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Climate Variability Influences Women's Attitudes Towards Intimate Partner Violence (IPV)

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Abstract: The World Health Organization (WHO) estimates 1 in 3 women worldwide has experienced violence against women. Our study examines the effects of climate conditions on women's attitudes towards wife beating. The demographic health surveys (DHS) dataset includes over 550,000 women in 38 countries, asked a series of wife beating justification questions in the domestic violence module. Using a linear probability model, we find prior year growing degree days (GDD), prior and current year rainfall variability have statistically significant effects. Most interestingly, we find that a one standard deviation (SD) rise in prior year annual rainfall decreases the likelihood of justifying wife beating this year by 2.81 percentage points. We posit changes in aggregate economic activity on the country level from climate variability influences women's attitudes towards IPV.

1. Introduction

The United Nations defines violence against women as "any act of gender-based violence that results in, or is likely to result in, physical, sexual or mental harm or suffering to women, including threats of such acts, coercion or arbitrary deprivation of liberty, whether occurring in public or in private life." The majority of violence against women is in the form of intimate partner violence (IPV), or an act of violence committed by an intimate partner that causes physical, psychological or sexual harm. Roughly 1 in 3 women has experienced either physical and/or sexual IPV or non-partner sexual violence (WHO, 2012). In WHO's 2004 multi-country study, 13-61% of women ever experienced IPV, with 4-49% reporting severe physical violence. For sexual violence, the results are similar with 6-59% of women and for emotional violence, 20-75% women confirmed. Violence against women is a global phenomenon that continues to contribute to economic and social inequality for women.

IPV has short and long run ill-health outcomes for women, both in the developing and developed world context. Poor, unemployed, and minority women are at higher risk and disproportionately affected by instances of IPV (Aizer, 2011). It is associated with adverse physical and mental health, such as depression, suicide (attempts), miscarriage, fetal injury, and others (Van Parys et al, 2014). It is also associated with trauma and psychological factors like fear and stress. In one study, women who experienced IPV in their lifetime were more than twice as likely to have depression (Duvvury et al, 2013). Violence against women has long-lasting physical and mental health concerns, perpetuating a cycle of intergenerational and socioeconomic impacts.

Other studies suggest similar results, with the Demographic and Health Survey (DHS) at 75% for married Bangladeshi women who have experienced IPV in their lifetime (WHO, 2012). IPV is an outcome of intrahousehold bargaining power conditional on many proximate factors. For men, this includes gender attitudes, work stress, use of alcohol, and childhood violence (MGEPP, 2011). When women were surveyed for the causes of IPV, low education and attitudes accepting of violence and gender inequality perpetuate violence (WHO, 2012). Women and men have different perspectives on acceptance of violence. What is the relationship between women's attitudes and men, the perpetrators of violence, attitudes? Does personal perception of the justifiability of violence facilitate actual violence?

Further, we examine climate variability to understand why women tolerate violence in order to contribute to the growing literature that links climate variability and violence. We use climate variability because it is exogenous and allows us to infer causal outcomes. Climate variability disproportionately alters people in low-income countries, who rely on agriculture for their livelihoods. Current literature delves into the weather conditions and conflict hypothesis, where weather shocks increase civil conflict. In developing countries, income shocks are looked at through exploiting local rainfall variation. Burke, Hsiang, and Miguel found that higher temperatures and extreme rainfall leads to increased conflict through a meta-analysis, or a collection of studies aggregated into one large dataset. In South Asia, they found low rainfall led to higher domestic violence. They also found food scarcity is prominent in sub-Saharan Africa, where extreme rainfall or temperature climate conditions lead to lower crop yields and less food for household consumption (2013). Their findings shed light on the relevance of climate variability and its effect on the agricultural cycle.

In the fifth assessment report from the Intergovernmental Panel on Climate Change (IPCC), a group focused on human-based climate change, researchers found it is likely more heavy precipitation events has increased in the same land region, where extreme precipitation increases risks of flooding. They further report, with very high confidence, heat waves, droughts, and floods increase vulnerability. When they forecast the future, collectively, they found it is very likely heat waves and precipitation events will both increase in frequency and extend for longer periods of time. Along with earlier studies, low-income countries are disproportionately affected by changes in climate. Figure 2 show the change in average precipitation with two global maps, the left is from 1986 to 2005 and considered the base map. The right shows the forecast for 2081 to 2100. The color differentials show the average change in precipitation, with dark blue indicating the largest change at 60% increase in precipitation. The largest effects occur at the tropics. Figure 3 shows the global average surface temperature change from 2000 to 2100 in comparison to 1986 to 2005. From 2081-2100, depending on the regression concentration pathways, the change could be between 0.3 to 4.8 degrees Celsius. The two figures show it is likely regions will continue to experience higher temperatures and precipitation levels, with risks greater for those in an agricultural-centered economy (2014). The IPCC findings conclude that it is likely weather deviations with occur with higher frequency, intensity, and duration.

The motivation for this paper is to disentangle the root risk factors of women's tolerant attitudes towards violence. Attitude towards wife beating continues to be difficult to measure. In addition, self-reported surveys are subject to the social desirability response bias that is likely to give downward estimates. This is because women are likely to give a response that better fit the cultural norm (Saunders, 1987). The definition of attitude is broadly defined in two ways. The first definition by Hogg & Vaughan suggests attitude is long-term and is "a relatively enduring organization of beliefs, feelings, and behavioral tendencies towards socially significant objects, groups, events or symbols" (2005). A second definition describes an attitude as more short-term and as "a psychological tendency that is expressed by evaluating a particular entity with some degree of favor or disfavor." This definition suggests attitudes vary in valuation and intensity (Eagly & Chaiken, 1996). Our sample further provides evidence that attitudes is malleable based on situational factors, with the mean percentage of women accepting any violence in each country varying month to month, year to year (Figure 6 & Figure 7).

We examine the role of economic factors through exploiting local rainfall variation and temperature to understand what renders women more likely to have tolerant attitudes towards violence against women. This approach follows Miguel's method to link poverty and witch killing, where poor, rural households in rain-fed agriculture's livelihoods are driven by economic conditions (2005). Does climate variability influence women's attitudes towards IPV in development contexts? We expect weather conditions to affect attitudes through both the economic and psychological pathways. We contribute to current literature by conducting a global study to have a more comprehensive picture of how climate conditions affect women's attitudes towards violence.

2. Literature Review

2.1 Overview

The motivation to study climate variability and attitudes towards violence is to fill in a gap in knowledge on the risk factors that cause women's attitudes towards gender-based violence to shift. This is important because women's attitudes towards violence may perpetuate actual violence. In a college student study, those with more tolerant attitudes towards IPV were more likely to physically assault and verbally abuse their partner. Additionally, those with more permissive attitudes have the highest perpetration rates (Anderson and DeWall, 2011). While there exists a wealth of literature on drivers of actual violence, this literature review will focus on drivers of attitudes towards violence. There are physical, socio-cultural, and biological environmental mechanisms that could facilitate women's attitudes towards violence.

The General Aggression Model (GAM) is a biological-social-cognitive framework to understand aggression and violence (Figure 1). The authors define aggression as "any behavior intended to harm another person who does not want to be harmed" and violence is defined as "any aggressive act that has as its goal extreme physical harm, such as injury or death." Through the lens of IPV, the GAM shows that the appraisal and decision processes depend on having the mental resources (inputs) to make aggressive or non-aggressive decisions. Climate variability affects situation and environmental modifiers, where extreme heat directly increases aggressive inclinations (Anderson and DeWall, 2011). The reasoning is this: people are uncomfortable in very hot temperatures. When people are negatively aroused, they blame is not at the weather itself but to a social target, such as your partner (Anderson, 1989). This psychological framework helps uncover the roots of aggression and violence, with biological and environmental factors influencing personality.

2.2 Women Attitudes

At the individual and community level, socio-cultural norms are highly correlated with incidences of violence. Rani and Bonu in a cross-country study in seven Asian countries, found that acceptance of wife beating ranged from 29% in Nepal to 57% in India. Generally, they find that wealth and education level were negatively correlated with acceptance of wife beating. Young, working women were equally or more likely to justify wife beating compared to nonworking women (2009). In Nigeria, Kapsou and Christou find there is a positive relationship between tolerance level and domestic violence, with 31.22% of Nigeria women having experienced domestic violence, and a 44.13% tolerance level. The authors find that those with no tolerance had the least likelihood of gender-based domestic violence. Those who were neither tolerant nor non-tolerant, had the highest likelihood of domestic violence. In addition, domestic violence was 1.5x more likely for women with tolerant attitudes that women with a non-tolerant attitude. They believe the variance depends on individual characteristics such as place of residence, education level, marital status or region (2011). Traditionally, since violence is seen as an acceptable way to exercise control, women perceive violence as acceptable as well (Hindin, 2003).

Other literature further document how socio-cultural norms centered on the familial traditional role of the woman with inegalitarian gender relations, perpetuate acts of violence. When women are inferior, husbands are assumed to "own" their wives. In India, domestic violence is anchored in gender relations and legitimized violence. Governmental intervention is lacking as institutions fail to prosecute men who wife beat. In North India, women have relatively low autonomy and limited economic control in the household (JeJeebhoy, 1998). Abused women are most likely to be the most powerless, with little authority in decision-making, mobility, or control. In a multi-country study by Dalal, Lee, and Gifford in Bangladesh, India, and Nepal, the authors found that men's relationship rights and autonomy are highly predictive of wife beating. Culturally, violence against women is a "normal life phenomena" and reinforced through gender norms (2012).

Benson et al. argued that violence was higher in poor areas for cultural and institutional reasons. The social disorganization theory postulates these areas have weaker social bonds, thus women have less social control and more social isolation. Men are given impunity, which can increase if attitudes towards violence are higher in poor areas. In addition, the institutional framework in these communities fails to protect women (2003). In rural settings, women cannot turn to local law enforcement officers because they uphold patriarchal attitudes. Cultural norms that objectify and devalue women facilitate family abuse, coupled with geographic isolation that allows men to assert violent social control (Hightower, et al. 2000). Wives who are abused suffer the primary injury from the abuse itself, and further "secondary injury" when they find apathy or hostility from others when they look for help. Thus they face self-derogation and also derogation by others. Sympathetic attitudes are related to liberal views of women's roles (Saunders, et al, 1987). Women in rural areas were significantly more likely to believe wife beating is justified, and those with adolescent pregnancy have even more conservative attitudes (Hindin, 2014).

In the biological environmental literature on violence, researchers explore the role of air pollution, atmospheric pressure, temperature, length of day, and humidity. In Norway, the monthly frequency of violence was correlated with the absolute value of monthly change in length of day from the prior month. With increasing latitude, violence was highest in the spring and fall (Morken, 2000). Seasonal affective disorder (SAD) is a type of depression which recurs in the autumn and winter seasons. This condition is caused by seasonal changes in the length of day, where less daytime light could change the melatonin secretion rhythms

(Matheson, et. al, 2015). In the winter, SAD symptoms include anergia and oversleeping, while in the summer, symptoms include agitation insomnia. In the winter and spring, serotonin (regulates mood, anxiety, and sexuality), is at the lowest level. In addition, women are more likely to suffer seasonal changes in mood and behavior, particularly in reproductive years (Tonello, 2008). Serotonin transporter binding is dynamic and can help explain the seasonal changes in normal and pathologic behaviors (Praschak-Rieder, et al, 2008). Some studies have shown the seasonality of suicides, with a peak in the spring and a low in the autumn and winter months. Low serotonin levels are linked to higher outward directed impulsive and aggressive behavior (Fruchwald, et al, 2003). There is a diminished arousal to the pain and distress that are associated with suicidal behavior (Anderson and Dewall, 2008). The biological effects of seasonality with lower arousal, mental exhaustion, and a depressive state may factor into women's higher tolerance of violence.

2.3 Climate Variability

In this next section, we will discuss the literature on climate variability and violence. Agricultural based economies typically have two seasons: wet and dry, which can be disrupted from climate variability through income shocks. The wet season, or kharif, is when local income is derived and households are working in agriculture. The dry season, or rabi, is the post-harvest season. In lower socioeconomic societies, climate variability has an even greater effect on agricultural societies. The countries near the Inter-tropical Convergence Zone, or the tropics, face higher rainfall variability. With high confidence, it has been shown climate change has negative impacts on crop yields. There is a significant nonlinear relationship between temperature and corn yield, where yields are increasing for moderate temperatures, but then are negatively affected when temperatures exceed 30 degrees Celsius (Schlenker and Roberts, 2006).

The frustration-aggression hypothesis is a psychological theory that examines the link between poverty and aggression (Barlett and Anderson, 2013). Frustration can be caused by income shocks when the real effects are worse than originally expected (Munyo and Rossi, 2013). If the household has insufficient income, the stress levels are higher (Jewkes, 2002). In addition, anxiety lowers the ability of people to exert self-control. Mani et al find that poverty reduces cognitive capacity in a laboratory when compared to people not in poverty (2013). Poverty is draining mentally, as households are force to make life or death situations and tradeoffs for survival are high. For example, sugarcane farmers in India who experience the cyclical cycles of agriculture were tested on cognitive ability both before and after a harvest. When poor (before harvest), the farmer exhibited lower cognitive ability than when rich (after harvest). The human cognitive system is limited, and when impoverished, Dewall claims mental processes are forced to compete with other human processes for attention (2011). Disasters are associated with helplessness-induced depression, emotional distress, and anxiety (Coelho, Adair, and Mocellin, 2004). Following climate stress, families face more mental health problems as their workload increases, with less time to build on their social capital and community (Berry, Rodgers, & Deer, 2007). Some migrate elsewhere.

In the tropics, "hot years" are associated with lower agricultural production. Burke found a 1% increase in temperature leads to a 4.5% increase in civil war in the same year, and a 0.9% increase in the next year—representing a 49% relative increase in the incidence of war (2009). To mitigate risk from rainfall variability, Menon (2009) and Bandyopadhyay and Skoufias (2012) find that in Nepal and Bangladesh's agricultural societies, additional members in the household are likely to work in non-agricultural activities. This is further supported by Rose's study where agricultural households are more likely to partake in the labor market when weather variability increases (2001). Through diversifying income, households become more resilient to climate shocks as less strain is put on the household to make decisions on resource scarcity.

Hsiang, Meng, and Cane examine the El Nino/Southern Oscillation (ENSO) in the tropics from 1950 to 2004 and find that conflicts in El Nino years are doubled relative to La Nina years. In addition, altered environmental conditions cause stress, which can lead to aggressive behavior (2011). Vulnerability is based on exposure, sensitivity, and adaptive capacity to climate change impacts (Scheffran, et al, 2012). Scarcity and its interactions produce several common social effects, including lower agricultural production, migrations from zones of environmental scarcity, and weakened institutions (Homer-Dixon, 1991). These factors contribute to the psychological component to shifting attitudes.

Studies have shown that nonlinear temperatures decrease overall country economic productivity. Dell, Jones, and Olken examined the effects of temperature in economic development and found that in poor countries, higher temperatures decrease economic growth through lowered growth rates and level of output. Temperature affects economic growth through reducing agricultural output, industrial output, and political stability (2012). Another study further determined nonlinear temperatures affect the economic productivity for all countries. All countries include the poor and the rich, the agricultural and non-agricultural based societies. The ideal temperature is 13 degrees Celsius, and productivity exponentially declines with higher temperatures (Burke, M., Hsiang, S., & Miguel, E., 2015). These studies provide evidence that climate variability affects the economic productivity of the country.

Data and Methodology

3.1 Demographic Health Surveys (DHS)

The DHS dataset comprises of the women's questionnaire, with surveyed women eligible between the ages of 15-49 years. The DHS provides reliable, detailed information on the population, health, and nutrition in each country. In this study, we are interested in the women's status and empowerment indicators, in particular women's attitudes toward wife-beating by husbands. The domestic violence module was implemented in 44 countries with 1.1 million women, taken between 1999 and 2011. Our total sample size is >550,000 women in 38 countries. Wife-beating is an aspect of domestic violence and was recorded through the following five questions:

Husband justified in beating his wife:

1. If she goes out without telling him?
2. If she neglects the children?
3. If she argues with him?
4. If she refuses to have sex with him?
5. If she burns the food?

The women were coded into three responses: "yes", "no", or "don't know." If the woman responds that beating is justified to at least one of the five questions, the outcome variable (beating is justified) is coded as a "1". If the wife disagrees to all five questions (beating is not justified), the outcome variable is coded as a "0". Likewise, we parse out additional control variables such as urban and rural outcomes, woman's education level, whether woman was working at time of survey, and total children.

3.2 Climate data

The climate data comes from the ERA-Interim, by the European Centre for Medium-Range Weather Forecasts, which uses data assimilation to provide frequent updates on climate conditions. In this study, we use growing degree days (GDD) in Celsius, temperature (Celsius), and precipitation (mm) on an annual basis. GDD is the sum of the daily temperature in degree, in excess of the base temperature, over the year. GDD is typically a measure to prepare for the growing season in agricultural cycles. The formula for GDD is

$$\text{(i) } GDD = \frac{T_{max}+T_{min}}{2} - T_{base}.$$

To interpret this, when GDD=0, there were no days over the course of the year where the mean daily temperature was higher than the base temperature. At over 30 degrees Celsius, this is consider a killing degree day (KDD), where the extreme heat halts seed development and lowers agricultural productivity. In this study, we use 30 degrees Celsius as the base temperature.

Prior year precipitation level is defined as the sum precipitation of the previous calendar year. In our analysis, the z-score for precipitation equals the actual precipitation level minus the mean precipitation level by DHS cluster over roughly 31 years and divided by the standard deviation by DHS cluster. A z-score of 0 equals the mean precipitation level by DHS cluster. A negative z-score means precipitation was lower than the mean. A positive z-score means precipitation was higher than the mean. The idea is that moderate variability can be beneficial, but extreme rainfall can result in flooding. Extreme lack of rainfall can result in droughts (Sekhri and Storeygard, 2014). The z-score looks at deviations in rainfall relative to the cluster mean over a long period of time. Thus, income variation is random.

Based on GPS coordinates by the nearest quarter degree latitude and longitude, the woman's DHS data is matched with the ERA dataset. Each woman now contains the woman's individual characteristics, wife beating justification questions, and the climate variables. Our sample includes 38 countries, over 550,000 women, interviewed between 1992 and 2011. We have repeated observations for 30 countries.

3.3 Methodology

We assume local rainfall variation, temperature, and GDD are plausibly exogenous, such that income shocks are random to allow for causal inference. In the tropics, income variation is typically from rainfall variation and rainfall variation is a proxy for income shocks. This follows Miguel's paper on the effects of income shocks on witch killings in Tanzania through exploiting local rainfall variation (2005). The intuition for our identification strategy is that when countries have higher precipitation levels, this affects aggregate economic output. In agriculture, this produces greater crop yields, which provides sufficient resources to households. This creates a psychological and economic channel, which affects attitudes towards violence. Increases in climate variability leave agricultural based societies more prone to these fluctuations. Extreme precipitation and heat, however, can disrupt the agricultural cycles. We expect rainfall deviation to have a greater effect on agricultural production than excess heat. Women in agricultural households will justify beating more when in the year prior, agricultural produce was scarce. When there are sufficient household resources, women are less likely to justify wife beating.

We estimate a linear probability model for the baseline model and the submodels.

Baseline Specification:

$$\boldsymbol{Y_{idct} = GDD_{t-1} + GDD_t + Temp_{t-1} + Temp_t + Precipz_{t-1} + Precipz_t + \alpha_m + \mu_{cy} + \gamma X_{idct} + \varepsilon_r}$$

The outcome variable Y_{idct} is a "yes" or "no" dummy variable on whether wife beating justified to any of the five situations for individual i in dhs cluster d, in country c at time t. The climate condition variables include previous year GDD, current year GDD, previous year temperature, current year temperature, and previous year precipitation level z-score, and current year precipitation level z-score. Other explanatory variables include an interview month fixed effect, a country-interview year fixed effect, with the errors clustered by region ($\boldsymbol{\varepsilon}_r$). This is because measurement errors are likely to be correlated within regions across time. The X is a vector for controls, including education, age, age squared, has radio, has television, is married, and total children. We use fixed effects to purge the time-invariant unobserved characteristics of the interview month, interview year, and country.

We predict prior and current year GDD increase likelihood of justifying wife beating, as additional degrees over 30 degrees is detrimental to agriculture. Current year GDD could also be subject to immediate effects on attitudes, as women face lower arousal and are willing to subject themselves to violence. For temperature, I predict the same effects as GDD. My hypotheses are based on the idea that higher heat levels negatively affects yields, where in the following year, less output leads to more food scarcity and higher justification for violence. The precipitation hypothesis is based on the idea that a one SD increase in precipitation, meaning higher than the average rainfall, increases crop yields, leading to less justification to violence. Since resource scarcity is less of an issue, the woman's mental processes can focus on attitudes towards violence instead of stress or anxiety. Higher productivity yields reduce resource scarcity and conflict in the household. However, we believe the relationship is parametric, where extreme precipitation or lack thereof, could cause the opposite effect as extreme drought or rainfall conditions will negatively affect household income.

Aside from income shocks, there is likely a psychological aspect to climate variability, which affects women's physical health, economic health, and bargaining power in households (Heckman and Rubinstein, 2001; Heckman et al., 2006). Environmental scarcities can lead to heightened grievances (Homer-Dixon, 1991). This occurs when people perceive a relative decrease in their standard of living compared with other groups or compared with what they had expected (Gurr, 1993).

IV. Results & Discussion

4.1 Main Specification Results

The first table is the summary statistics, which shows the percentage of women who justified wife beating in at least one of the five situations. The mean justification for wife beating for the total sample is 43%, with age at 29.62. The mean total children were 2.79 and 60% of the survey respondents were married. 62% of the sample owned a radio, while 41% of the sample owned a TV. When splitting the urban and rural sample, rural justification for wife beating mean was 0.5, while urban justification was 0.32. Rural areas had more children, on average. Age and temperature conditions were similar for both areas. Wife beating justification was highest amongst those with no education at 62%, primary education at 43%, and secondary education or higher at 28%. Those who were married were more likely to justify wife beating at 47%, while those not married were lower at 36%. Women whose husband was an agricultural worker justification for wife beating was similar to women with husband who was not an agricultural worker at 41% and 44%, respectively. In addition, women with at least one child justified wife beating at 45% and those with no children justified wife beating at 41%.

In table 2, the first column shows a simple regression of wife beating justified on previous and current year precipitation z-scores, previous and current year GDD, and previous and current year temperatures, with no fixed effects. The previous year precipitation z-score has a negative coefficient and is significant at the 1% level. We find that a one SD increase of rainfall above its long-term mean results in a decreased likelihood of justifying violence by 2.87 percentage points. The second column includes a country year fixed effect, while the third column includes the controls (education level, age, age squared, has radio, has tv, and total children). The fourth column includes a month fixed effect. The coefficient for previous year precipitation level z-score remains negative with significance at the 1% level across the four regressions. The main baseline specification in column 4, which includes the interview month, interview year, country fixed effects, shows an increase in one SD decreasing the likelihood of tolerating wife beating by 2.81 percentage points. The current year precipitation level z-score has the opposite effect with an increase in one SD increasing the likelihood of justifying wife beating by 2.01 percentage points. Previous year GDD sum appears to increase likelihood of justifying wife beating by 0.175 percentage points with one additional day where GDD is greater than 30 degrees. This is likely because we know days over 30 degrees, or extreme heat, is harmful to crop development. In addition, extreme heat mentally affects one's attitudes. The negative coefficient in the prior year precipitation z-score holds up across all four regressions, suggesting higher than mean precipitation in the prior year decreases women's likelihood of justifying wife beating this year. The standard errors are clustered by region for all four regressions.

4.2 Additional Results & Discussion

Table 3 breaks out the sample by rural and urban areas. The precipitation z-score remains significant in both areas, with a one SD increase decreasing tolerance by 3.19 percentage points in urban areas and 2.14 percentage points in rural areas. This is significant at the 1% level for the urban areas and at 5% for the rural areas. For current year precipitation z-score, one SD increase appears to increase tolerance by 1.80 percentage points in urban areas and in rural areas, increase by 1.49 percentage points. When the sample is split into the urban and rural samples, contemporaneous GDD has a statistically significant effect. For urban areas, previous year temperature GDD sum increases tolerance by .216 percentage point for each additional GDD above the base and current year decreases tolerance by .196 percentage points. Rural areas have previous year GDD at .179 percentage point for each additional GDD and current year at .177 percentage point less tolerance. We find that women experiencing current, higher heat are more likely to tolerate violent attitudes against women, while in the previous year, it increases tolerance. This is likely because GDD also operates through the biological channel in the current year. Temperature and higher aggression tendencies have commonly been linked.

General economic shocks could be the driver for why women are less likely to justify wife beating when previous year precipitation increases by 1 SD. We find that the effect is not only in rural areas, but urban areas as well. In rural areas, the rainy season north of the equator typically lasts from May to October, with the dry season from November to April. The opposite occurs in the south of the equator. Studies have shown that food insecurity is highest at the end of the dry season and beginning of the following wet season, where dry season droughts amplify food security. Food insecurity is highest at the end of the dry season, when food stocks are depleted and labor for the next harvest season increases (Maccini & Yang, 2009). When food is plentiful from the previous year, higher precipitation levels in prior year could lead to higher food security, where higher agricultural yields from the previous year could affect current year attitudes towards violence. Women have more mental ability when food insecurity is less of an issue and are more willing to be intolerant of violence. In urban areas, echoing Dell, Jones, and Olken's findings that temperature can affect industrial output and political stability, we suspect rainfall variation also influences aggregate economic activity (2012). We encourage further investigation.

We also test based on education level, with the main specification restricted into three categories: 1. None, 2. Primary, 3. Secondary and up. We find that the higher the education level, the less likely the individual will tolerate attitudes based on prior year precipitation deviation. The opposite occurs in the current year precipitation. In addition, with no education, the individual is more likely to tolerate attitudes towards wife beating when GDD the previous year is higher than normal. In the current year, they are less likely to tolerate attitudes towards violence. This is possible if the heat affects the previous year agricultural production, leading to food scarcity. However, in the current year, the individual is more affected by the heat in their biological system, which lowers tolerance towards violence. Sometimes, when households face difficultly with sufficient income, welfare decisions are more susceptible and negatively affected. This could affect women's tolerant attitudes towards wife beating.

Our final subsamples table shows additional specifications, with whether husband is an agricultural worker, whether the woman is working now, and whether the woman has any child. The results show that when the woman's husband is an agricultural worker or if she has any child, the previous year and current year GDD is statistically significant. For woman's husband is an agricultural worker, an additional day of high GDD increases attitudes towards wife beating by .396 percentage points. In the current year, one additional day above 30 degrees decreases likelihood of justifying wife beating by .459 percentage points. If the woman has any child and the prior year GDD increase by one, this increases likelihood of justifying wife beating by .228 percentage points. In the current year, wife beating justification decreases by .215 percentage points.

4.3 Robustness Checks

For robustness checks, we test whether countries in the north or south of the equator or whether the woman being surveyed in the beginning or later in the year is driving the outcome. The intuition is that individuals who were interviewed in the beginning of the year could vary from individuals who were interview later in the year, depending on the timing of the agricultural cycle. The beginning interview months are defined by January to March, while later interview months are defined by April to December. We find the results hold for later month interviews, with similar coefficients. We lose significance for the beginning month interview regression. For the second robustness check, we parse out the sample by north and south indicators, as timing of the wet and dry season could also bias our results. We find that the North sample results hold up to our regression, however the South sample loses significance. The signs of the coefficients remain the same. However, ~69.2% of the sample is from the North and ~81.2% of the sample were of women interviewed in the later months. We suspect the insignificance of the South and the beginning interview months is due to the smaller sample size.

V. Conclusion

Violence against women is a violation of human rights, and continues to afflict women in developing and developed countries. It has short and long run ill-health consequences that perpetuate justification of gender inequality. The results show climate conditions are indirect drivers of women's attitudes towards violence against women. As global climate models predict a 2 degrees Celsius temperature increase in the next half century, greater climate variability will affect crop growth and economic development (IPCC, 2012). This makes mitigating direct and indirect risks from climate variability a high priority.

Our study provides novel evidence on the link between climate variability and women's attitudes against violence. Since our findings occur in both rural and urban areas, we encourage further research on the mechanisms in which climate variability affects economic output in urban areas. We posit that aggregate economic activity at the country level is driving these attitudes. Several studies have predicted this to occur through GDP, industrial output, political stability, among other country level changes in the economy. By understanding the channels in which climate variability affects general economic activity, we can create policies that help countries better adapt to new climate conditions, such as irrigation or diversifying income-generating activities. Countries are then less dependent on weather and can manage rainfall risk better. Rainfall deviations can also lead to displacement, loss, and crop failure, leading people to be more conflict prone and socially discontent. Households face scarcity when excessive rain disrupts the agricultural cycle. Floods can increase social discontent as it can even destroy properties. In places with poor infrastructure, excessive rain further exacerbates social discontent because it is difficult to do any intervention when it is physically difficult to reach them (Hendrix, 2012). By lowering vulnerability to climate variability, households will have a more secure environment, which we hope will help women be less tolerant towards violence against women. We encourage further research on aggregate economic activity and the channels through which women's attitudes can change to understand the direct and indirect impacts of climate variability on attitudes toward violence.

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Figures and Tables

Figure 1: The General Aggression Model

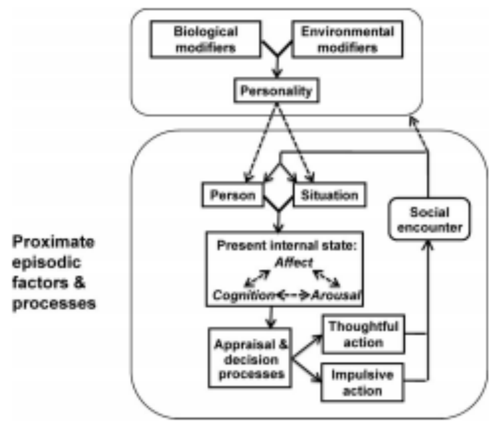


Figure 1. General aggression model.

(Anderson and DeWall, 2011)

Figure 2

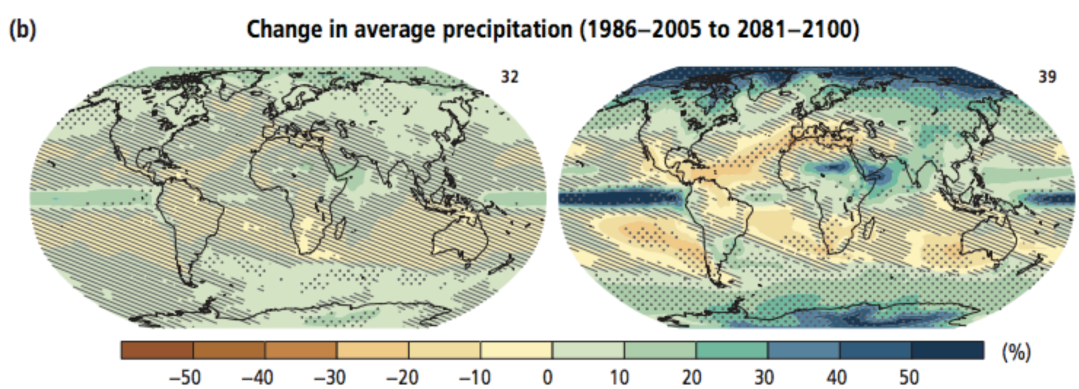
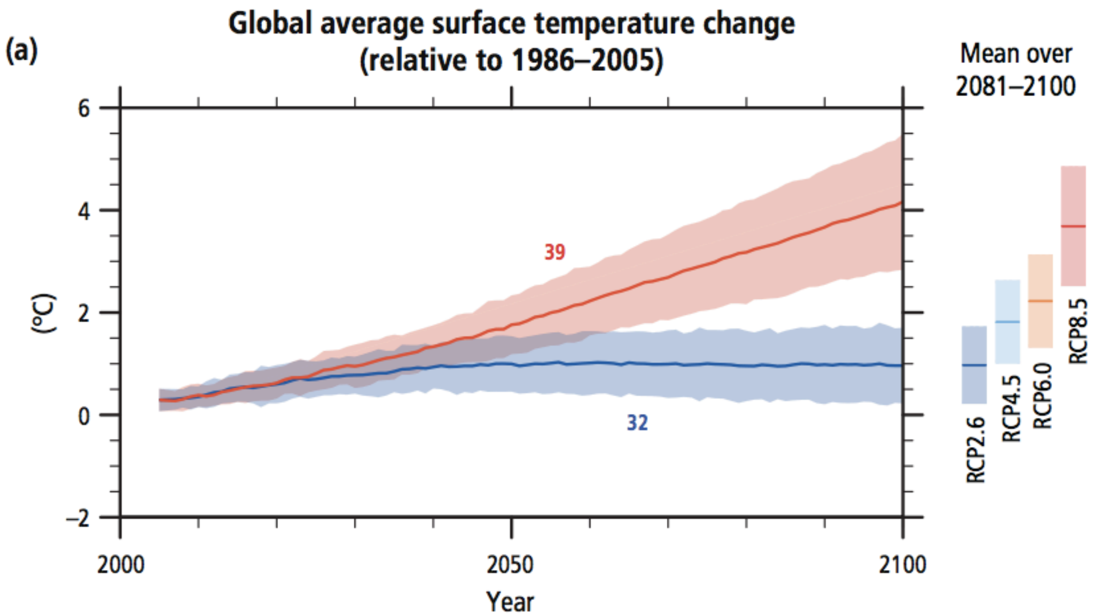


Figure SPM.7 | Change in average surface temperature **(a)** and change in average precipitation **(b)** based on multi-model mean projections for 2081–2100 relative to 1986–2005 under the RCP2.6 (left) and RCP8.5 (right) scenarios. The number of models used to calculate the multi-model mean is indicated in the upper right corner of each panel. Stippling (i.e., dots) shows regions where the projected change is large compared to natural internal variability and where at least 90% of models agree on the sign of change. Hatching (i.e., diagonal lines) shows regions where the projected change is less than one standard deviation of the natural internal variability. *{2.2, Figure 2.2}*

(IGCC, 2014)

Figure 3



(IGCC, 2014)

Figure 4

Climate Change Poses Risks for Food Production

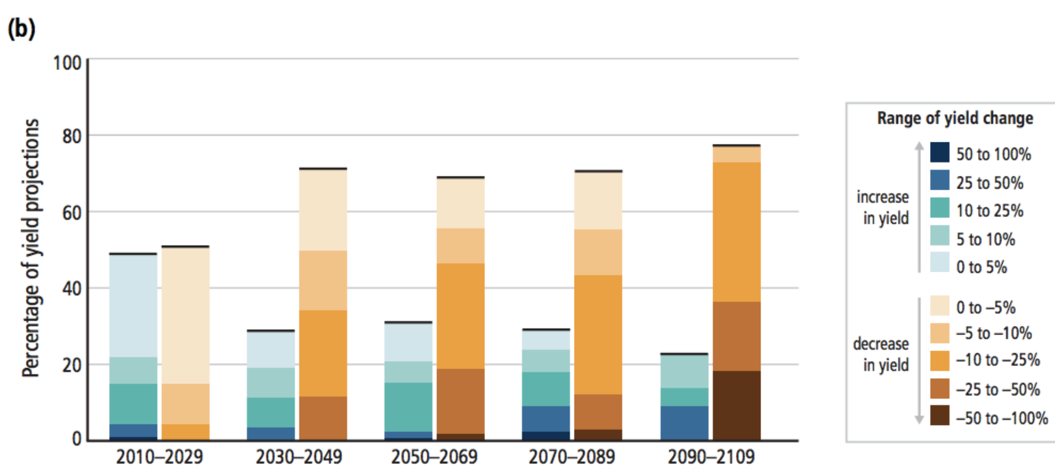
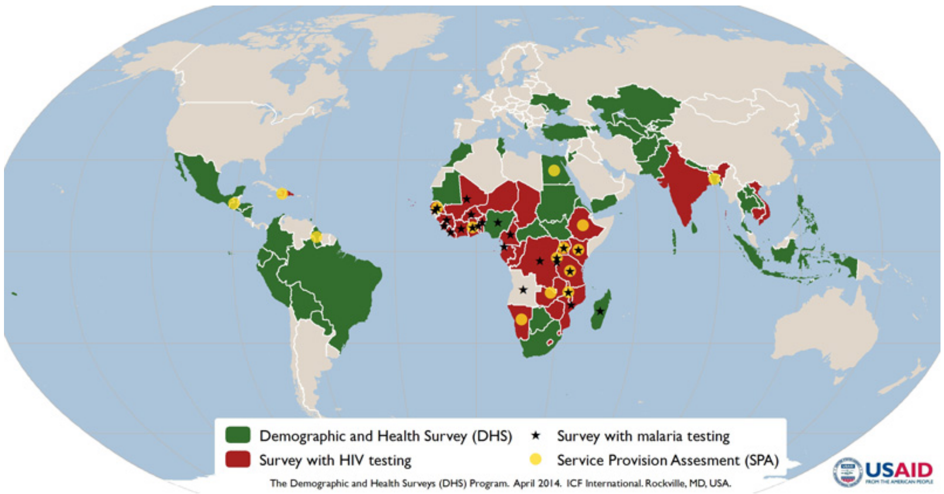


Figure SPM.9 | **(a)** Projected global redistribution of maximum catch potential of ~1000 exploited marine fish and invertebrate species. Projections compare the 10-year averages 2001–2010 and 2051–2060 using ocean conditions based on a single climate model under a moderate to high warming scenario, without analysis of potential impacts of overfishing or ocean acidification. **(b)** Summary of projected changes in crop yields (mostly wheat, maize, rice and soy), due to climate change over the 21st century. Data for each timeframe sum to 100%, indicating the percentage of projections showing yield increases versus decreases. The figure includes projections (based on 1090 data points) for different emission scenarios, for tropical and temperate regions and for adaptation and no-adaptation cases combined. Changes in crop yields are relative to late 20th century levels. *{Figure 2.6a, Figure 2.7}*

(IGCC, 2014)

Figure 5: DHS Countries



(DHS, 2015)

Figure 6: Total Sample, Acceptance of Wife Beating

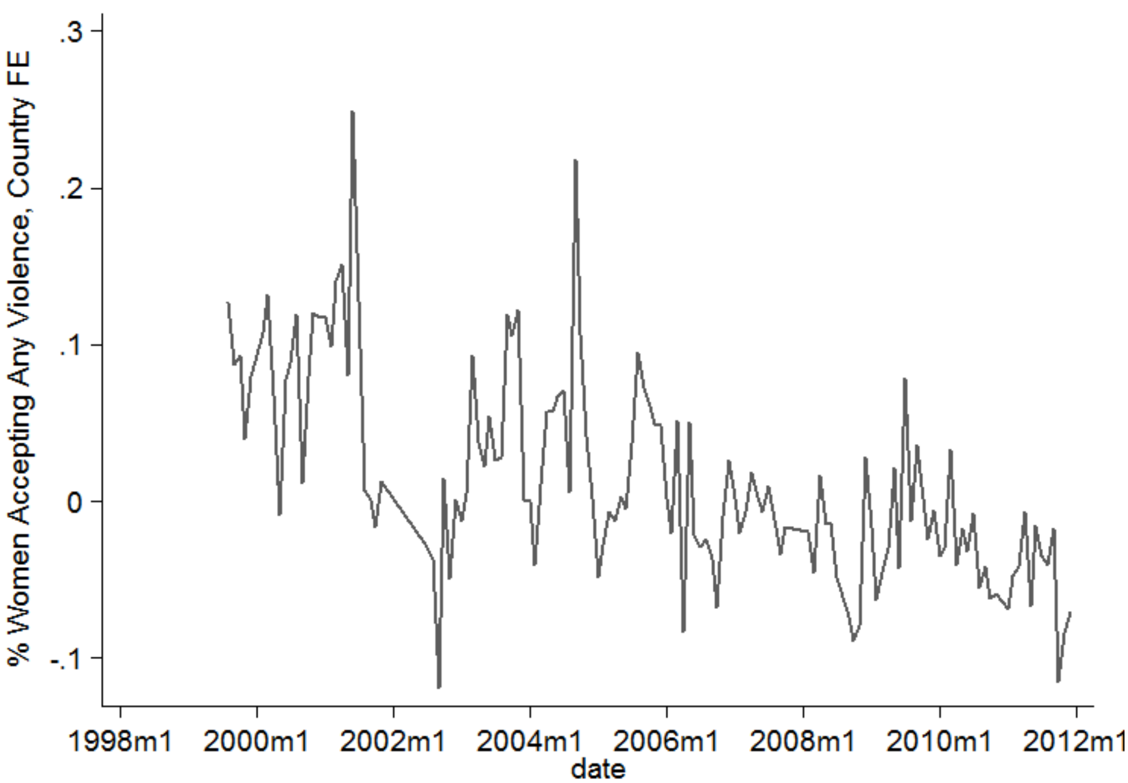


Figure 7: Urban and Rural, Acceptance of Wife Beating

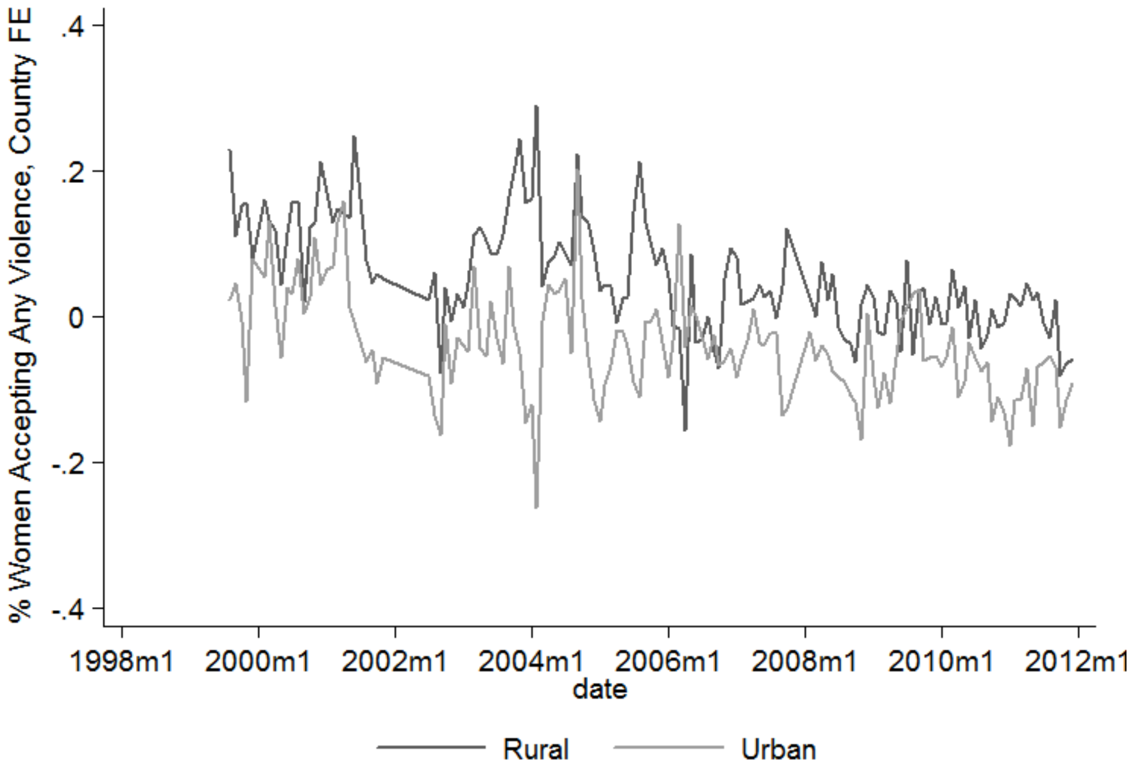


Table 1: Summary Statistics

	Total Sample		
Variables	Count	Mean	SD
Wife Beating Justified	773,388	0.43	0.49
age	1,097,206	29.62	9.70
has_radio	1,095,325	0.62	0.49
has_tv	1,089,923	0.41	0.49
married	1,039,217	0.60	0.49
total_children	1,097,206	2.79	2.73

	Wife Beating Jusfified		
Variables	Count	Mean	SD
Place			
Urban	307,595	0.32	0.47
Rural	465,793	0.50	0.50
Education			
No Education	211,201	0.62	0.49
Primary Education	261,108	0.43	0.50
Secondary Education+	301,057	0.28	0.45
Married Status			
Married	449,534	0.47	0.50
Not Married	323,851	0.36	0.48
Husband Agriculture Worker			
Husband Agriculture Worker	160,524	0.41	0.49
No Husband Agricultural Worker	431,467	0.44	0.50
Children			
Any Child	451,636	0.45	0.50
No Children	209,267	0.41	0.49

Table 2: Main Table

VARIABLES	(1)	(2)	(3)	(4)
Previous Year Precipitation Z-score	-0.0287***	-0.0320***	-0.0274***	-0.0281***
	(0.0110)	(0.00905)	(0.00777)	(0.00770)
Current Year Precipitation Z-score	-0.0291***	0.0228***	0.0212***	0.0201***
	(0.0103)	(0.00755)	(0.00636)	(0.00631)
Previous Year GDD	-0.00135	0.00263**	0.00176*	0.00175*
	(0.00207)	(0.00128)	(0.000989)	(0.000980)
Current Year GDD	0.00270	-0.00187	-0.00164*	-0.00159
	(0.00217)	(0.00127)	(0.000993)	(0.000986)
Previous Year Temperature	0.00629	-0.0154	-0.0311	-0.0333
	(0.0356)	(0.0335)	(0.0265)	(0.0264)
Current Year Temperature	-0.0128	0.0153	0.0323	0.0342
	(0.0362)	(0.0331)	(0.0260)	(0.0260)
edu_singleyrs			-0.0164***	-0.0164***
			(0.000937)	(0.000933)
age			-0.0107***	-0.0110***
			(0.000920)	(0.000918)
age2			0.000101***	0.000104***
			(1.32e-05)	(1.31e-05)
has_radio			-0.0181***	-0.0179***
			(0.00330)	(0.00326)
has_tv			-0.0582***	-0.0594***
			(0.00630)	(0.00616)
married			0.0220***	0.0226***
			(0.00358)	(0.00350)
total_children			0.00979***	0.00980***
			(0.000728)	(0.000720)
Constant	0.532***	0.416***	0.732***	0.819***
	(0.0886)	(0.0746)	(0.0553)	(0.0582)
Observations	565,095	565,095	564,293	564,293
R-squared	0.027	0.191	0.224	0.225
Controls	No	No	Yes	Yes
Month FE	No	No	No	Yes
Country Year FE	No	Yes	Yes	Yes

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 3: Urban and Rural

VARIABLES	(1) Total	(2) Urban	(3) Rural
Previous Year Precipitation Z-score	-0.0281***	-0.0319***	-0.0214**
	(0.00770)	(0.00835)	(0.00888)
Current Year Precipitation Z-score	0.0201***	0.0180***	0.0149**
	(0.00631)	(0.00694)	(0.00662)
Previous Year GDD	0.00175*	0.00216**	0.00179*
	(0.000980)	(0.000995)	(0.00103)
Current Year GDD	-0.00159	-0.00196*	-0.00177*
	(0.000986)	(0.00102)	(0.00104)
Previous Year Temperature	-0.0333	-0.0174	-0.0333
	(0.0264)	(0.0261)	(0.0283)
Current Year Temperature	0.0342	0.0196	0.0334
	(0.0260)	(0.0255)	(0.0278)
edu_singleyrs	-0.0164***	-0.0180***	-0.0113***
	(0.000933)	(0.000915)	(0.00125)
age	-0.0110***	-0.0103***	-0.00887***
	(0.000918)	(0.00100)	(0.00115)
age2	0.000104***	9.79e-05***	8.59e-05***
	(1.31e-05)	(1.41e-05)	(1.65e-05)
has_radio	-0.0179***	-0.0176***	-0.0117***
	(0.00326)	(0.00354)	(0.00361)
has_tv	-0.0594***	-0.0474***	-0.0317***
	(0.00616)	(0.00517)	(0.00576)
married	0.0226***	0.0194***	0.0162***
	(0.00350)	(0.00360)	(0.00421)
total_children	0.00980***	0.00861***	0.00776***
	(0.000720)	(0.000860)	(0.000730)
Constant	0.819***	0.709***	0.824***
	(0.0582)	(0.0598)	(0.0642)
Observations	564,293	224,027	340,266
R-squared	0.225	0.227	0.203
Controls	Yes	Yes	Yes
Month FE	Yes	Yes	Yes
Country Year FE	Yes	Yes	Yes

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 4: Education

VARIABLES	(3) No educ	(4) Primary educ	(5) Secondary educ	(6) Total
Previous Year Precipitation Z-score	-0.0294**	-0.0159*	-0.0292***	-0.0282***
	(0.0115)	(0.00861)	(0.00791)	(0.00772)
Current Year Precipitation Z-score	0.00111	0.0237***	0.0248***	0.0201***
	(0.00969)	(0.00671)	(0.00668)	(0.00629)
Previous Year GDD	0.00337**	0.00154	0.00118	0.00173*
	(0.00154)	(0.00106)	(0.000956)	(0.000982)
Current Year GDD	-0.00324**	-0.00134	-0.000618	-0.00150
	(0.00154)	(0.00110)	(0.000957)	(0.000989)
Previous Year Temperature	-0.0471	-0.0291	0.00309	-0.0296
	(0.0386)	(0.0285)	(0.0260)	(0.0267)
Current Year Temperature	0.0440	0.0302	-0.00213	0.0303
	(0.0384)	(0.0281)	(0.0251)	(0.0262)
edu_primary				-0.0491***
				(0.00711)
edu_secondary				-0.144***
				(0.0103)
edu_higher				-0.251***
				(0.0138)
age	-0.00533***	-0.0118***	-0.0184***	-0.0122***
	(0.00121)	(0.00117)	(0.00127)	(0.000901)
age2	4.10e-05**	0.000115***	0.000191***	0.000121***
	(1.77e-05)	(1.66e-05)	(1.84e-05)	(1.27e-05)
has_radio	-0.00706	-0.0245***	-0.0241***	-0.0197***
	(0.00593)	(0.00351)	(0.00354)	(0.00329)
has_tv	-0.0575***	-0.0602***	-0.0875***	-0.0634***
	(0.00844)	(0.00648)	(0.00535)	(0.00613)
married	0.0236***	0.0261***	0.0159***	0.0225***
	(0.00594)	(0.00397)	(0.00378)	(0.00346)
total_children	0.00813***	0.00882***	0.0212***	0.0109***
	(0.000889)	(0.000979)	(0.00124)	(0.000772)
edu_singleyrs				
Constant	0.870***	0.728***	0.713***	0.824***
	(0.0890)	(0.0617)	(0.0533)	(0.0588)
Observations	164,257	181,747	218,702	564,720
R-squared	0.151	0.173	0.177	0.224
Controls	Yes	Yes	Yes	Yes
Month FE	Yes	Yes	Yes	Yes
Country Year FE	Yes	Yes	Yes	Yes

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 5: Other Subsamples

	(1)	(2)	(3)	(4)	(5)	(6)
	Husband Agricultural Worker		Woman Working Now		Children	
VARIABLES	Yes	No	Yes	No	Yes	No
Previous Year Precipitation Z-score	-0.0244***	-0.0274***	-0.0213***	-0.0329***	-0.0266***	-0.0323***
	(0.00911)	(0.00897)	(0.00788)	(0.00899)	(0.00758)	(0.00948)
Current Year Precipitation Z-score	0.0119	0.0209***	0.0178***	0.0214***	0.0195***	0.0202**
	(0.0116)	(0.00652)	(0.00643)	(0.00718)	(0.00615)	(0.00788)
Previous Year GDD	0.00396**	0.00105	0.00166	0.00200*	0.00228**	0.000443
	(0.00178)	(0.00102)	(0.00105)	(0.00105)	(0.000982)	(0.00114)
Current Year GDD	-0.00459***	-0.000613	-0.00162	-0.00173*	-0.00215**	-0.000197
	(0.00174)	(0.00103)	(0.00108)	(0.00104)	(0.000982)	(0.00115)
Previous Year Temperature	-0.0217	-0.0389	-0.0237	-0.0399	-0.0364	-0.0266
	(0.0480)	(0.0277)	(0.0276)	(0.0283)	(0.0258)	(0.0306)
Current Year Temperature	0.0233	0.0375	0.0254	0.0399	0.0370	0.0276
	(0.0481)	(0.0272)	(0.0271)	(0.0277)	(0.0252)	(0.0302)
edu_singleyrs	-0.00996***	-0.0170***	-0.0144***	-0.0179***	-0.0171***	-0.0185***
	(0.00111)	(0.00111)	(0.000898)	(0.00102)	(0.00110)	(0.000963)
age	-0.0101***	-0.0135***	-0.0139***	-0.0100***	-0.00817***	-0.0101***
	(0.00180)	(0.00107)	(0.00118)	(0.00112)	(0.000949)	(0.00182)
age2	8.49e-05***	0.000139***	0.000141***	9.60e-05***	8.56e-05***	0.000106***
	(2.48e-05)	(1.49e-05)	(1.64e-05)	(1.65e-05)	(1.36e-05)	(3.01e-05)
has_radio	-0.00806	-0.0190***	-0.0126***	-0.0225***	-0.0193***	-0.0141***
	(0.00518)	(0.00397)	(0.00360)	(0.00378)	(0.00353)	(0.00391)
has_tv	-0.0471***	-0.0493***	-0.0659***	-0.0548***	-0.0548***	-0.0769***
	(0.00961)	(0.00682)	(0.00616)	(0.00682)	(0.00662)	(0.00637)
married	0.000754	0.0165***	0.0185***	0.0231***	0.0227***	0.0210***
	(0.00983)	(0.00406)	(0.00424)	(0.00412)	(0.00387)	(0.00509)
total_children	0.0109***	0.0102***	0.0107***	0.00881***		
	(0.00127)	(0.000793)	(0.000865)	(0.000842)		
Constant	0.833***	0.911***	0.830***	0.841***	0.795***	0.813***
	(0.111)	(0.0597)	(0.0618)	(0.0623)	(0.0589)	(0.0622)
Observations	97,834	339,492	270,486	293,807	415,204	149,089
R-squared	0.279	0.213	0.243	0.212	0.225	0.227
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Month FE	Yes	Yes	Yes	Yes	Yes	Yes
Country Year FE	Yes	Yes	Yes	Yes	Yes	Yes

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 6: Robustness Check

VARIABLES	(1) All months	(2) Beginning	(3) Later	(4) North	(5) South
Previous Year Precipitation Z-score	-0.0281***	0.00808	-0.0409***	-0.0498***	-0.00101
	(0.00770)	(0.0141)	(0.00918)	(0.0106)	(0.0101)
Current Year Precipitation Z-score	0.0201***	0.0147	0.0215***	0.0257***	0.0165
	(0.00631)	(0.0155)	(0.00677)	(0.00800)	(0.0101)
Previous Year GDD	0.00175*	-0.000563	0.00190*	0.00237*	0.000814
	(0.000980)	(0.00199)	(0.00107)	(0.00142)	(0.00151)
Current Year GDD	-0.00159	0.000836	-0.00176	-0.00209	-0.000428
	(0.000986)	(0.00193)	(0.00109)	(0.00144)	(0.00149)
Previous Year Temperature	-0.0333	0.0737	-0.0615**	-0.0855**	0.0381
	(0.0264)	(0.0566)	(0.0296)	(0.0405)	(0.0350)
Current Year Temperature	0.0342	-0.0737	0.0625**	0.0818**	-0.0359
	(0.0260)	(0.0540)	(0.0293)	(0.0407)	(0.0334)
edu_singleyrs	-0.0164***	-0.0146***	-0.0168***	-0.0191***	-0.00904***
	(0.000933)	(0.00125)	(0.00100)	(0.00103)	(0.00113)
age	-0.0110***	-0.00977***	-0.0112***	-0.00831***	-0.0163***
	(0.000918)	(0.00153)	(0.00102)	(0.000910)	(0.00161)
age2	0.000104***	8.94e-05***	0.000108***	7.21e-05***	0.000175***
	(1.31e-05)	(2.12e-05)	(1.46e-05)	(1.30e-05)	(2.25e-05)
has_radio	-0.0179***	-0.0160***	-0.0177***	-0.0171***	-0.0208***
	(0.00326)	(0.00525)	(0.00372)	(0.00408)	(0.00468)
has_tv	-0.0594***	-0.0563***	-0.0598***	-0.0536***	-0.0722***
	(0.00616)	(0.00911)	(0.00669)	(0.00679)	(0.0101)
married	0.0226***	0.0301***	0.0210***	0.0244***	0.0176***
	(0.00350)	(0.00703)	(0.00372)	(0.00449)	(0.00446)
total_children	0.00980***	0.00706***	0.0102***	0.00966***	0.00896***
	(0.000720)	(0.00138)	(0.000764)	(0.000801)	(0.00124)
Constant	0.819***	0.723***	0.674***	0.874***	0.817***
	(0.0582)	(0.0888)	(0.0611)	(0.0935)	(0.0899)
Observations	564,293	105,884	458,409	390,308	173,985
R-squared	0.225	0.226	0.226	0.244	0.181
Controls	Yes	Yes	Yes	Yes	Yes
Month FE	Yes	Yes	Yes	Yes	Yes
Country Year FE	Yes	Yes	Yes	Yes	Yes

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1