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Poverty and Witch Killing

Edward Miguel*
University of California, Berkeley and NBER

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Abstract: This study uses rainfall variation to estimate the impact of income shocks on murder in rural Tanzania. Extreme rainfall (drought or flood) leads to a large increase in the murder of "witches" – typically elderly women killed by relatives – but not other murders. The findings provide novel evidence on the role of income shocks in causing violent crime, and religious violence in particular.

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* Correspondence: Department of Economics, University of California, 549 Evans Hall #3880, Berkeley, CA 94720-3880, USA; phone: 1 (510) 642 7162; fax: 1 (510) 642 6615; email: emiguel@econ.berkeley.edu. The author thanks ICS Africa and the Meatu District Council for their cooperation in all stages of the project, and would especially like to acknowledge the contributions of Polycarp Waswa, Alicia Bannon, Elizabeth Beasley, Mzee Bushiri, Stephanie Jayne, Dorothy Ndege, Avery Ouellette, the entire ICS field staff, and especially Melissa González-Brenes, without whom this project would not have been possible. Farhan Zaidi, Frances Fontanilla, Negar Ghobadi, Tina Green, Pamela Jakiela, and Giovanni Mastrobuoni have provided excellent research assistance. I thank Adam Ashforth, Marcia Caldas de Castro, Esther Duflo, Gerard Kiers, Michael Kremer, Matthew Rabin, Ragnar Torvik, Chris Udry, many seminar participants, and four anonymous referees for helpful comments. I am grateful for financial support from the National Science Foundation (SGER-#0213652), and a U.C. Berkeley Committee on Research Junior Faculty Research Grant. All errors are my own.

1. Introduction

Many observers have noted that poverty and violence go hand in hand. There is a strong negative relationship between economic growth and crime across countries, as well as across districts in India, and a link between low income and the occurrence of civil war.[1] Yet existing studies are typically unable to resolve the key econometric identification issues of omitted variable bias and endogeneity. To illustrate, the unobserved quality of local government institutions may affect both income growth and crime rates, and poverty could lead to violence if desperate people with "nothing to lose" commit more crimes, but violence itself may in turn affect economic productivity.

This paper uses local rainfall variation to identify the impact of income shocks on murder in a rural Tanzanian district.[2] Extreme rainfall – resulting in drought or floods – is exogenous and is associated with poor harvests and near-famine conditions in the region, and a large increase in the murder of "witches": there are twice as many witch murders in years of extreme rainfall as in other years. The victims are nearly all elderly women, typically killed by relatives. These econometric results, across eleven years in 67 villages, provide novel evidence on the role of income shocks in causing violent crime, and religious violence in particular, and also provide insights into witchcraft – an important social phenomenon in Africa rarely studied by economists.

The view that economic conditions are a driving force behind witch murders is bolstered by the fact that most witch killing in Tanzania takes place in poor rural areas largely dependent on rain-fed agriculture, and that most victims in our sample are from poor households. However, it is difficult to definitively disentangle this *income shock theory* from alternative socio-cultural explanations. The concentration of Tanzanian witch murders in a region dominated by one particular ethnic group (the Sukuma), and the especially high number of witch murders in villages where indigenous religious beliefs are strong both point to the important role of non-economic factors. Economic theories and

[1] Refer to Fajnzylber et al (2002) for cross-country crime results, and Fearon and Laitin (2003) on civil war. Dreze and Khera (2000) find strong negative links between murder and socioeconomic measures across Indian districts.
[2] Other studies have used rainfall variation to identify relationships between income and saving (Paxson 1992), and income and child health (Rose 1999, Hoddinott and Kinsey 2001).

cultural theories are perhaps best viewed as complements: the empirical findings demonstrate the power of economics to rationalize a phenomenon that has previously been understood almost solely through a socio-cultural lens.[3]

Examining the effects of two different "shocks", however, provides suggestive evidence in favor of the income shock theory over one particular socio-cultural explanation, the theory that victims are singled out as "scapegoats" by families in need of someone to blame for their suffering. Extreme rainfall and disease epidemics are both shocks that "witches" can control according to the ethnographic literature on Tanzania, and that have negative welfare consequences for households. The *scapegoat theory* predicts that both types of shocks should lead to more witch murders, as households eliminate the "cause" of their suffering. However, only the shock that leads to lower income (extreme rainfall) results in more witch murders, while disease epidemics lead neither to lower income nor to witch murders empirically. There is also survey evidence that a second socio-cultural explanation – that there simply exists a *cultural norm* in this region to kill elderly women as witches following extreme rainfall shocks – is unlikely to be behind the observed empirical patterns, again suggesting that income shocks are a key factor driving witch killings.

The remainder of the paper is structured as follows. Section 2 discusses existing anthropological and historical research on witch killing, and discusses theoretical frameworks for understanding witch killings. Section 3 describes the data, and Section 4 lays out the estimation strategy and presents the empirical results. The conclusion discusses possible policy implications and responses.

2. Background on Witchcraft

Witchcraft beliefs are widely held throughout Sub-Saharan Africa, serve a variety of social purposes, and have shown no tendency to lose salience during the post-colonial period (Moore and Sanders 2001). A belief in witchcraft allows people to make sense of the seemingly arbitrary misfortunes that affect them, and pin blame on a particular person rather than on chance (Evans-Pritchard 1937, Ashforth

[3] Other notable recent examples of this approach in economics include Berman (2003) and Oster (2004).

2001). In particular, African witches – who may be female or male – are widely thought to use their occult powers to inflict harm on other community members, often people in their immediate social circle whom they envy or against whom they harbor grudges (Geschiere 1997). Note that witchcraft beliefs are likely to be particularly persistent and difficult to falsify in a world of mean-reverting income, weather, and health stochastic processes, since actions taken to combat witchcraft will all too often appear successful.[4]

Witchcraft beliefs are strong in ethnically Sukuma western Tanzania ("Sukumaland"), where a large proportion of the population follows traditional religions and have never adopted Christianity or Islam. In our study area, Meatu District in Shinyanga Region, nearly two-thirds of 2001 household survey respondents claimed to mainly follow traditional religions. Mesaki (1994: 49) writes:

> Belief in witchcraft is rooted in the whole Sukuma system of knowledge and morality. … [When] misfortunes strike, such as the loss of livestock or a poor harvest, explanation may be found in strained relationships with living people or perhaps the spirits of the dead. … [W]itchcraft in Sukumaland may be held responsible for almost any calamity or misfortune such as sudden storms on the lake, the sudden death of a healthy person, miscarriages and infertility, the failure of rain, death from snake bite, losing one's way, and various diseases.

Government statistics show a rise in witch killings in western Tanzania since the 1960s, and some have tied this to the radical economic reforms pursued by Tanzania's socialist regime in the decades after independence, including villagization and agricultural collectivization (Abraham 1987). The government reported that 3,072 accused witches were killed in Sukumaland from 1970 to 1988, more than two-thirds of the Tanzanian national witch murder total. According to these figures, approximately 80% of victims were women and their median age was between 50 to 60 years old – an advanced age for Tanzania, where life expectancy is only 51 years (UNDP 2002).

Residents of western Tanzania and anthropologists who study the area claim that relatives, kin, and neighbors are typically behind the murders, and this is consistent with claims from other parts of Africa that "witchcraft is the dark side of kinship" (Geschiere 1997: 11). The following 1991 account of

[4] For a model of failed learning about the quality of health providers in the context of mean-reverting (self-limiting) health processes, refer to Das (2000).

a seventy year old woman who fled from her home near our study area, and subsequently lived homeless near the railway station in the regional capital of Shinyanga, suggests that household misfortunes are prime motivations for witch killing and that household members play a leading role in the attacks (Mesaki 1994: 59):

> I ran away from Rusule in Shinyanga District after being suspected of being a witch. … There were many deaths in the family … then rumour began to spread in the village that I was the one who killed them … [M]y own children started to hate me, … some of them started taunting me as a witch. I tried to explain but they did not give me the chance to vindicate myself. I knew what would befall me in view of what had happened to others previously, for they were brutally killed. Thus, when … one of the grandchildren whispered to me that they were about to kill me, I left the same evening. … I have lived in this camp for three years now, and though I love my family, there is no way of going back to face certain death.

Those unwilling or unable to flee are brutally massacred in their homes, usually with machetes.[5]

Former Tanzanian President Mwinyi addressed a 1987 rally in our study district with the following statement (Mesaki 1994: 58):

> You are killing innocent women, some of them your own mothers, grandmothers or old people who have all along taken good care of you: how come they suddenly become witches? Do (you) pay them back by killing them?

Although public witchcraft accusations have been illegal since the British Witchcraft Ordinance of 1928, and this law remains largely unchanged to the present day (Green 1994: 23-24), Tanzanian government efforts to stop the killings have been limited and unsuccessful. In one notable episode during the late 1970s, the Shinyanga regional government did arrest 897 individuals suspected of carrying out witch killings, yet the campaign was quickly called off once twelve suspects died in police custody, and the remaining suspects were later released (Mesaki 1994: 57). Such campaigns place government officials in a precarious political position, leading to a popular perception that they are "siding with" witches. The government reports that only seven of 1622 individuals arrested in connection with witch killings during the 1970s and 1980s were convicted, and since then the conviction rate has apparently fallen even lower, largely due to a lack of witnesses (perhaps not surprising given the frequent complicity of relatives).

[5] Note that women like the one cited in the above excerpt are unlikely to be counted as witch attack victims in our dataset since they fled before any actual attack took place.

Witch killings have also been tied to the resurgence of a pre-colonial village political institution, called *Sungu-sungu*, the male elders council. The *Sungu-sungu* first appeared in western Tanzania in response to a wave of cattle theft that exploded during the severe national economic crisis of the early 1980s, and is popularly credited with having put an end to rural disorder by organizing village patrols to punish suspected thieves and recover stolen property (Abrahams and Bukurura 1992: 94-5). In some villages, the *Sungu-sungu* also organizes mutual insurance and emergency credit schemes, and is entrusted with collecting funds for local development projects.

But in addition to these activities, the all-male *Sungu-sungu* consider combating witches central to their mission of promoting village security. They have been implicated in the expulsion of suspected witches from the village, as well as in some witch killings, after receiving "credible" information on the witchcraft activities of a particular individual – usually from a traditional healer hired by the purported witchcraft victim (Abrahams 1994). Witchcraft is a tangible reality for many Tanzanians and witches are considered criminals just as dangerous as ordinary thieves and murderers. From this perspective witch killers are pursuing justice, a view that runs against both Tanzanian law and international human rights norms. A recent news article reports that witch killing is viewed as public service: "In the Sukuma community, if you kill a witch it is not really considered a crime. It's like you are doing something for the community" (BBC 2002).[6]

2.1 Witch Killing Around the World

Witch killings are not unique to Tanzania. Attacks follow a similar pattern in northern Ghana, where thousands of women have been attacked or driven from their villages in the past decade, often following struggles over household resources (BBC 2001, EWD 2002). Witch killings of elderly women have also been documented in Kenya, Mozambique, and Uganda, and in Zimbabwe (EWD 2002, Otieno 2003). Over 400 witches have been killed since 1985 in South Africa's poor Northern Province (Niehaus 2001).

[6] Of course, not all Tanzanians take this stance, and in fact several local human rights groups have actively campaigned against witch killings, most notably the Tanzania Media Women's Association (TAMWA).

Witchcraft accusations in Africa are not restricted to elderly women. In the face of recent economic crises in Congo, young children have become common culprits (BBC 1999, 2003), and many have been kicked out of their homes or killed by family members following household calamities and negative income shocks (The Economist 2002):

> By one estimate there are 40,000 street children in Kinshasa, of whom 80% have been kicked out of their homes because their families thought they were witches. … Death or disease in the family is often taken as evidence of sorcery. Failed crops, lost jobs and bad dreams also arouse suspicion. Midway through last year, several hundred children were turfed onto the street of Mbuji-Mayi, a mining town, after a sudden drop in diamond prices.

Witch murders extend beyond Africa. In Andean regions of South America, isolated indigenous communities punish suspected witches with expulsion or execution. Yet it is not only witches who are sometimes killed in these communities: "there are also cases where the community practice is to kill or abandon infant twins or babies born handicapped, female or to large families, as well as old or very sick people, because they are considered to be a burden on the community" (Von Cott 2000: 222). Witch attacks have also been widely documented in Bihar, the poorest state in India (EWD 2002).

There are also parallels between contemporary Tanzania and witch killing in Europe in the 16th-18th century, when at least 40,000 individuals were murdered (Rowlands 1998). Most European victims were women, often widows, and they were predominantly poor and elderly (Rowlands 1998: 300). As in Tanzania, witches in early modern Europe were credited with power over health, weather and crops (Behringer 1999: 339). Witch killings continued despite the opposition of Europe's leading political and church authorities, and were concentrated in poor and outlying agrarian regions as noted by Behringer (1999) in his study of German cases. There is recent historical evidence that extreme weather – mainly heavy precipitation and low temperatures, which reduced crop yields – was often a proximate cause of witchcraft accusations in Europe and North America (Behringer 1999: 344; Baten and Woitek 2001; Oster 2004), including possibly the Salem witch trials, which occurred during particularly cold years.

2.2 Related Perspectives from Anthropology

An extensive literature in anthropology finds that poor pre-industrial societies frequently responded to acute environmental stress by killing the elderly ("geronticide") or infants, when they were seen as a burden on the community. Brogden (2000: 67) writes:

> Many societies, from the Artic to the tropics, when they perceive a resource threat to the common good … kill expendable persons, thereby stabilizing their conditions. The expendable persons were the very young or the very old.

Over one-third of the pre-industrial societies surveyed in Simmons (1945), Glascock (1987), and Silverman and Maxwell (1984) engaged in "death-hastening" activities for the elderly, including food being withdrawn, abandonment or murder, and these authors find that the availability of food resources is often the key determinant of the treatment of the elderly. For instance, "[w]here resources were even more meager … with the Amassalik Inuit, the decrepit elderly, when perceived as a community burden … were abandoned on an ice floe when the tribe was out fishing" (Brogden 2000: 65). Icelanders, Amazonian Bororos, Siberian Chukchees, Fijians, North American Hopis, Gabon Fang, African San, and Australian Tiwi are a few of the many other groups that are thought to have practiced death-hastening activities against the elderly. As in western Tanzania, Maxwell, Silverman, and Maxwell (1990: 77) claim that "geronticide is usually … the result of decisions made by an intimate group of kinsmen". A variety of norms have developed to justify violence against the elderly in extremely poor societies, and witch killing in Tanzania can possibly be seen as one manifestation of this phenomenon.

2.3 Theoretical Explanations for Witch Killing

There are a number of possible theoretical explanations for the empirical finding that extreme weather shocks lead to violence against witches in Tanzania. One hypothesis consistent with the main empirical patterns is that the large negative income shocks associated with extreme weather are the driving force behind witch attacks. This *income shock theory* highlights economic motivations as a cause of witch killing, but note that it does not imply that individuals in western Tanzania do not genuinely believe in witchcraft. The belief that the murder victim truly is a witch is important since it may alleviate the psychological trauma and social stigma associated with the murder of a relative, allowing killers to

justify their actions both to themselves and to the community. Psychologists have found that people tend to hold views consistent with their self-interest (Baron 2001), and this may further contribute to the belief that certain individuals truly are witches and must be killed.[7]

The targeting of elderly women rather than men as witches merits discussion. There are roughly equal numbers of women and men above 50 years of age in this area according to the 2001 household survey data we use, so it cannot simply be the case that women are disproportionately attacked because they are much more numerous than men. Elderly women's fate in rural Tanzania can be viewed as part of a broader pattern of gender inequality in East Africa. For instance, village political leaders are almost all male in Tanzania, which means that elderly men – most of whom serve on the *Sungu-sungu* – provide households with valuable access to political power but elderly women cannot. Patrilocal exogamy – a norm in which women move out of their natal village upon marriage – is commonly practiced in the study area, and this further contributes to the social marginalization of women since they are not typically surrounded by siblings, cousins, and childhood friends during old age, unlike elderly men. The greater average physical strength of men may also reduce their vulnerability to attack.

One variant of the income shock theory is the *extreme scarcity theory*, in which households near subsistence consumption levels kill, expel, or starve relatively unproductive elderly household members to safeguard the nutritional status of other members. If a minimum caloric threshold is required for survival or for minimal labor productivity (as in Dasgupta and Ray 1986), then when there is insufficient income to meet the minimum nutritional needs of all household members, spreading resources equally among all members puts all at risk of starvation. As Ray (1998: 279) writes: "unequal division [of resources] … helps some individuals in the household to be minimally productive under extreme circumstances."[8] The elderly have the lowest future income of all household members (on average), and by the above logic are thus most likely to be chosen for zero consumption. Reducing someone to zero

[7] I thank a referee for this point.
[8] Mirrlees (1975) was the first to make this theoretical point. The framework is also related to Rosenzweig and Schultz (1982), who find within-household resource allocation differentials across girls and boys in India as a function of women's labor market opportunities.

consumption can be thought of as literally starving her to death, driving her out of the household, or murdering her. Infants are the other obvious target since they will remain unproductive for many years and are particularly susceptible to mortality from reduced food consumption, neglect, and violence.[9]

Although theoretically attractive, the empirical relevance of the Dasgupta and Ray (1986) extreme scarcity framework has been challenged by Srinivasan (1994), who finds that the cost of nutrition required to achieve basal metabolism is typically but a small fraction of income even for the poorest workers in less developed countries. This also appears to be the case in the Tanzanian study district, where recent survey data indicates that the average price of maize is often only US$0.11 per kilogram, an affordable level even for the poorest households. To the extent negative income shocks lead to increased violence against elderly women in rural Tanzania, they are likely to do so through channels other than the extreme scarcity channel emphasized in Dasgupta and Ray (1986).[10]

As mentioned in the introduction, there are also possible socio-cultural explanations for witch killings following extreme rainfall shocks. One explanation is a seemingly arbitrary *cultural norm* which dictates that elderly women witches must be killed following extreme rainfall, but not after other calamities or events. However, a 2004 survey conducted in the Tanzanian study district indicates that such a norm does not exist in the study district. Very few survey respondents believed that causing bad rainfall is a common reason for the murder of "witches": the most common stated explanations for witch murders are causing death of an individual at 95.1% of respondents, causing poor health to another individual at 36.3%, and causing livestock to die (14.3%), while only 4.9% of respondents named causing drought and zero percent named causing floods as a common witch crime that leads to an attack

[9] Given strong within-household food-sharing norms in rural Tanzania, and the control that women often have over household food stocks, the most effective way to reduce elderly women to zero consumption in this setting might be expulsion from the household or murder.

[10] Chen (2004) develops an alternative economic theory of religiously motivated violence, inspired by the rise of Islamic fundamentalism in Indonesia during the Asian financial crisis. In this view the need for insurance following adverse economic shocks may lead individuals to join religious "clubs" that have an insurance function, and where commitment to the group can be demonstrated by taking violent actions against non-group members. This insurance motive does not appear to apply directly to the Tanzanian case studied in this paper, however.

(just 7.7% named causing crop failure).[11] This quantitative survey evidence is consistent with the ethnographic accounts, which do not mention any such cultural norm directly linking extreme rainfall to subsequent witch killings in Tanzania (Abrahams 1994, Mesaki 1994).

A second leading socio-cultural theory is that witches are killed as scapegoats following household or village calamities, which may include extreme rainfall. We attempt to distinguish between the income shock theory and the scapegoat theory in section 4 below.

3. Data and Measurement

3.1 Survey Data

Data collection for two survey instruments – the Village Council Survey and the Household Survey – was carried out in two waves during 2001-2002 by local non-governmental organization (ICS Africa) enumerators, with the cooperation of Meatu District Council authorities.

The Village Council Survey was administered in all 71 villages and relied both on interviews with Village Council members and on local administrative records. Four villages are missing data for at least some survey component, reducing the sample to 67 villages. We asked the Village Council the following question: *"Has this village faced any natural disasters or calamities in the past ten years? (Prompt: For example, drought, famine, floods, locusts.)"* There was typically broad consensus on what constituted a "natural disaster or calamity" among village officials, five to fifteen of whom participated in the interviews. We also collected information on outbreaks of human disease epidemics (usually cholera or measles) by year.[12]

Unfortunately, precise village-level rainfall gauge measures (in millimeters, for example) do not exist for most villages, and that is why we rely on the survey reports. However, we did obtain annual

[11] The sum of these percentages is greater than one since respondents were allowed to name multiple "crimes" that commonly lead to witch murders. The survey was conducted among 182 respondents in a representative sample of 12 villages in the study district during April-May 2004. The question read: *"When someone is attacked or killed for being a witch in this area, what crime(s) are they most commonly accused of?"* There is no statistically significant difference between the proportion of female and male respondents claiming causing drought was an important cause of witch murders (6.5% and 4.2%, respectively).

[12] The working paper version (Miguel 2003, Table 8) presents suggestive evidence that disease epidemics are often associated with large increases in infant mortality in the study area, especially for boys.

rainfall data over six years from the single rainfall station in the district capital, and compared these figures to Village Council Survey reports from the seven villages located in the same administrative ward as the rainfall station, to validate the accuracy of the survey reports. The small number of rainfall gauge observations prevents us from using these official rainfall data in the regressions. Mean annual rainfall in the district capital during 1996 to 2001 was 675 mm (s.d. 226 mm). The correlation between millimeters of rainfall and average reported flooding in these villages over 1996-2001 is over 0.8 (and statistically significant) and the correlation between millimeters of rainfall and drought is -0.6, providing suggestive evidence that the rainfall reports are reliable.[13]

In a separate section of the survey, we asked Village Council members whether there had been any murders in the village during the previous ten years, and if so, the number and years of the murders. The collection of violent crime data in each village in the presence of multiple local village officials is a strength of the current project, since such interviews are likely to yield more reliable information than government crime statistics in rural Tanzania. Murders are sufficiently rare events that they are widely remembered in a village, and there was a high degree of consensus among village officials on the events. There was also a remarkable openness in discussing witch killings (recall that witch murderers are rarely if ever punished by national government authorities). If a witch killing had ever occurred in the village, we also collected information on the personal characteristics of the most recent victim, including gender, age, and ethnic group; asset ownership of the victim's household relative to others in the village; and month of the murder.

The reliability of the witch murder reports is a key issue for the analysis. One concern is that respondents might expect witch killings to occur in extreme rainfall years a priori, and thus may falsely

[13] In an attempt to further validate the accuracy of retrospective rainfall reports in rural East Africa, we also collected peasant farmers' recollections of extreme rainfall events over the previous ten years in a nearby district in rural western Kenya (called Teso district), during April-May 2004. The existing rainfall gauge data is more extensive in the Kenyan district than in the Tanzanian study district, and the author already had some ongoing data collection in that region of Kenya, hence the choice of Teso district. The correlation between retrospective extreme rainfall reports and rainfall gauge data is also reasonably high in Kenya (correlation coefficient 0.54), although not as high as in the Tanzanian study district – perhaps in part because the respondents in the Tanzanian case were local government officials rather than peasant farmers, as in Kenya. The main limitation of the Kenyan sample is its small size of only 18 farmers (the small sample was due to logistical, financial, and time constraints).

attribute murders to extreme rainfall years when their memory of the exact year is somewhat uncertain. However, as mentioned above (in section 2.3), survey evidence from the study district indicates that, by far, the most common witch "crimes" that are believed to precipitate witch murders are causing illness or death to other individuals, while only 4.9% of respondents associated causing extreme weather shocks with subsequent witch murders. This is evidence against the view that respondents in the study area are predisposed to "lumping" witch murders and extreme rainfall together. Regarding the possibility that rainfall reports could somehow contaminate murder reports, or vice versa, by making certain years particularly "salient" to respondents, we know of no compelling reason why witch murders should be over-reported in years of extreme rainfall but not in years of other local calamities (for example, disease epidemics), or why witch murders, but not other types of murder, would be over-reported in extreme rainfall years. As reported below, there is no significant correlation between witch murders and other local calamities, or between extreme rainfall and non-witch murders, partly ameliorating these reporting bias concerns.

The number of non-fatal witch attacks by year was also collected during village council surveys; however, this variable is more difficult to capture than murder, since although in practice we sought to collect information on all those who were "forced out" of the village as well as those actually physically assaulted, many individuals who flee in anticipation of a witch attack are likely to be missed. Retrospective questions on non-violent (e.g., property) crimes were not included in the survey because it was felt that recall data stretching back across many years would not be sufficiently reliable for these crimes, which are much more common than witch murders and attacks.

The Household Survey was administered to 15-20 households from each village, and in all, 1293 households were surveyed. Surveyed households were randomly sampled from the Village Tax Register, and a neighbor of each sampled household was also surveyed, in order to obtain a broadly representative sample. The Household Survey collected detailed socioeconomic and demographic information, as well as a consumption expenditure module for a subset of households.

3.2 Descriptive Statistics

There are 0.2 murders per village-year on average, or roughly one per village every five years (Table 1, Panel A).[14] Murders are nearly evenly divided between witch murders and non-witch murders, with a total of 65 witch murders and 68 non-witch murders during the period. In total, there were 138 witch murders or non-lethal attacks during the period, which is equivalent to an annual 1 in 500 chance that a woman over age 50 was killed or attacked as a witch. Although these are relatively low odds, if the probability of being attacked is identically and independently distributed for individuals each year (which seems a reasonable starting point), then a 50 year old woman faces a 2.0 percent chance of being the victim of a witch attack over the next ten years.

Extreme rainfall occurs approximately once in six years, typically from drought but also from flooding (including the massive 1998 El Niño floods – Table 1, Panel B). Villages experience two consecutive years of extreme rainfall in 0.08 of all years. Famine and human disease epidemics also typically occur approximately once every six years (the means are 0.18 and 0.15, respectively).

Annual per capita income in 2001 was only $197 (Table 1, Panel C), meaning that households in this area are poor even for Tanzania, one of the poorest countries in the world with per capita income of approximately US$256 (UNDP 2002). The average household survey respondent had four years of education, again below the Tanzanian average (United Republic of Tanzania 1999). The Sukuma ethnic group make up approximately 90% of the population, and the district has a high rate of adherence to traditional religions, at 64%. There are only two women's community groups per village on average.

As further evidence on poverty in this region, just two percent of households use irrigation rather than rain-fed agriculture, only 6% have a household member with a salaried formal sector job, and 75% of income goes toward food consumption on average. The principal food crop in the district is corn (maize), which is grown by 84% of households, while the main cash crop is cotton, grown by 64% of

[14] The annual murder rate in Meatu from 1992-2002 is roughly 6 per 100,000 population, lower than the U.S. rate of 8 per 100,000 population during the 1990s (http://www.ojp.usdoj.gov/bjs/) but higher than the Indian rate of approximately 4 per 100,000 (Dreze and Khera 2000). Note that this pattern is not consistent with the broader cross-country correlation between violent crime and income, since the U.S. is the wealthiest of these countries.

households. Unpaved roads to neighboring districts, a minimal formal financial infrastructure, and poor grain storage conditions combine to produce large fluctuations in the local price of grain through the calendar year. Although formal crop insurance is unknown, fully 73% of villages had received at least some food relief aid from the Tanzanian government or a non-governmental organization in the recent past (although we unfortunately do not have the exact years of relief), highlighting the chronic food insecurity in this area.

Witch killing victims are nearly all female (96% – Table 2, Panel A), with relatives living in the village (98%), and ethnically Sukuma (96%). Both the median and mean victim age is over 50 years old. Although 87% of victims lived with relatives at the time of the murder, some lived alone (we unfortunately did not collect information on widow status, but it is reported anecdotally that those living alone are often widows). The profile of witch murder victims is in sharp contrast to the victims of non-witch murders, 59% of whom were male and over 70% of whom were killed during armed robberies (typically related to cattle theft).[15]

Along three dimensions of wealth, witch murder victims tend to come from households either "below average" or "average" for the village (Table 2, Panel B). For example, in terms of ownership of household goods (e.g., radios, bicycles) 69% of victims' households were below average for the village, 31% were average, and none above average. Similarly for livestock ownership, 55% were below average, although the figures are more balanced for land ownership.

The agricultural year in this area is roughly divided in two periods: the post-harvest period from August to January – during which time food is relatively plentiful – and the "hungry season" from February to July, during which time food becomes increasingly scarce, in the months before and during the next harvest. The Household Survey data indicates that most food stores from the previous harvest are typically depleted by February of the following year, after which time many households dip into

[15] These figures on the characteristics of non-witch murder victims should be interpreted with some caution: this information was only collected for a subset of the non-witch murders in the form of open-ended descriptions, unlike the explicitly coded survey questions on witch murder victims.

their limited savings, sell assets (e.g., cattle), or labor on other farms to survive. Witch murders are concentrated in the six months of the "hungry season" from February to July during the pre-harvest/harvest period, when the rainfall shock for the next harvest has been realized and most food stocks from the previous harvest are already exhausted. The caloric demands of the household are greatest during the harvest season due to high labor needs, placing further pressure on resources. There is a sharp drop in the murders immediately after the harvest, which ends in July or August, when food is more plentiful (Table 2, Panel C). The hypothesis that the proportion of witch murders is the same in the pre-harvest/harvest and post-harvest periods is rejected at 99% confidence.

The observed timing of witch murders provides further evidence against the extreme scarcity theory described in section 2.3 above. In the simplest version of that theory, witch killings should occur in the January-April period of the year following a bad harvest, when the limited existing food stocks have run out and food from the upcoming harvest has not yet started to come in. However, we find that many killings take place at the end of the harvest period, in June and July, when some food from that harvest is already starting to become available. More importantly perhaps, witch killings typically occur in the year of the extreme rainfall shock rather than the following year. In a "forward-looking" variant of the extreme scarcity theory, witch killings could take place in anticipation of future food shortages – since those who understand that resources will soon be scarce may choose to safeguard the nutritional status of other household members by preemptively killing (or expelling) a "witch" sooner rather than later. In this case, however, witch killings should occur immediately after rains for the upcoming harvest have been realized, perhaps February to April in the year of bad rains. However, nearly half of witch killings occur later, during May to July in the year of bad rains.

4. Empirical Results

4.1 Estimation Strategy

The exogeneity of local rainfall variation is central to the identification strategy. Ideally, we would have access to household income data for each village in each year of the study, and would employ an

instrumental variable approach to identify the effect of income shocks on murder (using rainfall as an instrument for average village income, or for the proportion of village households experiencing a drop in income, in the first stage). However, in the absence of longitudinal income data, we instead focus on the reduced-form impact of extreme rainfall on murder.

There is longitudinal rainfall and murder data for 67 villages over eleven years, 1992-2002. In Equation 1, M_{kt} represents the number of witch murders in village k during year t. Murder is a function of X_{kt}, village socioeconomic, demographic, and disease characteristics, as well as a function of an indicator variable for extreme rainfall, R_{kt}, which takes on a value of one if a drought or floods occurred in village k during year t. To the extent that weather reports are "noisy", coefficient estimates will be biased toward zero and thus serve as lower bounds on the true rainfall effect.[16] The idiosyncratic village-year disturbance term, ε_{kt}, is included in all specifications, and we allow regression disturbance terms to be correlated (clustered) across years for the same village, but to be independent across villages in all specifications.[17] The estimation equation becomes:

$$M_{kt} = \alpha_1 + X_{kt}'\beta_1 + \gamma_1 R_{kt} + \varepsilon_{1kt} \qquad (1)$$

(The "1" subscript denotes the equation number.) We primarily focus on the number of murders, although, as we show below, the results are largely robust to the use of murder rates.

The ethnographic literature and survey evidence both suggest that illness often leads to witchcraft accusations, and to explore this possibility we include controls for disease epidemics in certain specifications. We also interact village explanatory variables with the rainfall shock to test whether villages with particular characteristics are prone to killings in extreme rainfall years.

[16] This will be non-classical measurement error (refer to Aigner 1973). Still the resulting bias will be toward zero as long as error is not too severe (the exact condition is that Pr(Type I error) + Pr(Type II error) < 1).
[17] Spatial correlation of witch murders across villages is minimal according to Moran's I coefficient (which equals 0.01). Regression estimates do not change appreciably when using spatially correlated disturbances (not shown).

Village fixed effects (α_k) capture time-invariant omitted variables – most obviously geographic factors – that could be correlated with both rainfall and murder, so in Equation 2 $\tilde{X}_{kt}$ includes only time-varying village characteristics, such as disease epidemic controls. This yields the preferred specification:

$$M_{kt} = \alpha_{2k} + \tilde{X}_{kt}'\beta_2 + \gamma_2 R_{kt} + \varepsilon_{2kt} \qquad (2)$$

Note that 19% of the variation in extreme rainfall is explained with village fixed effects, and including both village fixed effects and year indicators captures 29% of the variation, so most variation is due to idiosyncratic village-year shocks. The geographic diversity of Meatu District is central to understanding why there is considerable idiosyncratic variation. The total surface area of Meatu district is large, at 8835 km^2, more than twice the size of the U.S. state of Rhode Island; altitude in the district varies considerably, between 1000-1400 meters above sea level; and the northern part of the district often receives over 900 mm of rain per year, while southern and eastern parts receive only 400 mm of rain (United Republic of Tanzania 2001).

The possibility of food relief in famine years somewhat complicates the interpretation of the coefficient estimate on extreme rainfall: if relief aid blunts the impact of extreme rainfall on income coefficient estimates should be interpreted as lower bounds on effects in the absence of relief. [18]

4.2 Witch Killing Results

Extreme rainfall leads to large income drops in Meatu district: regressing average village income in 2001 on an indicator for extreme rainfall in that year, as well as on geographic division indicators and village characteristics – average educational attainment, proportion of households growing a cash crop, proportion Sukuma, proportion who follow traditional religions, number of households in the village,

[18] There are a number of reasons to focus on rainfall variation rather than famine. First, famine is partly a function of village institutional capacity and the strength of political links to district authorities, and both of these characteristics may also affect murder. These characteristics could also vary through time, and hence would not be captured in village fixed effects. Another concern relates to the classification of famine years: the coefficient estimate on famine will be downward biased if years when food aid arrives are more likely to be considered "famines" by the Village Council, *ceteris paribus*. Nonetheless, specifications including an indicator for famine as the key explanatory variable generate results broadly similar to – though somewhat weaker than – regression specifications with extreme rainfall (results not shown).

and the number of women's groups per household – indicates that average income is approximately US$51 lower (standard error US$25) in villages experiencing extreme rainfall, about 25% of average income, and this effect is statistically significant at 95% confidence (Table 3, regression 1). In contrast, human disease epidemic years are not associated with per capita income (regression 2); a priori, human disease outbreaks may either increase or decrease per capita income, depending on the labor productivity of disease victims. Floods have a somewhat more negative effect on income than droughts, but we cannot reject the hypothesis that floods and drought have the same effect (regression 3, F-test p-value = 0.45), and thus the extreme rainfall indicator is used as the main explanatory variable in the analysis below. Extreme rainfall is also associated with famine: the coefficient estimate on extreme rainfall is 0.47 (standard error 0.07), while disease epidemics are not associated with famine (regression 4). Extreme rainfall is uncorrelated with human disease epidemics (regression 5).

In the main empirical result of the paper, extreme rainfall is strongly positively associated with witch murders (Table 4, regression 1): extreme rainfall is associated with 0.085 more witch murders per village-year (significant at 95% confidence) in the village fixed effects specification, which implies that there are twice as many witch murders in years of extreme rainfall as other years. Results are similar with Poisson, negative binomial, ordered probit and probit estimation (Appendix Table A1). However, the fact that there are also some witch killings in normal rainfall years, and that extreme rainfall shocks explain only a fraction of total variation in the killings, suggest that negative income shocks may be just one of several causes of witch killing.

Drought and flood both have a similar impact on murders – with point estimates of 0.099 and 0.080, respectively (regressions not shown) – and hence we again focus on the single extreme rainfall indicator. Including geographic division indicators and village characteristics yields similar results (Table 4, regression 2, coefficient estimate 0.076, standard error 0.037) – although note that these non-fixed effect estimates may potentially suffer from bias due to endogeneity, since the village characteristics were collected at the end of the study period (in 2001-2002). The main witch murder

result is similar when controls for extreme rainfall in the previous year and in two consecutive years are included (regression 3), neither of which is significantly associated with witch murder. One explanation for the weak effect of two consecutive years of extreme rainfall is the possibility that the most vulnerable elderly die (of either natural or unnatural causes) during the first extreme rainfall year. An indicator for extreme rainfall in the following year is not a significant predictor of witch murders (estimate 0.046, standard error 0.050, regression not shown), which serves as a specification check.

Disease epidemics are not significantly associated with witch murders (Table 4, regression 4), a finding that bolsters the income shock theory over the scapegoat theory. Extreme rainfall and disease epidemics are both shocks that witches can control according to the ethnographic literature, and which have negative welfare consequences for households. The scapegoat theory thus predicts that both types of shocks should lead to more witch murders, as households eliminate the "cause" of misfortunes. However, only the shock that leads to a drop in income (extreme rainfall) results in more witch murders, while disease epidemics affect neither income (Table 3) nor witch murders.[19, 20]

The rainfall results are also largely robust to the inclusion of year fixed effects (Table 4, regression 5), although in this case the point estimate falls from 0.085 to 0.056 and is only marginally significant (p-value = 0.14).[21] This drop is not unexpected since parts of the district are subject to common exogenous weather shocks in certain years, such as the 1998 El Niño floods. Figure 1

[19] It is possible that people in this area could have "learned" that witch killing does not end disease epidemics, due to positive serial correlation in epidemics, but that they did "learn" that witch killing ends extreme rainfall (due to negative or zero serial correlation in rainfall). However, observed serial correlation patterns across years are nearly identical for both extreme rainfall (correlation coefficient 0.12) and epidemics (0.16), indicating that different mean reversion patterns for these two shocks are unlikely to account for the findings in Table 4, regression 4, bolstering the income shock theory. Note that it remains possible that auto-correlation patterns *within* a year are substantially different for these two shocks, though unfortunately we do not have within-year data and so cannot directly test this possibility. I thank a referee for this point.

[20] There is an apparent discrepancy between this result and the 2004 survey finding that individuals claim causing illness and death is the main cause of witch attacks. One possible partial explanation is that illness and death sometimes do serve as triggers for witch attacks (recall that negative income shocks explain only a fraction of all variation in witch killings), although not disproportionately in disease epidemic years; however, the reasons behind this divergence between epidemic years and other years remains elusive. A more speculative explanation is that many 2004 survey respondents were reluctant to abandon, or openly contradict, the "conventional wisdom" that illness and death lead to witch attacks, a belief rooted in deeply held traditional religious convictions.

[21] The 2002 surveys were collected during July-August 2002, and hence the 2002 data may miss some murders committed after August (although Table 2 suggests that very few witch killings occur in the post-harvest period). Nonetheless, dropping 2002 data leaves the main result unchanged (estimate 0.086, standard error 0.046).

graphically illustrates the proportion of villages experiencing extreme rainfall and witch murders by year, and the correlation coefficient between the two series is high (at 0.5). Including year fixed effects eliminates considerable rainfall variation from the sample, and so it is not surprising that regression coefficient estimates change somewhat when this variation is eliminated, given the moderate size of the sample (736 village-year observations). Note that we cannot reject that the 0.085 and 0.056 point estimates (from Table 4) are equal at traditional confidence levels, and thus it would be a mistake to over-interpret the difference between these two estimates. One plausible explanation for larger point estimates on the extreme rainfall indicator when district-wide rainfall variation is utilized is that aggregate, district-wide rainfall shocks tend to be the most severe shocks (i.e., a major regional weather shock). However, due to data limitations, we are unable to distinguish between extreme weather episodes of varying degrees of severity, and so cannot directly test this possibility.

Another potential estimation concern is bias due to time-varying omitted variables, for instance, if some underlying characteristic – say, village "development" – leads both to less witch killing and to fewer reported extreme rainfall shocks, perhaps because more "developed" communities deal more effectively with weather shocks. This could produce a spurious positive correlation between extreme rainfall reports and witch killing. Unfortunately, the dataset only contains village socioeconomic measures for one year near the end of the sample period (2001), so local characteristics cannot be directly controlled for each village-year observation. However, any bias from such village-specific time-varying factors is likely to be small: the main empirical result is largely robust to the inclusion of village-specific time trends, which capture linear trends in village development (point estimate 0.074, standard error 0.048).[22]

[22] A second method – which compares extreme rainfall reports across neighboring villages – also suggests that any reporting bias due to changing village "development" is likely to be small. For 2001, the year socioeconomic data was collected, villages at higher levels of "development" (proxied by three measures: average adult education, proportion of households growing cash crops, and the number of women's groups) are no less likely to report extreme rainfall shocks than other villages within their same geographic ward, nearby villages which are subject to similar extreme rainfall shocks (there are 19 wards in the sample, each with about four villages on average). In a regression with the 67 sample villages, none of the three village socioeconomic measures (the explanatory variables) is statistically significantly associated with the extreme rainfall report in 2001 (the dependent variable).

To test for outliers, we also dropped one village at a time and the resulting estimates range from 0.07-0.11 and are significantly different than zero at 90% confidence in all cases (results not shown).[23, 24] Using a two-sample instrumental variable approach, related to Angrist and Krueger (1992), we estimate the structural relationship between average village income (in U.S. dollars) and witch murders as (0.085) / (–50.7) = –0.00167, and thus an increase in income from the Meatu average to the Tanzanian national average of US$256 would reduce witch murders by –0.1 per village-year.

Witch murders in extreme rainfall years are concentrated in villages where residents practice traditional religions: the coefficient estimate on the interaction between extreme rainfall and the proportion practicing traditional religions, in a specification without village fixed effects, is 0.27 (standard error 0.14, regression not shown). It remains possible that this term is actually capturing an unobserved dimension of local socioeconomic status correlated with the strength of traditional religion, in line with a theory in which low income is a main driver of witch killings. However, this finding also provides suggestive evidence that income shocks and strong witchcraft beliefs are both necessary conditions for the killings to occur, highlighting the possible interaction of economic conditions and cultural factors. In fact, witch killing patterns in Tanzania as a whole appear consistent with a view in which socio-cultural factors are central: while many parts of Tanzania are poor, semi-arid and are regularly hit with large rainfall shocks, nationally two-thirds of all reported witch killings occur in the ethnically Sukuma regions of western Tanzania (which account for only 12% of the national population,

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In particular, the coefficient estimate on average years of education is only 0.01 (s.e. 0.13), on growing a cash crop is -0.39 (s.e. 0.26), and on the number of women's groups is -0.0 (s.e. 24.0). If we examine the period 1999-2002 in order to increase sample size, and include ward-year fixed effects, the point estimates are again all statistically insignificant and economically small: the coefficient estimate on average years of education is -0.02 (s.e. 0.05), on growing a cash crop is 0.11 (s.e. 0.22), and on women's groups is -9.0 (s.e. 8.8). Although neither of these two approaches alone completely rules out the possibility of bias due to time-varying omitted variables, taken together they cast considerable doubt on the possibility that such bias is driving the main empirical result.

[23] We also investigated using world cotton prices as an alternative source of exogenous variation in income, but the cotton price is not significantly related to witch killings (results not shown). However, note that there is just a single world price of cotton and hence no variation across villages in a given year. The effect of extreme rainfall on witch murders is robust to the inclusion of the cotton price as an additional explanatory variable (result not shown).

[24] A specification in which extreme rainfall is used as an instrument for famine yields a point estimate of 0.20 (standard error 0.11), although this is potentially misleading since extreme rainfall that does not result in full-blown famine may still be associated with a negative income shock, i.e., the exclusion restriction may not hold.

Mesaki 1994). In contrast, the effect of extreme rainfall is not significantly different in villages with more income, education, households growing cash crops, total households, or local women's groups (results not shown).

The witch murder results are robust to the use of a murder rate per 1000 households[25] (Table 5, row 2), and coefficients are similarly large and positive, though not always statistically significant, when the number of witch killings plus attacks is the dependent variable (rows 3-4).[26]

Yet extreme rainfall is unrelated to the number of non-witch murders in these villages: the point estimate on extreme rainfall is near zero (Table 5, rows 5-6). Note that this result appears to rule out the possibility that a general breakdown in local law enforcement is the true underlying cause of increased witch murders in extreme rainfall years, since non-witch murders would presumably also be affected in that case. Taking both types of murder together, extreme rainfall has a positive but only marginally statistically significant effect on total murders (rows 7-8).[27]

5. Conclusion

The analysis suggests that income shocks are a key underlying cause of the murder of elderly women as "witches" in Tanzania: extreme rainfall leads to large income drops and a doubling of witch murders.

A natural question is what public policy could (or should) do to eliminate witch killings in Tanzania. The most immediate solution would be to target police apprehension efforts in the areas where most such crimes occur and more aggressively prosecute witch killers in the courts. However, this is likely to be strongly resisted – as past attempts have been – by residents of the region, most of whom believe that killing witches ultimately promotes community welfare. Many politicians are also reluctant

[25] Total village population is missing in several villages, hence the use of the number of households.
[26] One plausible explanation for the weaker results in rates is the possibility that elderly women vulnerable to witchcraft accusations flee villages that have experienced even a single recent witch attack, and more such women flee larger villages; unfortunately, we cannot capture these flows due to data limitations.
[27] The working paper version (Miguel 2003, Table 7) examines the relationship between village characteristics (measured in 2001-2002) and the number of murders during the entire 1992-2002 period, and finds that villages with higher education levels have significantly fewer witch murders. However, due to the timing of data collection on village characteristics, these regressions may suffer from endogeneity, and hence we do not emphasize them. The working paper version (Table 8) also provides suggestive evidence that infant mortality rates were higher for girls than for boys in villages that had experienced two consecutive years of extreme rainfall.

to move against those who murder witches, since doing so may open them up personally to witchcraft accusations.

There are a number of other more attractive approaches to reducing witch killings, to the extent that negative income shocks play a key role. One possibility is improving the system of formal insurance against extreme rainfall shocks, to provide households with better means of smoothing their consumption across years of good and bad rainfall. The existing African Famine Early Warning System (FEWS) could provide detailed and reliable quantitative local weather measures for such a large-scale formal insurance scheme in Tanzania or elsewhere in Sub-Saharan Africa.

Another potentially attractive policy option is to provide elderly women in the study area with regular pensions, which would transform them from a net household economic liability into an asset, and could help households smooth their consumption. The South African case provides suggestive evidence that this could have a substantial impact: witch killings in Northern Province, South Africa have dropped dramatically since the introduction of an old age pension in the early 1990s (Singer 2000) – although it is, of course, difficult to definitively establish causality given the many other political and social changes that have occurred in South Africa during the same period. Unfortunately, Tanzania is too poor to afford a pension scheme as ambitious as the South African program without considerable external donor assistance. The results of this paper suggest that violence against "witches" is likely to continue in rural Tanzania as long as most households live in grinding poverty and are unable to insure themselves against large income shocks.

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Tables and Figures

Table 1: Descriptive Statistics

	Mean	Std dev.	Obs.
Panel A: Crimes per village-year (Village Council Data)			
Witch murders	0.09	0.33	736
Witch murders per 1000 households	0.23	0.87	736
Witch murders and attacks	0.20	0.57	736
Witch murders and attacks per 1000 households	0.47	1.56	736
Non-witch murders	0.11	0.41	736
Non-witch murders per 1000 households	0.23	1.01	736
Total murders	0.20	0.53	736
Total murders per 1000 households	0.45	1.35	736
Panel B: Natural calamities per village-year (Village Council Data)			
Extreme rainfall (drought or flood)	0.18	0.38	736
Extreme rainfall, current year and previous year	0.08	0.27	736
Drought	0.13	0.34	736
Flood	0.06	0.23	736
Famine	0.18	0.38	736
Human disease epidemic (e.g., cholera, diarrhea, measles)	0.15	0.36	736
Livestock disease epidemic	0.01	0.08	736
Panel C: Village characteristics (Village Council and Household Survey Data)			
Annual per capita consumption expenditures (USD)	196.8	81.1	736
Average years of education	4.0	1.1	736
Proportion Sukuma ethnic group	0.91	0.16	736
Proportion households grow cash crops	0.62	0.22	736
Households per village	409.2	176.4	736
Proportion practice traditional religions	0.64	0.21	736
Women's community groups per household	0.0035	0.0045	736

Table 1 Notes:
In the Household Survey, both men and women were surveyed, though two-thirds of respondents were men. Year 2002 data is for the period January to August 2002 (and was collected during July-August 2002). The rainy season runs from October (of the previous calendar year) to February. These averages are weighted by the number of households per village.

Table 2: Witch Murder Victim Characteristics

	Mean
Panel A: Demographic characteristics	
Female	0.96
Age	57.6
Had relatives in the village	0.98
Lived in a household with others	0.87
Sukuma ethnic group	0.96
Panel B: Socioeconomic characteristics	
Ownership household goods (e.g., radio, bicycle):	
"Below average"	0.69
"Average"	0.31
"Above average"	0
Ownership of livestock:	
"Below average"	0.55
"Average"	0.38
"Above average"	0.08
Ownership of land:	
"Below average"	0.32
"Average"	0.57
"Above average"	0.11
Panel C: Timing of witch murders	
Pre-harvest/harvest season (February through July)	0.74
February	0.02
March	0.07
April	0.21
May	0.12
June	0.12
July	0.19
Post-harvest season (August through January)	0.26
August	0.07
September	0.05
October	0
November	0.05
December	0.07
January	0.02

Table 2 Notes:
Data are from the 2002 Village Council Survey, on the most recent witch murder victim in the village. The standard deviation of victim age is 12.9 years. Data on ownership of household goods is missing for 4 of 53 victims, and month data is missing for 11 of 53 victims.

Table 3: Extreme Rainfall and Village Calamities

	Dependent variable:				
	Annual per capita consumption expenditures (USD)			Famine	Human disease epidemic
Explanatory variable	OLS (1)	OLS (2)	OLS (3)	OLS (4)	OLS (5)
Extreme rainfall (drought or flood)	-50.7**	-50.1*		0.47***	-0.03
	(24.8)	(26.6)		(0.07)	(0.04)
Human disease epidemic		4.4		0.04	
		(25.7)		(0.05)	
Drought			-38.5*		
			(21.3)		
Flood			-74.9		
			(48.4)		
Average years of education	1.7	1.8	0.0		
	(13.0)	(13.4)	(12.9)		
Proportion Sukuma ethnic group	-12.0	-12.1	-14.5		
	(63.5)	(64.8)	(65.3)		
Proportion households grow cash crops	-2.7	-2.9	3.7		
	(56.2)	(56.3)	(56.2)		
Households per village / 1000	0.07	0.07	0.07		
	(0.07)	(0.07)	(0.07)		
Proportion practice traditional religions	17.2	17.4	22.7		
	(52.5)	(53.4)	(52.4)		
Women's community groups per household	2116	2083	2333		
	(2492)	(2465)	(2571)		
Geographic division fixed effects	Yes	Yes	Yes	No	No
Village fixed effects (67 villages)	No	No	No	Yes	Yes
R^2	0.14	0.14	0.15	0.26	0.06
Root MSE	81.4	82.1	81.8	0.34	0.37
Mean of dependent variable	196.8	196.8	196.8	0.18	0.15
Number of observations	67	67	67	736	736

Table 3 Notes:

Huber robust standard errors in parentheses. Significantly different than zero at 90% (*), 95% (**), 99% (***) confidence. Observations are weighted by the number of households per village. Regression disturbance terms are clustered at the village level. Regression 1 only contains data for 2001, the only year in which a household consumption expenditure survey was conducted. In Regression 3, we cannot reject the hypothesis that the coefficient estimates on Drought and Flood are equal (p-value=0.50).

Table 4: Extreme Rainfall and Witch Murders

	Dependent variable: Witch murders				
Explanatory variable	OLS (1)	OLS (2)	OLS (3)	OLS (4)	OLS (5)
Extreme rainfall (drought or flood)	0.085** (0.042)	0.076** (0.037)	0.098 (0.059)	0.085** (0.042)	0.056 (0.038)
Extreme rainfall, previous year			-0.000 (0.042)		
Extreme rainfall, current year and previous year			-0.032 (0.080)		
Human disease epidemic				-0.006 (0.036)	
Village fixed effects (67 villages)	Yes	No	Yes	Yes	Yes
Socioeconomic controls, and geographic division fixed effects	No	Yes	No	No	No
Year fixed effects (11 years)	No	No	No	No	Yes
R^2	0.15	0.05	0.16	0.15	0.19
Root MSE	0.32	0.32	0.31	0.32	0.31
Mean of dependent variable	0.09	0.09	0.09	0.09	0.09
Number of observations	736	736	736	736	736

Table 4 Notes:

Huber robust standard errors in parentheses. Significantly different than zero at 90% (*), 95% (**), 99% (***) confidence. Observations are weighted by the number of households per village. Regression disturbance terms are clustered at the village level. Socioeconomic controls include Average years of education, Proportion Sukuma ethnic group, Proportion households grow cash crops, Households per village / 1000, Proportion practice traditional religions, and Women's community groups per household.

Table 5: Extreme Rainfall and Violent Crime

Dependent variable	Coefficient estimate on Extreme rainfall (drought or flood)	R^2	Root MSE
Panel A: Witch Murders and Attacks			
1) Witch murders	0.085**	0.15	0.32
	(0.042)		
2) Witch murders per 1000 households	0.173*	0.16	0.84
	(0.094)		
3) Witch murders and attacks	0.144*	0.11	0.56
	(0.082)		
4) Witch murders and attacks per 1000 households	0.206	0.11	1.56
	(0.162)		
Panel B: Non-witch Murders			
5) Non-witch murders	-0.001	0.11	0.41
	(0.036)		
6) Non-witch murders per 1000 households	-0.01	0.14	0.99
	(0.08)		
Panel C: Total Murders			
7) Total murders	0.100	0.13	0.54
	(0.068)		
8) Total murders per 1000 households	0.125	0.12	1.33
	(0.124)		

Table 5 Notes:
Huber robust standard errors in parentheses. Significantly different than zero at 90% (*), 95% (**), 99% (***) confidence. Observations are weighted by the number of households per village. Regression disturbance terms are clustered at the village level. Village fixed effects are included in all specifications, which are analogous to Table 4, regression 1. All regressions have 736 observations. Each coefficient estimate is from a separate regression.

Figure 1: Proportion of Villages with Extreme Rainfall and Average Witch Murders, by year (1992-2002)

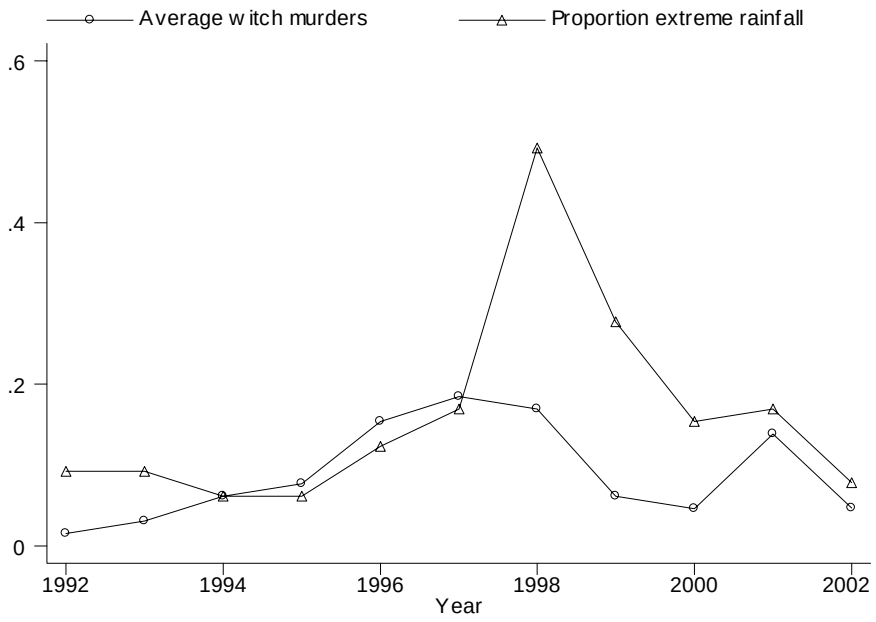

Figure 1 Notes: The data for 2002 are for January through July/August.

Appendix

Table A1: Extreme Rainfall and Witch Murders, Robustness

	Dependent variable:				
	Witch Murders	Any witch murder	Witch Murders	Witch Murders	Witch Murders
	OLS	Probit	Ordered probit	Poisson	Negative binomial
Explanatory variable	(1)	(2)	(3)	(4)	(5)
Extreme rainfall (drought or flood)	0.076**	0.071**	0.39**	0.46*	0.46*
	(0.037)	(0.035)	(0.17)	(0.27)	(0.27)
Socioeconomic controls, and geographic division fixed effects	Yes	Yes	Yes	Yes	Yes
R^2	0.05	-	-	-	
Root MSE	0.32	-	-	-	
Mean of dependent variable	0.09	0.08	0.09	0.09	0.09
Number of observations	736	736	736	736	736

Table A1 Notes:
Huber robust standard errors in parentheses. Significantly different than zero at 90% (*), 95% (**), 99% (***) confidence. Observations are weighted by the number of households per village. Regression disturbance terms are clustered at the village level. Socioeconomic controls include Average years of education, Proportion Sukuma ethnic group, Proportion households grow cash crops, Households per village / 1000, Proportion practice traditional religions, and Women's community groups per household.