV index specification are mainly useful as a check for a consistent pattern of DV categories with those in the DV incidence.

are not necessary driven by rainfall shocks relative to physical abuse. While rainfall shock estimates for all DV and physical DV category specifications are significant at 5%, rainfall shock estimates for severe-physical DV and sexual DV specifications are not significant at any traditional t values. This shows that the emerging patterns conform to results earlier reported for the DV incidence estimated across diverse categories. Estimates of rainfall shock for wives' DV indices in table A2 present similar trend.

5.2 Household level outcomes

We also estimate the effect of rainfall shocks on additional outcomes related, including separation of partners and the incidence of divorce within the household in the past twelve months. Results in table A3 indicate that a negative rainfall shock leads to an increase in the likelihood of separation among partners. In particular, a one standard deviation negative rainfall shock increases the likelihood of separation by 6 percentage points (Column 2 Table A3). Likewise, we find an effect on the probability of divorce.

5.3 Community level outcomes

We can repeat the exercise using additional information on the number of disputes at the village level, which include information on community disputes brought to the village elders. Administrative data on monthly community level disputes resolved by the tribunal avails us the opportunity to explore relevant outcomes from community level variables on rainfall shock. Results in table A4 reiterate the relevance of rainfall shock with respect to marriage cases reported to the tribunal relative to others. A one standard deviation negative rainfall shock increases the number of marriage cases reported to the tribunal. Rainfall shock estimate for natural logarithm of the number of marriage cases is -1.97(Column 1 Table A4). Apart from smaller rainfall shock estimates for other tribunal cases in money dispute, land dispute and inheritance dispute, these are insignificant at the traditional levels as with marriage cases which is significant at 1% (Columns 2 – 4 Table A4).

5.4 Non-linear impacts of rainfall shocks and timing of shocks

Estimates from the regression of eq. (3) reported in table 6 allow us to investigate simultaneously the impact of dry shock and wet shock on the incidence of DV. This exercise helps us to disentangle the main components of rainfall shocks as it relates to agricultural crop production. The estimates in table 6 show that the overall effects are driven by dry shocks, while wet shocks have a much smaller impact and are not statistically significant at conventional levels. Importantly, across different models, dry shocks are very robust and the coefficients are considerably stable when controlling for a large array of community and individual controls, diminishing any concerns raised from table 3. A one standard deviation increase in dry shock increases the incidence of DV targeted towards female in a typical household by a probability of 0.22 and the effect is precisely estimated at the 1 percent level of significance. Table 7 presents rainfall shock estimates of regression outcomes for *planting-season* and *out-of-season* shocks respectively related to agricultural practices from eq. (2). Estimates show that rainfall shock within planting season displays a stronger impact (Column 1) on DV than out-of-season effects (Column 2). These estimates reiterate that the timing of our shock is primarily driven by shocks to harvests potentially linked to changes to weather pattern during crop cultivation.

5.5 Robustness checks

To be able to interpret the estimates of rainfall shocks as the consequence of economic shocks to the household, we would like to rule out that the rainfall leads to an increase in DV directly, i.e. even in the absence of an underlying economic shock. For example, more rainfall could lead families to spend more time in limited living space increasing tensions between household members. Likewise, dry shocks could be associated with excessively high temperatures directly leading to an increase in violence, even in the absence of economic shocks to the household. Although we do not find that including temperature in the estimates of dry shocks, and while we do find that violence is specifically targeted at the spouse rather than any female in the household in table 9, we would like to test if the inclusion of relevant controls does make a difference to the estimates. Table 8 reports robust rainfall estimates by including measures of household living conditions, which may potentially cause tensions and household violence, as controls. Column 1 repeats our rainfall shock estimate for baseline specification while columns 2 - 6 reports rainfall shock estimates after sequentially including potentially confounding variables such as household living conditions and water scarcity respectively.

Intra-household exposure can be determined by the number of rooms available in the house. Column 2 includes number of rooms available in the house as an additional control to our main model (eq. 2). Our rainfall shock estimate remains largely unchanged in magnitude to the baseline rainfall shock estimate in column 1. Also, the differences in household roofing type used for covering the house may indicate that the impact of rainfall shock is not credibly channelled through income shocks since wet rainfall shock can permeate most of the roofing materials used in Tanzania. Column 3 includes different types of roofing materials used for building as a control. Resulting rainfall shock estimate is exactly the same as the baseline estimate in column 1. This indicates that leakage caused by some roofing material is not a driver of the impact of rainfall shock on the incidence of DV. Columns 4 and 5 include type of water access used during rainy and dry seasons as controls respectively to investigate the role of access to water in the effect of rainfall shocks on the incidence of DV. Rainfall shock estimates for respective specifications is -0.09. While this effect is slightly weaker than our main specification rainfall shock effect in column 1, the margin is not wide and does not imply any threat on the robustness of rainfall shock estimate. Column 6 includes water shortage shock experience of household in the last 12 months as a control. Rainfall shock estimate for this specification is -0.10 which indicates that the impact of rainfall shock on DV is not driven by water shortage shocks. Overall, all the robustness check specifications from columns 2 – 6 present rainfall shock estimates that are not different from our baseline rainfall shock estimate in column 1. More importantly, the rainfall shock estimates from columns 2 – 6 are statistically significant at 5 percent following the baseline rainfall shock estimate which indicates a robust rainfall shock estimate for our baseline result.

We also would like to rule out that the estimates are driven by spatial correlation of rainfall shocks. Although we make use of household level variation in rainfall, we want to make sure that village level rainfall shocks are not correlated with the village level long-run incidence of DV. For this purpose we regress incidence of DV on the community level on long term rainfall variability (measured by the standard deviation of 30-year historical rainfall pre-empting the 2008-09 agricultural season). Table A7 presents the results using both 12 month and life-time DV incidence. We do not find any significant and sizeable effect of long-term rainfall variability on these measures, reducing any remaining concerns around spatial correlation of rainfall in our cross-section.

6. Potential mechanisms and heterogeneous effects

An in-depth understanding of rainfall shock effects along diverse heterogeneous classifications is important to understand potential mechanism of DV incidence attributable to response to shocks in Tanzania. Educational background of females and level of financial independence are commonly explored to capture the prevalence of female-targeted DV (Aizer 2010; Bobonis *et al.* 2013; Hidrobo and Fernald 2013). Outcomes associated with rainfall deviation are commonly affiliated with agricultural practices and agricultural associated shocks may be cushioned using non-agricultural assets at the household level.

6.1 Gender of household head

An empowerment story can be built around the catering responsibility and headship status of females involved in an intimate relationship. Table 10 splits the spousal specification by female headship and male headship categories of the household. The estimates of rainfall shock impact on DV for male headed and female headed households are -0.26 and 0.04 respectively (including all controls). This indicates that a one standard deviation negative rainfall shock increases the probability of DV incidence by 0.26 for households with male head. This estimate is slightly higher than the baseline spousal specification where rainfall shock estimate is -0.21. Whereas, households with female head reports 0.04 rainfall shock estimate on DV. Since most sub-Saharan African (SSA) communities attribute household headship to responsibility, we perceive that ex-ante bargaining power play an important role in moderating the impact of rainfall shock on DV.

6.2 Female empowerment

Previous papers have pointed out the importance of female empowerment as a mediating factor for economic shocks. We investigate this by using information on the inheritance policy at death of husband, as proxy for female empowerment. We estimate eq. (2) including an interaction term for both rainfall shock and empowerment dummy (1 if women and children are allowed to inherit husband when husband is dead and zero otherwise)[12]. Results reported in table 11 shows that the empowerment interaction mitigates the effect of rainfall shock on DV. While the rainfall shock estimate remains negative as expected, interaction of rainfall shock and empowerment dummy is positive. Importantly, the positive interaction estimate negates and diminishes the negative rainfall shock effect on DV incidence. Combining the rainfall shock estimate and the interaction estimate indicates a weakened effect of rainfall shock on DV for females within the empowered community[13]. This is not the case for the impact of rainfall shock on DV for females that belong to communities where wives or children are not legally allowed to inherit the man's wealth after death as the shock effect persists.

6.3 Non-agricultural household assets

Table 12 reports result of baseline estimations by asset valuation quartiles for the household. We adopt the 2012/2013 household asset valuation since the actual values of assets are not available within the 2008/2009 survey. Using the average valuation of household asset for both purchase price and current price respectively, our results reflect that both first and second quartiles have considerable rainfall shock estimates of -0.17 and -0.20 respectively. These are significant at 10% and 5% respectively. The third and fourth quartiles yield relatively trivial and statistically insignificant rainfall shock estimates of -0.01 and -0.00. While rainfall shock estimates patterns across quartiles seems to be largely similar for other asset values using purchase or current worth, the most obvious trend is the trivial magnitude of rainfall shock for the third and fourth quartiles under all the wealth definitions. Hence, we have suggestive evidence of cushioning shock through household assets, as this is one viable channel through which the impact of rainfall shock on DV can be mitigated.

The heterogeneous rainfall shock estimates from the above indicate that inter-household resource distribution dynamics play a crucial role in the strength of the effect of rainfall shock on the incidence of DV. The households in the lower half of the non-agricultural asset valuation are disproportionately more affected than the upper half of our sample. This is suggestive evidence of cushioning drought effect on households using asset sale as consumption smoothing strategy which incidentally weakens the effect of rainfall shock on DV. Our result is consistent with Cools and Kotsadam (2015) which unveil resource inequality as a viable source of intimate partner violence both within household and at the aggregate level.

6.4 The effect of employment outside of agriculture

[12] Table A11 shows that inheritance customs in our sample favours widows in 45.9 percent of the communities and children of deceased in 32.3 percent.

[13] More details on the orthogonal nature of rainfall patterns to our inheritance measure can be found in the online appendix. Table A13 shows a 0.00 correlation between historical rainfall pattern and inheritance empowerment status for women and children across communities.

Table A5 shows a stronger rainfall shock effect when both partners[14] belong to the agricultural sector than for any other[15] combination of sectors between partners. Rainfall shock estimate for both partners being engaged in agricultural sector is -0.30 while the estimate for other occupational sector combination is -0.09. Rainfall shock estimate for both spouses in agricultural sector is significant at 1 percent level contrary to the combination identifying at least a spouse outside the agricultural sector. The agricultural spouses' rainfall shock effect is stronger than the spousal baseline estimate in table A1, which indicates that agricultural dependence family suffer higher level of intimate partner DV in times of drought, which affects agricultural harvests.

6.5 Age gap

The role of differential age gap between intimate partners has not been explored in the DV literature. It is unclear how age differentials will influence the underlying effect of shocks on DV particularly in the developing country setting where partner's age difference matters – especially in SSA. Table A6 shows a differential in the estimates across age gap between partners. Rainfall shock estimate of the sample of older male spouses reported in the table is similar to that of overall spousal specification (β = -0.21) while the estimate in the group for older female spouses unveils a negligible magnitude (β = 0.01). These results indicate that age gap in favour of women in a marital relationship is a deterrent to abusive acts with respect to economic shock consequences.

7. Discussion and conclusion

The primary objective of this paper is to estimate the relationship between transitory shocks and female targeted DV in Tanzania using unique micro level data in Tanzania. It contributes to the DV literature by investigating different mechanisms when investigating the impact of income shock on DV incidence – through exogenous weather shocks. In addition, given the inherent limitations poised by aggregate impact evaluation in the literature, our analysis is based on precise micro-level empirical framework as deemed fit to highlight specific channels of the shocks to DV.

Our estimation exploits exogenous variation in rainfall and finds that rainfall shock has a significant effect on domestic abuse of females by males. We consistently find that rainfall shock has an inverse and considerable impact on the likelihood of DV incidence. A one standard deviation negative rainfall shock increases the likelihood of abuse by 18.8 percentage points for female spouses. Also, the most prominent part of the evidence is linked to physical abuse category (which includes beating, hitting, slapping and pushing) and not severe-physical abuse (such as choking or use of weaponry) or sexual abuse (forced sex or unwanted sex) respectively. Marginal effects of rainfall shock estimates from the use of severity indices of DV constructed by the authors provide similar evidence for the impact of rainfall shock on DV incidence.

[14] We restrict our analysis in this section to spousal relationship with 1,665 observations in total. Estimates from this regression are technically comparable to estimates in table A1.
[15] Others in this case is a combination of either spouse belonging to a mixed of agricultural and non-agricultural occupational sectors or both belonging to non-agricultural occupational sector.

Our main results are robust to sequentially controlling for household living conditions, which may confound our rainfall shock's impact on DV. We find that the main rainfall shock estimate is driven by a negative rainfall shock – dry shocks or droughts – while the impact of wet shock is generally muted in our non-linear specification. In addition, while DV incidence is more responsive to rainfall shock during planting seasons, we find no evidence for the impact of out-of-season shocks. Further findings reveal an asymmetric effect along asset valuation quartiles with poorer household disproportionately affected. Lastly, our results provides a supporting evidence of consistent patterns of outcomes from partner's separation and reported marriage cases along household and community levels respectively to complement our individual level results.

We show that female empowerment through female household headship and female inheritance rights play an important role in mediating the relationship between rainfall shocks and DV. The latter is illustrated from localized empowerment measure derived from community level inheritance policy for women and their children which considerably weakens the impact of rainfall shock on DV incidence while communities with no such female-oriented policy continues to exhibit significant effects of rainfall shock on DV. Our results provide unique framework in favour of the effectiveness[16] of female empowerment to cushion the impact of shock on DV.

The estimated effect of rainfall shocks on DV is also important for the understanding of the total costs of rainfall shocks, in particular droughts, on individual welfare. As we demonstrate in this paper, droughts significantly increase the incidence of DV in rural households where agriculture is the main source of income. The results in this paper may therefore contribute to the understanding of the persistent high incidence rates of DV in SSA countries subject to frequent droughts. The findings are also important for understanding the possible consequences of an increase in the variability of rainfall in the context of climate change. There is a general consensus that productivity of rainfed agriculture predominant in SSA will suffer with the increase in the prevalence of droughts linked to climate change (Kurukulasuriya *et al.* 2006; IPCC 2012). There is a risk that climate change may lead to an increase in the incidence of DV in affected countries and the findings contribute with household level evidence to a literature linking more generally weather variability and climate change to violent conflict in Africa (Hsiang *et al.* 2011; O'Loughlin *et al.* 2012; Burke *et al.* 2013).

[16] Female empowerment does not always lead to relatively higher bargaining power as argued in the literature. Chin (2012) explores male backlash as a potential threat for women employment status in India, while Bobonis *et al.* (2013) considers instrumental use of further abuse targeted at uncooperative spouses in Mexico.

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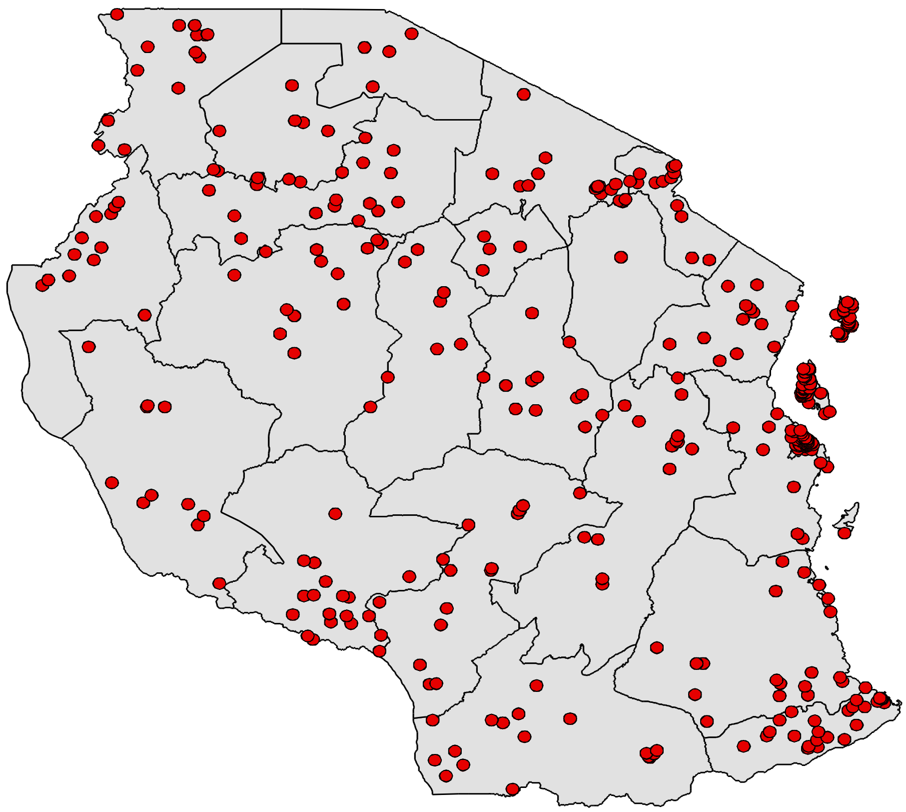
Figure 1: Map of the United Republic of Tanzania (Depicting the Enumeration Areas of LSMS Survey.



Notes: The map depicts the 26 regions of Tanzania with the red dots representing the Enumeration Areas in the LSMS-ISA used in this paper.

Table 1: Summary Statistics: Household and Individuals.

Variables	Mean	Std. Dev.
Household Characteristics		
Rural	0.688	0.463
Household size	7.166	3.947
Female head	0.183	0.387
No. of children	4.190	2.903
Asset (ln)	4.136	0.693
SACCO membership	0.065	0.246
Rainfall shock (household)	-0.003	0.151
Rainfall shock (community)	-0.003	0.150
Individual Characteristics		
Age	21.141	17.772
Male dummy	0.471	0.499
Married dummy	0.529	0.499
Education(Adults)		
None	0.004	0.064
Primary	0.797	0.402
Junior high	0.178	0.382
Senior high	0.016	0.124
College	0.006	0.076
Sector of employment (Adults)		
Agricultural and Extractive	0.674	0.468
Self-employed	0.150	0.357
NGO and private	0.068	0.251
Unemployed and Domestic work	0.061	0.240
Civil servant	0.047	0.211

Notes: Number of observations are 2,933. SACCO stands for Savings and Credit Co-operative. Rainfall shock is measured as the deviation of natural logarithm of approximate household/community rainfall measure from the natural logarithm of the historical rainfall mean.

Table 2: Summary Statistics of Domestic Violence (DV) Incidence for Females Aged 15-50.

Variables	All		Wife only		Other females in HH	
Chart A: Prevalence of DV	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
DV (lifetime)	0.231	0.421	0.309	0.462	0.129	0.335
DV (12-months)	0.124	0.330	0.168	0.374	0.066	0.249
Categorised DV (12-month):						
Physical	0.099	0.299	0.137	0.344	0.050	0.217
Severe Physical	0.013	0.112	0.015	0.122	0.009	0.097
Sexual	0.053	0.224	0.070	0.256	0.030	0.171
Chart B: Perspective on justification for DV						
DV incidence is generally justified if (there is):						
A woman goes out without permission	0.332	0.471	0.386	0.487	0.284	0.451
A woman neglects children	0.366	0.482	0.406	0.491	0.324	0.468
A woman argues with him	0.301	0.459	0.344	0.475	0.275	0.447
A woman refuses sex	0.311	0.463	0.393	0.489	0.255	0.436
Household problems	0.029	0.169	0.040	0.195	0.027	0.162
Financial problems	0.015	0.123	0.026	0.159	0.007	0.084
No food	0.060	0.238	0.075	0.264	0.058	0.235
Chart C: Reporting of incidence of DV to:						
Family	0.485	0.500	0.500	0.501	0.434	0.497
Hospital	0.069	0.254	0.075	0.263	0.053	0.224
Community Leaders	0.202	0.402	0.214	0.410	0.164	0.372
NGO	0.009	0.096	0.010	0.100	0.007	0.081
Religious Leader	0.037	0.189	0.034	0.182	0.046	0.210
Police	0.052	0.223	0.046	0.210	0.072	0.259

Notes: Total number of observations for All is 2,933. This is divided into 1,665 observations for wives and 1,268 observations for other household females respectively. Categorised DV by Physical DV, Severe Physical DV and Sexual DV presents mutually non-exclusive events of 12 months DV incidence in Chart A. Chart B reports fraction of women that accept outlined conditions as justification for DV incidence.

Table 3: The Impact of Rainfall Shock on DV Incidence.

	Dependent Variable: DV Incidence		
Variables	(1)	(2)	(3)
Rainfall shock	-0.217***	-0.137***	-0.101**
	(0.045)	(0.048)	(0.046)
Constant	-1.168***	-1.282***	-0.476
	(0.032)	(0.301)	(0.392)
R^2	0.012	0.053	0.129

Notes: The table above presents marginal effect coefficients of probit regression for 2,933 observations. Each column represents a separate regression. Outcome variable is DV incidence where 1 indicates an affirmative response for being a victim of aggression in the previous 12 months and 0 otherwise. Columns (1) – (3) each represents estimation without controls, with community level controls and all controls respectively. Community level controls include mainly infrastructural facilities at the community level as these portray access to facility for residential households. Infrastructures include bank, court, district headquarters, government primary and secondary schools, government hospital and/or other government health facilities, private primary and secondary schools, private hospital and/or other private health facilities, daily and weekly market stores, post office facility, police station and SACCO group. All controls include household controls and individual level controls with the community level controls. Household controls include household characteristics such as household size, gender of household head, number of children, urban dummy and wealth base measured by asset possession of household. Lastly, the individual controls mainly consist of individual demographic characteristics including individual's age and education, marital status, education and occupational categories. Robust standard errors (clustered at the household level) are reported in parentheses.

***, ** and * represent significance at 1 percent, 5 percent and 10 percent levels respectively.

Table 4: The Impact of Rainfall Shock on DV Incidence (By Categories).

	Dependent Variables: Categories of DV Incidence		
Variables	Physical	Severe Physical	Sexual
	(1)	(2)	(3)
Rainfall shock	-0.097**	-0.005	-0.031
	(0.041)	(0.014)	(0.032)
Constant	-0.911**	-10.451***	-0.478
	(0.454)	(0.554)	(0.460)
R^2	0.128	0.206	0.129

Notes: The table above presents marginal effect coefficients of probit regression for 2,933 observations. Each column represents a separate regression for physical DV, severe physical DV and sexual DV respectively. The coefficients presented follow table 3 column 3 with all controls. See table 3 above for a list of all controls. Robust standard errors (clustered at the household level) are reported in parentheses. ***, ** and * represent significance at 1 percent, 5 percent and 10 percent levels respectively.

Table 5: The Impact of Rainfall Shock on DV Index

	Dependent Variable: DV Index			
		Categories of DV Index		
Variables	Overall	Physical	Severe Physical	Sexual
	(1)	(2)	(3)	(4)
Rainfall shock	-0.498**	-0.615**	-0.135	-0.322
	(0.243)	(0.257)	(0.516)	(0.319)
Marginal effect	-0.035**	-0.031**	-0.001	-0.012
	(0.017)	(0.013)	(0.005)	(0.012)
R^2	0.096	0.098	0.177	0.101

Notes: The table above presents both actual and marginal effect coefficients of ordered probit regression for 2,933 observations. Each column represents a separate regression for all DV, physical DV, severe physical DV and sexual DV index respectively. Categories are hierarchically ranked from highest to lowest for many times, a few times and one time respectively; while 0 indicates none. The coefficients presented follow table 3 column 3 with all controls. See table 3 above for a list of all controls. Robust standard errors (clustered at the household level) are reported in parentheses. ***, ** and * represent significance at 1 percent, 5 percent and 10 percent levels respectively.

Table 6: The Impact of Dry Shock and Wet Shock on DV incidence.

	Dependent Variable: DV Incidence		
Variables	(1)	(2)	(3)
Dry shock	0.285***	0.240***	0.218***
	(0.081)	(0.088)	(0.085)
Wet shock	-0.141	-0.026	0.023
	(0.088)	(0.082)	(0.078)
Constant	-0.555	-1.359***	-1.209
	(0.389)	(0.302)	(0.053)
R^2	0.013	0.054	0.130

Notes: The table above presents marginal effect coefficients of probit regression for 2,933 observations. Flood and drought shock indicate quantified positive and negative rainfall shocks as exogenous independent variables. The coefficients presented follow table 3 column 3 with all controls. See table 3 above for a list of all controls. Robust standard errors (clustered at the household level) are reported in parentheses. ***, ** and * represent significance at 1 percent, 5 percent and 10 percent levels respectively.

Table 7: The Effects of Planting Season and Out-of-Season Rainfall Shocks on DV Incidence.

	Seasonality of rainfall shock	
Variables	Planting Season Shock (1)	Out-of-season Shock (2)
Rainfall shock	-0.066*	-0.018
	(0.038)	(0.025)
Constant	-0.454	-0.488
	(0.396)	(0.397)
R^2	0.129	0.127

Notes: The table above presents marginal effect coefficients of probit regression for 2,933 observations by seasons of rainfall shock. Each column represents a separate regression for overall DV incidence. The coefficients presented follow table 3 column 3 with all controls. See table 3 above for a list of all controls. Robust standard errors (clustered at the household level) are reported in parentheses. ***, ** and * represent significance at 1 percent, 5 percent and 10 percent levels respectively.

Table 8: Robustness Check on the Impact of Rainfall Shock on DV Incidence.

	Dependent Variable: DV Incidence					
Variables	(1)	(2)	(3)	(4)	(5)	(6)
Rainfall shock	-0.101**	-0.102**	-0.101**	-0.093**	-0.093**	-0.100**
	(0.046)	(0.046)	(0.046)	(0.046)	(0.046)	(0.046)
Constant	-0.476	-0.428	-0.438	-0.587	-0.589	-0.486
	(0.392)	(0.395)	(0.398)	(0.402)	(0.400)	(0.394)
No. of rooms		-0.008				
		(0.005)				
Roofing material			-0.002			
			(0.005)			
Water (rainy season)				0.003		
				(0.002)		
Water (dry season)					0.004*	
					(0.002)	
Water shortage (dummy)						0.018
						(0.023)
R^2	0.129	0.131	0.130	0.130	0.131	0.130

Notes: The table above presents marginal effect coefficients of probit regression for 2,933 observations. While column 1 presents our baseline rainfall shock coefficient of eq. 2, columns 2 – 6 add number of rooms, roofing materials used for the house, water source in rainy season, water source in dry season and a dummy for water shortage in the past year. The coefficients presented follow table 3 column 3 with all controls in addition to the household level variables inputted as controls. See table 3 above for a list of all controls. Robust standard errors (clustered at the household level) are reported in parentheses. ***, ** and * represent significance at 1 percent, 5 percent and 10 percent levels respectively.

Table 9: Rainfall Shocks and Targeting of DV Incidence

Variables	Wives	Children (18 years old and younger)	Others
Rainfall shock	-0.211***	0.005	0.057
	(0.067)	(0.045)	(0.070)
Constant	-0.014	0.092	-4.713***
	(0.469)	(0.139)	(0.871)
Observations	1,665	336	932
R^2	0.103	0.111	0.197

Notes: The regressions for the table above repeat estimation in table 3 column 3 by household membership dichotomy for 2,933 observations. Others indicate female household residents who are neither wives nor children within the household. Each regression is carried out with all controls. See table 3 above for a list of all controls. Robust standard errors (clustered at the household level) are reported in parentheses. ***, ** and * represent significance at 1 percent, 5 percent and 10 percent levels respectively.

Table 10: The Impact of Rainfall Shock on DV Incidence by Household Head Gender.

Variables	Male household head	Female household head
Rainfall shock	-0.259***	0.037
	(0.072)	(0.174)
Constant	-0.083	-3.509***
	(0.503)	(1.339)
Observations	1,449	216
R^2	0.113	0.312

Notes: The regressions for the table above splits observations in table 9 column 1 by household head gender. Each regression is carried out with all controls. See table 3 above for a list of all controls. Robust standard errors (clustered at the household level) are reported in parentheses. ***, ** and * represent significance at 1 percent, 5 percent and 10 percent levels respectively.

Table 11: Community Inheritance Rights and the Impact of Rainfall Shock on DV Incidence.

Variables	Wives' inheritance right	Wives and children's inheritance right
Rainfall shock	-0.138**	-0.441***
	(0.066)	(0.166)
Inheritance dummy	0.022	0.074***
	(0.014)	(0.023)
Rainfall shock * Inheritance	0.112	0.399**
	(0.092)	(0.171)
Constant	-4.912***	-5.093***
	(0.367)	(0.433)
R^2	0.133	0.140

Notes: The table above reports marginal effect coefficients of probit regression for 2,872 observations with the addition of community inheritance rights for wives and their children with interaction terms to baseline specification. This is short of 61 observations from the baseline observations due to non-reported inheritance right for some communities. The coefficients presented follow table 3 column 3 with all controls. See table 3 above for a list of all controls. Robust standard errors (clustered at the household level) are reported in parentheses. ***, ** and * represent significance at 1 percent, 5 percent and 10 percent levels respectively.

Table 12: The Impact of Rainfall Shock on DV Incidence by Household Asset Valuation Quartiles.

Variables	quartile1: 0-25%	quartile2: 25-50%	quartile3: 50-75%	quartile4: 75-100%
Rainfall shock	-0.172*	-0.198**	-0.015	-0.003
	(0.099)	(0.093)	(0.081)	(0.090)
Constant	-0.423	-4.876***	-0.429	0.323
	(0.848)	(0.724)	(0.975)	(0.839)
Observations	733	734	733	733
R^2	0.208	0.206	0.208	0.217

Notes: The table above presents marginal effect coefficients for probit regression. The coefficients presented follow table 3 column 3 with all controls by household non-agricultural asset quartiles referenced by the average of purchase and current price. See table 3 above for a list of all controls. Robust standard errors (clustered at the household level) are reported in parentheses.
***, ** and * represent significance at 1 percent, 5 percent and 10 percent levels respectively.

Table A1: The Impact of Rainfall Shock on DV Incidence for Wives

	Dependent Variable : DV incidence			
		Categories of DV incidence		
Variables	All	Physical	Severe Physical	Sexual
	(1)	(2)	(3)	(4)
Rainfall shock	-0.211***	-0.184***	-0.013	-0.082*
	(0.067)	(0.062)	(0.022)	(0.046)
Constant	-0.014	-0.710	-0.019	0.043
	(0.469)	(0.532)	(0.023)	(0.534)
R^2	0.103	0.103	0.035	0.117

Notes: The table above presents marginal effect coefficients of probit regression for 1,665 married women. Each column represents a separate regression for all DV, physical DV, severe physical DV and sexual DV respectively. The coefficients presented follow table 3 column 3 with all controls. See table 3 above for a list of all controls. Robust standard errors (clustered at the household level) are reported in parentheses. ***, ** and * represent significance at 1 percent, 5 percent and 10 percent levels respectively.

Table A2: The Impact of Rainfall Shock on DV Index for Wives

	Dependent Variable : DV index			
		Categories of DV index		
Variables	All DV index	Physical	Severe Physical	Sexual
	(1)	(2)	(3)	(4)
Rainfall shock	-0.073***	-0.057***	-0.001	-0.033*
	(0.027)	(0.020)	(0.008)	(0.020)
R^2	0.074	0.078	0.252	0.086

Notes: The table above presents the marginal effect coefficients of ordered probit regression for 1,665 married women. Each column represents a separate regression for all DV, physical DV, severe physical DV and sexual DV index respectively. Categories are hierarchically ranked from highest to lowest for many times, a few times and one time respectively; while 0 indicates none. The coefficients presented follow table 3 column 3 with all controls. See table 3 above for a list of all controls. Robust standard errors (clustered at the household level) are reported in parentheses. ***, ** and * represent significance at 1 percent, 5 percent and 10 percent levels respectively.

Table A3: The Impact of Rainfall Shock on Household Divorce and Separation

Variables	Dependent Variable: Divorce Dummy	Separation Dummy
	(1)	(2)
Rainfall shock	-0.097***	-0.057**
	(0.033)	(0.029)
Constant	-5.284***	-1.476***
	(0.534)	(0.542)
R^2	0.220	0.173

Notes: The table above presents the marginal effect coefficients of probit regression for 2,930 observations. Each column represents a separate regression for twelve months household incidence of divorce and separation respectively. The coefficients presented follow table 3 column 3 with all controls. See table 3 above for a list of all controls. Robust standard errors (clustered at the household level) are reported in parentheses. ***, ** and * represent significance at 1 percent, 5 percent and 10 percent levels respectively.

Table A4: The Impact of Community Rainfall Shocks on Community Dispute Cases

	Dependent Variables: Community Disputes			
Variables	Marriage (ln)	Money (ln)	Land (ln)	Inheritance (ln)
	(1)	(2)	(3)	(4)
Community rainfall shock	-1.969***	-1.180*	-0.638	-0.928
	(0.614)	(0.674)	(0.678)	(0.677)
Constant	1.013	1.605*	0.654	1.428**
	(0.777)	(0.879)	(0.624)	(0.598)
Observations	2,610	2,618	2,610	2,608
R^2	0.368	0.325	0.276	0.333

Notes: The table above presents coefficients of ordinary least square regression for four major dispute categories in Tanzanian communities. Each column represents a separate regression for the natural logarithm of the number of reported disputes (by type) on community rainfall shock respectively. The coefficients presented follow table 3 using only community level controls. See table 3 above for a list of all controls. Robust standard errors (clustered at the household level) are reported in parentheses. ***, ** and * represent significance at 1 percent, 5 percent and 10 percent levels respectively.

Table A5: The Heterogeneous Impact of Rainfall Shock on DV Incidence By Occupational Sector Of Partners

Variables	Both spouses in agricultural sector	At least one spouse outside agricultural sector
Rainfall shock	-0.302***	-0.090
	(0.088)	(0.119)
Constant	-0.944	-0.024
	(0.815)	(0.778)
Observations	1,048	599
R^2	0.117	0.163

Notes: The regressions for the table above split the observations in table A1 column 1 above by occupational sector mix of spouses. Please note that 18 spouses for which occupational categories were not specified in the data are exempted from this regression. The coefficients presented follow table 3 column 3 with all controls. See table 3 above for a list of all controls. Robust standard errors (clustered at the household level) are reported in parentheses. ***, ** and * represent significance at 1 percent, 5 percent and 10 percent levels respectively.

Table A6: The Impact of Rainfall Shock on DV Incidence For Wives (By Age Gap Between Partners)

Variables	Husband Age > Wife Age	Husband Age ≤ Wife Age
Rainfall shock	-0.266***	0.009
	(0.074)	(0.157)
Constant	-0.100	-3.920***
	(0.521)	(1.296)
Observations	1,360	305
R^2	0.114	0.226

Notes: The regressions for the table above split the observations in table A1 column 1 above by age difference of spouses. The coefficients presented follow table 3 column 3 with all controls. See table 3 above for a list of all controls. Robust standard errors (clustered at the household level) are reported in parentheses. ***, ** and * represent significance at 1 percent, 5 percent and 10 percent levels respectively.

Table A7: The Impact of Long-term Rainfall Variation on Aggregate DV

	Dependent Variable: Aggregate Domestic Violence	
Variables	12 months	Life-time
	(1)	(2)
Long-term shock	-0.009	-0.030
	(0.019)	(0.023)
Constant	4.071	10.522
	(7.103)	(8.858)
R-squared	0.269	0.284

Notes: The table above presents coefficient estimates of linear regression for our focus sample observations. Estimations are carried out by aggregating DV cases at the community level and weighed by number of observations by community. Long-term shock is computed as the standard deviation of 30-year historical rainfall distribution at the community level from UDel precipitation data. The standard deviation measure adopted centralizes drought and flood over the years. Coefficients presented follow table 3 column 2 with community level controls. See table 3 above for a list of community level controls. Robust standard errors (clustered at the community level) are reported in parentheses. ***, ** and * represent significance at 1 percent, 5 percent and 10 percent levels respectively.

Table A8: The Impact of Rainfall Shock on DV Incidence (Linear Probability Model)

	Dependent Variable: DV Dummy		
Variables	(1)	(2)	(3)
Rainfall shock	-0.212***	-0.129***	-0.102**
	(0.043)	(0.047)	(0.047)
Constant	0.124***	0.106*	0.381
	(0.006)	(0.059)	(0.271)
R^2	0.009	0.037	0.085

Note: The estimated coefficients above are from a linear probability model of the impact of rainfall shock on DV incidence. See table 3 in the main text for a list of all controls. Number of observation is 2933. Robust standard errors are reported in parentheses. ***, ** and * represent significance at 1 percent, 5 percent and 10 percent levels respectively.

Table A9: The Impact of Rainfall Shock on DV Incidence (by DV categories)

	Dependent Variable: DV Dummy							
	Slapped	Pushed	Hit	Beat	Burnt	Use weapon	Forced sex	Unwanted sex
Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Rainfall shock	-0.087**	-0.089**	-0.082**	-0.083***	-0.006	-0.001	-0.060**	-0.013
	(0.035)	(0.035)	(0.032)	(0.028)	(0.009)	(0.011)	(0.029)	(0.025)
Constant	-4.745***	-0.804	-3.655*	-0.742	-1.212	-11.084***	1.587	2.298
	(1.772)	(1.717)	(2.041)	(2.121)	(4.086)	(3.772)	(1.793)	(1.981)
R^2	0.150	0.118	0.153	0.150	0.379	0.269	0.134	0.173

Note: Each column is a separate regression for different types of DV dummy for 2933 observations. The estimation uses a probit model. The estimated coefficients reported above include all controls. See table 3 in the main text for a list of all controls. Robust standard errors are reported in parentheses. ***, ** and * represent significance at 1 percent, 5 percent and 10 percent levels respectively.

Table A10: The Impact of Community Rainfall Shock on DV Incidence

Variables	DV incidence
Community rainfall shock	-0.112***
	(0.046)
Constant	-0.480
	(0.392)
R^2	0.130

Notes: The table above presents marginal effect coefficients of probit regression for 2,933 observations. The community rainfall shock coefficient presented follow table 3 column 3 with all controls. See table 3 above for a list of all controls. Robust standard errors (clustered at the household level) are reported in parentheses. ***, ** and * represent significance at 1 percent, 5 percent and 10 percent levels respectively.

APPENDIX

Weather Data: Rainfall Data from the LSMS-ISA

The main rainfall data used in this paper are obtained from the National Oceanic and Atmospheric Administration Climate Prediction Centre (NOAA CPC) African Rainfall Estimation Algorithm Version 2.0. The rainfall dataset from Rainfall Estimate (RFE) v2.0 is a valuable component of geographical variables because it provides a standardized time-series for all of the LSMS-ISA countries. Toté *et al.* (2015) provide a validation of the RFE rainfall measure relative to other measurement methods. The RFE outperforms Climate Hazards Group InfraRed Precipitation with Stations (CHIRPS) and TAMSAT African Rainfall Climatology and Time-series (TARCAT) v2.0 products, especially in drought detection for Mozambique.

It is important to understand that RFE is a merged product using data from multiple meteorological satellites and rainfall stations. The remote sensing data provide a continuous surface, at a specific resolution, measuring rainfall estimates. According to a sourced technical document from the World Bank's LSMS team, station data are essentially used to calibrate the merged satellite surfaces. The apparent granularity of the household measure comes from the RFE modelling, as well as the method used to extract the data. Rainfall values are extracted at household locations using a bilinear interpolation or distance-weighted average of 4 nearest grid cell values as used in practice.

Seasonal precipitation data gathered from the Tanzanian meteorological weather stations are used in the interpolation of the global positioning system (GPS) of surveyed Tanzanian households[17]. These data include annual and wet season precipitation measures respectively. While the household level GPS are withheld for confidentiality reasons, these are engaged to capture household specific approximates of precipitation measures outlined above. Spatial distribution of households included in the LSMS-ISA survey for Tanzania enhances the credibility of the rainfall variation at the Enumeration Area (EA) level with additional variation achievable within the EA – engaging the household level approximations of the precipitation measures. Preliminary analysis shows that rainfall measures within the same locality are actually correlated but different in absolute terms. It is important to reiterate that while this unique data displays more variation of precipitation measures between EA compared to within EA, availability of such sophisticated level of precipitation augments rainfall shock driven inquiries in the literature.

Furthermore, specific nature of the rainfall data helps to address inter-spatial correlation of rainfall data with broader geographical precipitation variation, such as the district level, commonly used in the literature. Other weather parameters captured are geophysical characteristics at the landscape level including rainy season parameters and soil fertility

[17] Due to spatial distribution of household observations in the survey data, enumerators were provided with a technological device that helps to capture exact GPS location of the respondent household and its immediate environs. Households close to each other have exactly the same GPS while households farther away may have different GPS measurements.

conditions for agricultural production. While the unmodified household GPS measured are not released for confidentiality of survey observations, modified EA level GPS are released as part of the survey data.

Descent Tracing (Patrilineal and Matrilineal) and Inheritance Patterns: The Tanzanian Context

Various succession laws guide inheritance in Tanzania. These range from customary, Islamic to statutory laws. Ethnicity and religious affinity are the major underlying factors in the decision for the appropriate inheritance legal system applicable in each Tanzanian community. However, in rural communities, the customary laws play a predominant role in guiding inheritance sharing. Given that most deceased persons in the sub-Saharan Africa die intestate, the intent of the deceased may not be a feasible way for property sharing.

Islamic law somewhat contends with the customary laws with inheritance procession concerning Muslims due to diverging views on inheritance sharing in the community and Quran. In the case of conflict of customary and Islamic laws, the court of law is resorted to; to engage in the mode of life test of the deceased[18]. In essence, customary laws overrule Islamic laws on distribution of estates except otherwise proven unacceptable to the deceased through means of official documents (testate succession category) or mode of life test. Statutory law is generally applicable to most of the other population in the rural communities (Christians and Traditional rulers) and this consists of the use of codified egalitarian principles of inheritance sharing among survivors/dependants. However, it is rarely applied in the rural communities since upholding customs lead to preference for customary laws compared to others laws.

The laws that generally apply to the majority of people in inheritance are the Customary Law and Probate Administration Ordinance. Importantly, the codified customary law, contained in the Customary Law Declaration Order (CLDO) 1963 (Government Notice No. 436 of 1963) applies to diverse patrilineal ethnic groups (constituting about 80 percent) of Tanzania communities. On the contrary, the unmodified customary law rules remain the guiding rule for the matrilineal communities (20 percent of the communities) subject to proof of authenticity from groups relying on them (Rwebangira, 1996).

There is historical evidence that women are marginalized in sub-Saharan African countries when it comes to inheritance. Household resources are generally not equally owned by married partners by virtue of the belief that domestic contribution to the ownership of household property is not suitable enough for women to claim equality of household assets. The undervaluation of domestic work, contributed mainly by women, further inhibits their rights to inheritance after the deaths of their husbands. This form of disempowerment may contribute to the prevalence of DV in the communities where these beliefs are upheld. For instance,

[18] The mode of life test investigates the more accustomed of either the religious or customary affiliation that an individual engages in before demise and decides which of the two dominates his/her life. The outcome determines the premise upon which the estate of the deceased is shared among beneficiaries.

complexity surrounding widow's inheritance rights eludes the Marriage Act and thus solely relies on Customary Laws for resolution of widow's inheritance matters.

Custom of the parties' community prevail in the treatment of widows over the inheritance rights that should be adopted after a deceased husband irrespective of patrilineal or matrilineal descent tracing in such communities (Rwebangira, 1996). This is contrary to a clearer pattern of children's inheritance rights following closely with patrilineal or matrilineal structure practised within the community. In addition to descent tracing for community individuals in each village (Table A12), the 2008 Tanzania World Bank Household data extracts information on the inheritance patterns of widows (Table A11). This sheds light on female empowerment status across various Tanzanian communities, which we use in the estimation of heterogeneous effects by widows' inheritance status. Because the spousal inheritance status may not be exogenous for the purpose of our exercise, we investigate the orthogonality of the local inheritance practice (the practice adopted at the village level) with historic rainfall patterns.

Table A11 below shows that inheritance customs in the sample communities favours widows in 45.9 per cent of the communities. Also, descent is commonly traced to the father in a majority (81.9 percent) of the communities as sole patrilineal societies while 11.7 per cent others are shared with the matrilineal societies (Table A12).

Historical Rainfall and Inheritance Rights

It is important that historical rainfall pattern is orthogonal to inheritance practice to ensure the heterogeneous effect across inheritance platform is not driven by historic rainfall variability. A positive relationship between inheritance customs and historic rainfall shocks would invalidate the findings for heterogeneous effects using inheritance rights. In order to examine the orthogonality of female inheritance customs to rainfall pattern, we regress inheritance practice on historical rainfall.

Table A13 reports the estimates of this exercise. We basically find a zero relationship between historic rainfall pattern and the predominant inheritance rule on the community level (please note that the coefficients in table A13 are multiplied with 10,000) removing any concerns one may have about the use of inheritance practice for the estimates in table 11.

Table A11: Inheritance Custom for Deceased Husbands in Tanzanian Communities

Custom	Freq.	Fraction
Wife of Deceased	177	0.459
Children	125	0.323
Clan	14	0.036
Extended Family	62	0.161
Unknown	8	0.021
Total	386	100

Source: 2008 LSMS Tanzanian Data.

Table A12: Descent Tracing in Tanzanian Communities

Descent	Freq.	Fraction
Father	316	0.819
Mother	17	0.044
Both	45	0.117
Unknown	8	0.021
Total	386	100

Source: 2008 LSMS Tanzanian Data.

Table A13: Women's Inheritance Rights and Historical Rain Pattern in Tanzania

Variables	Wives' inheritance right	Wives' and children's inheritance right
Historical rain	0.503	0.206
	(0.517)	(0.300)
Constant	5.871***	7.693***
	(0.469)	(0.813)

Notes: The table above presents coefficients of probit regression for 2,872 observations. Each column represents a separate regression of inheritance rights for wives and children respectively. Estimates for historical rain above are reported in multiple of ten thousands (x10,000). The coefficients presented follow table 3 column 3 with all controls. See table 3 above for a list of all controls. Robust standard errors are reported in parentheses. ***, ** and * represent significance at 1 percent, 5 percent and 10 percent levels respectively.

Domestic Violence Questions (Page 29, 2008 Tanzania LSMS Questionnaire)

SECTION I: VIOLENCE AGAINST WOMEN

1. ENTER THE HOUSEHOLD ROSTER ID OF THE RESPONDENT: [ ]

THIS SECTION SHOULD BE ASKED TO EVERY WOMAN, AGE 15-50. QUESTIONS SHOULD BE ASKED IN PRIVATE. REMIND RESPONDENT THAT SHE IS FREE TO STOP AT ANY TIME.

2. Sometimes a husband is annoyed or angered by things that his wife does. In your opinion, is a husband justified in hitting or beating his wife in the following situations: YES…1 NO…2

A. If she goes out without telling him?		E. If there are problems with his or her family	
B. If she neglects the children?		F. If there are money problems	
C. If she argues with him?		G. If there is no food at home	
D. If she refuses to have sex with him?		H.Other (specify)	

	3. Has your current partner, or any partner ever ……[….]	4. Has this happened in the past 12 months?	5. In the past 12 months would you say this has happened once, a few times or many times?	6. Before the past 12 months would you say this has happened once, a few times or many times?
	YES…1 NO…2 ►NEXT ROW	YES…1 NO…2 ►NEXT ROW	NEVER………….0 ONE TIME………1 A FEW TIMES….2 MANY TIMES….3	NEVER………….0 ONE TIME………1 A FEW TIMES….2 MANY TIMES….3
A. Slapped or thrown something at you that could hurt you?				
B. Pushed you or shoved you?				
C. Hit you with his fist or with something else that could hurt you?				
D. Kicked you, dragged you, or beaten you up?				
E. Choked or burnt you on purpose?				
F. Threatened to use or actually used a gun, knife or other weapon against you?				
G. Physically forced you to have sexual intercourse when you did not want to?				
H. Did you ever have sexual intercourse you did not want because you were afraid of what he might do?				

7. DID RESPONDENT REPORT 'YES' TO ANY ITEM IN QUESTION 3? [ ] YES…1 PROCEED TO 8; NO….2 ► END

8. After any of the incidents of physical violence, did you ever go to […] for help? YES…1 PROCEED TO OPTIONS NO….2

A. Family		D. NGO	
B. Hospital/health centre		E. Religious leader	
C. Village/community leaders		F. Police	