Climate, Conflict and Social Capital in Africa

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Abstract

Aggregate estimates suggest that higher temperatures are associated with increases in violence and conflict in many parts of the world, but multiple studies have suggested that these mean effects obscure enormous heterogeneity. Quantifying and understanding this heterogeneity will be key for determining how future changes in climate might affect conflict, and identifying which policy options are available to moderate these impacts. I explore heterogeneity in the temperature-conflict relationship related to one potential moderating factor: social capital. Using data on trust, associational membership, community activity and contact with local leaders from 2800 grid cells and 680 ethnic group areas in Africa, I show that social capital moderates the climate-conflict link. Places with greater bridging, linking an overall social capital, although not bonding social capital, exhibit a lower likelihood of conflict in their hotter years relative to places with less social capital. The size of this moderating effect is as great as twice the size of the mean effect of temperature on conflict. This association suggests conflict prevention and climate resilience measures should be directed towards low social capital places. If later shown to be causal, these results indicate that enhancing bridging and linking social capital can decrease the likelihood of violence as the climate warms.

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I. Introduction

Global climate change is projected to generate wide-ranging impacts on ecological and human systems, from coral reef and species losses, to agricultural and human health affects (Hoegh-Guldberg et al., 2007; Urban, 2015; Schlenker and Roberts, 2009; Grace et al., 2015; Carleton and Hsiang, 2016). In recent years a robust debate has arisen regarding some of the most dire potential human impacts: violence and civil conflict (Becker, 2013; Buhaug et al., 2014; Carleton et al., 2016). Recent meta-analyses of climate-conflict links suggest a large, causal relationship: that rising temperatures and other climatic extremes will increase interpersonal and inter-group conflict, relative to counter-factual un-warmed worlds (Hsiang et al., 2013; Burke et al., 2015). While the main effects of temperature and precipitation extremes on conflict appear to be positive, they exhibit considerable heterogeneity in their strength, and even direction, across contexts (Theisen et al., 2011; Salehyan and Hendrix, 2014; O'Loughlin et al., 2012; Burke et al., 2009). The effects of climate on conflict are likely to depend on a range of human factors that can provide resilience (or allow vulnerability) to environmental conditions, or staunch the rise of violence when social stability is perturbed (Fetzer, 2014; von Uexkull et al., 2016; Moscona et al., 2018). If warming is increasing the likelihood of violence, understanding the sources of this effect heterogeneity in the climate-conflict relationship will be necessary to mitigating climate change's most hostile effects.

The puzzle motivating this study is suggested by the maps in Figure 1. Each unit is colored according to the direction and strength of the β_1 coefficient from the following regression:

$$Temperature_{it} = \beta_0 + \beta_1 Climate_{it} + \epsilon_{it} \quad (1)$$

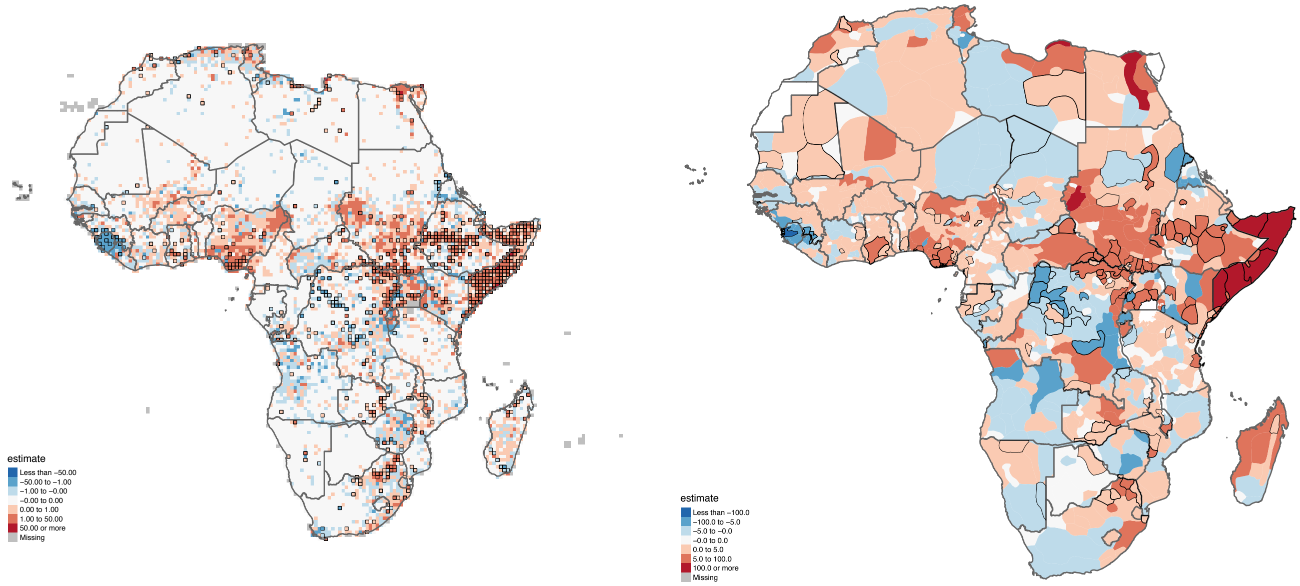
`Conflict` is the number of violent conflict events in a geographic unit of analysis-year and `Temperature` is the mean temperature in the unit-year. Places that have a positive correlation between temperature and number of conflict events are red, while those that show a negative correlation are blue. What factors can explain the different strengths and even directions of the relationships between temperature and conflict in these different locations?

One source of heterogeneity that, where greater, may better support resilience under climate

Figure 1: Climate-Conflict Coefficients - Violent Events on Temperature

(a) 0.5 Deg Grid Cells

(b) Murdock Area - Country Units



For each geographic unit, a regression was run, one unit at a time, of *Viol* on *Mean Annual Temperature* across the 21 years of the dataset. This is an imperfect proxy for, but is meant to be suggestive of, the way that each individual unit affects the regressions run in this study's main analysis (because in regressions, year fixed effects are used to remove the influence of common annual shocks - here no such fixed effects are employed). Reds indicate a positive coefficient on `Mean Temperature`; blues indicate a negative coefficient; darker colors indicate greater magnitude. White or a lack of cells indicates there was no available variation with which to estimate a coefficient (in most cases this implies there were no conflict events in a given unit). Thin black unit area outlines indicate that the individual unit's coefficient was significant at the 0.10 level; thicker black outlines indicate significant at the 0.05 level. Figure 1b uses Murdock ethnic area - Country units; Figure 1a uses 0.5x0.5 degree grid cells.

stress, is the level of social capital: the capabilities embedded in social networks and groups (Vásquez-León, 2009; Adger, 2003). Here, I generate measures of social capital related to interpersonal trust, participation in community associations and activities, and interaction with local leaders, using geolocated survey responses from 35 countries in Africa. Social capital index values are then constructed for each 0.5 by 0.5 degree longitude-latitude grid cell and ethnic group area that contains a survey response. These index values exhibit considerable variation across as well as within countries. As a first step in my analysis, I exploit interannual variation in temperature and geolocated conflict event counts to identify the effect of temperature on conflict. This analysis uses geographic unit and year fixed effects to control for time-invariant unobservables at the unit level and common yearly shocks. To test this paper's main relationship of interest: whether variation in social capital is associated with variation in the strength of this temperature-conflict effect, I then interact temperature with social capital indices and examine the results of this interaction. I find that social capital is associated with a lower (high) temperature to (high) conflict link, suggesting that places with more social capital are less likely to experience conflict during their warmer years compared to places with less social capital.

The paper proceeds as follows. Section II. outlines the motivation, related literature and theoretical framework for the paper. Section III. describes data sources and dataset construction. Section IV. describes the main empirical strategy. Section V. then provides the main results, first the reduced form relationship between temperature and conflict, and second the moderating relationship of social capital. Section VI. then addresses concerns about the consistency of social capital measures over time, the endogeneity of social capital and conflict, and the consistency of social capital's moderating role within as opposed to between countries. Finally, Section VII. considers heterogeneity within the main social capital moderation result, across varying indicators of social capital and conflict event types, and Section VIII. concludes.

II. Motivation & Theory

A. Motivation: Temperature and Conflict

When a possible link between climate change and conflict is discussed in the general public (Oba, 2015), as in much academic work (von Uexkull, 2014; Kelley et al., 2015; Detges, 2017; Linke et al., 2017; Harari and La Ferrara, 2018), the most prominent notion is one of a mechanism through drought and agricultural productivity. When crops fail, people may become more desperate and seek alternative, potentially violent sources of work, become more angry and likely to act violently against their government, feel lower inhibitions against taking land or resources from other communities, or pick up their lives, migrate and add to population pressures that can stress economic opportunity and social fabric in the receiving area, among other possible mechanisms (Fetzer, 2014; Dube and Vargas, 2013; Schilling et al., 2012; Kelley et al., 2015). Certainly, temperature, as a cause of enhanced evapotranspiration, and evaporation in general is one factor in driving drought, and through drought, high temperature may be implicated in climate-related conflict (Schlenker and Roberts, 2009; Kelley et al., 2015). Yet there are additional mechanisms through which temperature may operate, and reasons to consider this particular climatic variable in studies of climate-conflict links.

First, high temperature is consistently and strongly associated with violence and conflict impacts among climatic variables, according to a benchmark meta-analysis by Hsiang et al. (2013). They find that a one-standard deviation "change in the climate towards warmer temperatures or more extreme rainfall increases the frequency of interpersonal violence by 4% and intergroup conflict by 14%" (Hsiang et al., 2013, p 1212).

Second, in addition to the agricultural mechanisms discussed above, links between temperature and conflict can take additional forms. Other economic mechanisms can operate through non-agricultural activities. Though the precise reasons are not clear, general work productivity for individuals and aggregate economic productivity for countries respond negatively to temperature increases (Dell et al., 2012). This applies even for countries and industries not heavily dependent on agriculture. If countries face temperature-related economic downturns at the aggregate level, the same sorts of opportunity-cost and anti-state grievance mechanisms that have been proposed to drive conflict through (potentially drought-related) economic losses would be relevant (Dube and Vargas, 2013; Miguel et al., 2004; Acemoglu and Robinson, 2006).

A separate set of potential mechanisms flow through more direct psychological conditions. Hotter temperatures may leave humans more irritable, less able to sleep, or more prone to impulsive decision-making and erratic behavior (Anderson et al., 2000; Larrick et al., 2011; Obradovich et al., 2017, 2018). Links between temperature and violent crime have been explored extensively and recent work has begun to show a greater role for temperature influences in larger-scale organized violence (Shaver and Bollfrass, 2018; Jacob et al., 2007). In the context of certain sub-state conflicts, such as Mexico's drug war, temperature may play a role through potential physiological mechanisms that exceeds that of precipitation or other combined climatic factor impacts like drought (Baysan et al., 2017).

Finally, motivation for further study of the role of temperature in particular comes from the simple fact that global climate change will increase temperatures on average in most parts of the world for the forseable future. Without additional efforts to restrain greenhouse gas emissions, the Earth's global mean surface temperature is expected to rise 1.4 to 4.8 degrees Celsius above the 1986-2005 baseline (IPCC, 2014b). Even the most rosy scenarios and highest ambitions of the Paris Climate Accords will not mitigate the climate change already baked into the Earth's oceans and atmosphere by 200 years of greenhouse gas emission (Mauritsen and Pincus, 2017; IPCC, 2014a).

To prepare for a warming world, we need to better understand the ways and the conditions under which temperature affects human activities like violence and conflict. If temperature indeed has differential effects on the propensity of conflict in different places, that is, if there is heterogeneity in the effect, then identifying the sources of that heterogeneity will be crucial to future efforts to reduce the likelihood and harm of conflict. Even if there were no average positive effect of temperature on conflict, work to identify where temperature is more strongly and more weakly related to conflict is worthy of further study.

B. Background: Human Factors in Climate-Related Conflict

A collection of recent work explicitly analyzing links between climate and conflict, along with related work on natural resource-associated economic conditions and conflict, has added considerable rigor and nuance to our understanding of the human factors in climate-conflict links. Moscona et al. (2018) argue that social structure can moderate one such link. They suggest that: a) for many conflict outcomes, rainfall deficits are associated with conflict, and b) that these are largely or entirely driven by rainfall deficits occurring in areas inhabited by ethnic groups with a particular "segmentary lineage" social structure. vonUexkull and co-authors show that vulnerability to climate shocks on the one hand, and the lack of political representation on the other can act as important moderators to the effects of drought (von Uexkull, 2014; von Uexkull et al., 2016). Conditional on a major source of expected vulnerability: reliance on rainfed agriculture, they show that more vulnerable areas, particularly those that are especially poor and inhabited by ethnic groups whose representatives are politically excluded, experience more civil conflict. Fetzer (2014) considers the role of national policy: India's NREGA social insurance program. He demonstrates that the rollout of this public employment and wage guarantee seems to break the link between rainfall shocks associated with monsoon conditions and levels of violence by various insurgent groups. Harari and La Ferrara (2018) show, using grid cells as their geographic unit of analysis, that negative shocks to a measure of water availability for crops (SPEI) during a grid cell's main crop's growing season, are associated with increases in conflict outcomes in the given cell. They also demonstrate that these effects spill over to neighboring cells, using spatial econometric techniques. Each of these recent advances adds considerably to our understanding of climate-conflict links, emphasizing the roles of: persistent social structures, careful construction of relevant climate impact measures and detection of geographic spillovers, political exclusion, vulnerability through rainfed agriculture and intervention through public insurance. This study intends to build on these advances by considering the moderating role of social features of communities described as social capital, in the link between temperature and conflict.

C. Theory: Social Capital's Role

The notion of social capital gained considerable prominence in political science following its description in Putnam et al. (1993)'s *Making Democracy Work*. He explains: "...[S]ocial capital...refers to features of social organization, such as trust, norms, and networks that can improve the efficiency of society..." (Putnam et al., 1993, p 167). I view social capital and trust as playing a role that can mitigate climate-violence links through two types of processes. First, social capital could provide resilience to adverse climatic conditions and shocks, making negative impacts that may follow from such conditions, including conflict, less likely. Second, social capital could support the particular sorts of human conditions that restrain or prevent violence when individuals or societies are stressed by their climate.

Additionally, following Woolcock (2001) I disaggregate social capital into three types: "bonding," "bridging" and "linking." He explains: "[bonding] refers to relations between family members, close friends and neighbours...[bridging refers] to more distant friends, associates and colleagues" (Woolcock, 2001, 71-72). And while "bridging" suggests "horizontal" connections, "social capital also has a vertical dimension" described as "linking," which can involve "forging alliances with sympathetic individuals in positions of power" (Woolcock, 2001, 72). Considering social capital in these distinct, while related, forms allows for more clear theorizing about the role it can play in moderating climate-conflict links.

C.*1* Social Capital and Resillience

Social capital may make enduring and recovering from climatic shocks and handling stressors easier. It can, for example, involve the sharing of tools, resources, and labor. It can act as a form of social insurance (often where actual financial insurance mechanisms are expensive or unavailable) that can buffer the community and facilitate its recovery. If a community finds it easier to recover from shocks, then I expect its members will be less desperate and less likely to pursue illegal and violent means to make a living, such as engaging in theft or joining an armed group.

This description is most immediately tied to bonding social capital. My close friends and neighbors can help me out in a pinch by providing a gift or loan to sustain my family or tools, seeds or other supplies to help manage through a particularly challenging year. They can also provide physical work to rebuild, or engage in preventive action against floods. And they can share knowledge about best practices or new opportunities when one member of a close social network becomes aware of them. Yet there are limits to bonding as a resilience mechanism. To the extent that bonding occurs between individuals who are geographically close (which may not be so in the case of family members who move away temporarily or permanently for work, for example), the geographic spread of most climate phenomena will mean that a whole tightly bonded group will be affected simultaneously, making it difficult to smooth out the negative effects of a shock across the group. In addition, unless a member gains access to information or other resources through their external network - that they can then share with the others, the tightly bonded group may not become knowledgeable of such opportunities. High social capital may even engender social stigmas against the kind of external connection and social ladder escalation that would provide such knowledge (Portes, 1998). So, bonding social capital can likely help buffer against smaller scale climatic conditions, but may struggle to fully support people under considerable stress.

Bridging social capital can help to fill some of these deficiencies. Connecting with individuals further out in one's social network can provide the kind of information about expected weather, work opportunities, agricultural best practices and extension services, or resilient seeds that could benefit an individual facing a (potential) climatic shock. Bridging also occurs through participating in community meetings and organizations, and these sorts of activities can directly facilitate broader-level collective action (McCarthy and Kilic, 2015). Consistent meetings and persistent organizations can help individuals to come together to take on tasks as a group. These can first involve both direct action to fix a problem - such as providing labor or funds towards digging a well or a trench to improve water access or mitigate floods. They can also facilitate collective force to lobby for support from those in power or with means. In this way, bridging social capital (as well as particularly strong and outward-oriented bonding social capital) can bolster the third type: linking.

Connections between people in a community and their local leaders can bring to the community the informational and financial resources they need to better address climate-related challenges. Infrastructure like roads, dams, wells and irrigation equipment can most easily be acquired through the help or facilitation of local leaders. These leaders can provide resources over which they hold sway themselves, or lobby on behalf of their constituents for access to resources from a higher level of government or an NGO. High levels of linking capital can also go the other way: leaders can more easily generate support from their communities to act collectively to solve local problems or advocate for resources from outside. In either direction, linking social capital can help provide a community with the kinds of material and informational resources that can help them prepare for and bounce back from adverse climatic conditions.

Completing the circle of links between social capital types, the concern with collective action to solve local problems or advocate for support, returns our attention to bonding social capital. Where collective action often suffers from free-rider problems (Olson, 1965), bonding can enhance the monitoring and sanctioning capabilities of community members, leading to more collective action capacity. All three types of social capital can work together to jointly produce resilient outcomes, but where climatic shocks tend to affect large geographic areas simultaneously, I expect linking, along with the kind of bridging activities that support linking to play a particularly strong role in providing resilience through access to outside resources.

C.2 Social Capital and Violence Suppression

Sometimes relatively small actions, mistakes or alterations to beliefs can trigger tipping processes that shift a generally stable and peaceful equilibrium into a kind of breakdown, or a violent passage to a new equilibrium (Kuran, 1989; Acemoglu and Robinson, 2006; Fearon and Laitin, 1996). The Earth's atmospheric system is nothing if not a generator of stochastic shocks that can bring storms, floods, heat waves, dangerous winds and greater propensity for and acceleration of fires. At the same time, higher temperatures (potentially coupled with greater humidity) can affects individuals' moods in ways that can lead to more mistakes or intentional aggression, which can subsequently increase the propensity for additional violence (Kenrick and MacFarlane, 1986; Larrick et al., 2011). Features of social capital can play important roles in moderating the level of violence that can arise in these instances

As just noted, bonding social capital supports monitoring and sanctioning capabilities within the bonded in-group. Fearon and Laitin (1996) show how in the case of ethnic groups, "in-group policing," facilitated by this social capital, can cauterize inter-group violence. If higher temperatures increase the probability of "noise" in inter-ethnic relations: aggressive or harmful actions towards others, this sort of social capital can limit the damage. In-group members with higher social capital are more knowledgeable of one another, and can better identify members who are likely to (or identify those who have) act(ed) aggressively towards an outgroup. So, fearing a spiral of inter-group violence, they can visibly police their own in order to maintain peace.

Next, bridging across groups, ethnic, religious or otherwise, can directly offer opportunities to quell tensions. Varshney (2001, 363) argues: "Because they build bridges and manage tensions, inter- ethnic networks are agents of peace, but if communities are organized only along intraethnic lines and the interconnections with other communities are very weak or even nonexistent, then ethnic violence is quite likely." He notes that though general social interaction (visiting one another's families, participating together in celebrations) helps, persistent community organizations and associations, are especially robust to the spread of inter-ethnic violence. These can even limit the precursors to violence, by restraining the degree to which political entrepreneurs heighten-inter-ethnic tension (Varshney, 2001). Moreover, bridging can increase the degree to which individuals know (about) one another, which can facilitate successful targeted responses to aggressive slights. Finally, the more bridging supports in generating mutually beneficial social relations and economic ties across groups, the greater the costs of tension and violence if and when they arise.

Third, linking can support violence suppression in two important ways. First, leaders can act to resolve disputes between those within their purview and second, they can bargain over issues with leaders of other communities. Regarding the first capability, greater connection and trust between the leaders and the led can make the dispute-resolution process more credible and likely to hold (Turner et al., 2012). Disputes within a community can be more easily resolved if there is contact with and trust of, and thereby a feeling of legitimacy about, leaders of the community. This sort of condition can operate at a higher level of organization as well: a more regional leader can, if there is strong linking capital to more local leaders and groups, help to resolve tensions between them. Second, well-linked leaders can more credibly and successfully bargain on behalf of their communities, with other communities. The prevention and resolution conflict relies heavily on credible bargaining processes (Fearon, 1995; Walter, 1997). If individuals and community actors are well connected with leaders and trust those leaders to bargain on their behalf, they are more likely to then stick with the bargain that is struck. If there are multiple potential leaders, or multiple community actors with disparate agendas who may act of their own accord, spoiling potential compromises, then bargains made by leaders will be less credible and less likely to prevent or limit conflict (Kydd and Walter, 2006). Vertical links also go the other way: if leaders are well connected to and can police their own communities, they can more successfully enforce the terms of a bargain, once struck.

Finally, these three types of social capital can bolster one another in violence suppression. If leaders are to credibly bargain with opposing leaders or with outside armed actors to maintain peace for their communities (Kaplan, 2017), bonding capital between their community members will facilitate in-group policing and respect for the bargains struck. Bridging capital can provide community members and leaders with alternative pathways through which to interact and negotiate with members of other communities, which can allow for such negotiations to proceed. At the same time, bridging capital can generally increase the value of intergroup interaction, and thereby increase the cost of breakdown, supporting the maintenance of peace.

In sum, social capital can provide resilience to climatic conditions more broadly, or resilience to violence than can follow from those conditions in particular. The ability to distinguish between these two pathways will be a valuable pursuit for future work. While this study will not be able to explicitly distinguish between the two, it will help to demonstrate the role social capital plays in the temperature conflict relationship, through either pathway.

C.*3* Hypotheses

First, following the general point that forms of social capital provide buffering against climate shocks and/or against the particular threat of violence, I expect to find less of a climate-conflict relationship where social capital is high.

> **H1**: In places where social capital, across all forms, is greater, high temperature will be less associated with violent conflict.

Next, the above discussion assigns particular importance to linking social capital. From a climate resilience perspective, linking capital helps to overcome the challenge of the simultaneous and geographically distributed impact of climate shocks, which limit the efficacy of geographically constrained binding capital. Moreover, linking provides the easiest access to large-scale resources - as local leaders can interface with higher level government units and facilitate access to NGOs. These sorts of links can lead to the provision of public goods that support both preventative climate resilience (wells, roads, seeds), and the responsive provision of aid to support recovery in the face of major shocks to food security or livelihoods. From a violence suppression perspective, linking - by connecting people and their leaders and fomenting their mutual trust - supports an important component that bonding and bridging on their own would struggle to provide: leader legitimacy. Where individuals and communities are willing to abide by leaders' arbitration decisions and conform to (or inform) bargaining processes, those violent-suppressing actions are more likely to stick.

> **H2**: Among the various types, linking social capital will most strongly reduce the temperature - conflict relationship

III. Data

A. Geographic Units of Analysis

For this study, I focus on two geographic levels of aggregation. The first is the grid-cell (hereafter "`GID`"). I use 0.5° x 0.5° latitude-longitude cells taken from the PRIO-GRID framework that allows for easy merging with variables from the PRIO-GRID 2.0 dataset (Foro Tollefsen et al., 2012).[1] The continent of Africa includes 10671 such units.

Then, following its use by Nunn and Wantchekon (2011), Michalopoulos and Papaioannou (2013) and others, I use polygons of ethnic group homeland areas from the "Tribal Map of Africa" by George Murdock" (Murdock, 1959), digitized by Nathan Nunn.[2] In order to employ country-level controls and fixed effects, and more sensibly match units to Afrobarometer data (which are gathered in specific countries), I follow Michalopoulos and Papaioannou (2013) in splitting the ethnic area units where they intersect contemporary country boundaries to generate "Ethnic Area - Country" units (abbreviated "`MK-ST`" for "Murdock-State"). This generates a total of 1303 units of analysis.

B. Climate

I follow the suggestion of (Schultz and Mankin, 2018) and employ temperature data from Berkeley Earth (hereafter BEST). The sparse coverage by weather stations in Sub-Saharan Africa magnifies the limitations in the re-analysis and modeling processes of other commonly used climate datasets, such as those from Climatic Research Unit (CRU) of the University of East Anglia and the University of Delaware (Matsuura and Willmott, 2015; Harris et al., 2014). The BEST data

[1] http://grid.prio.org/

[2] https://worldmap.harvard.edu/data/geonode:Murdock_EA_2011_vkZ

provides a raster[3] in NetCDF format in a 1° by 1° latitude-longitude grid of monthly average temperatures, whose values can be aggregated with zonal statistics for any given set of polygons (see Subsection A. below). I aggregate the monthly temperature values to mean annual temperature values, before finding the annual mean for any given geographic unit.

C. Conflict

Conflict data comes from the Armed Conflict Location and Event Data Project (ACLED) Version 7, which provides data on 49 African countries for the years 1997-2016 (Raleigh et al., 2010).[4] ACLED provides the geolocation and date of "events" that can be of the following types: 1) Battle-No change of territory, 2) Battle-Non-state actor overtakes territory, 3) Battle-Government regains territory, 4) Headquarters or base established, 5) Strategic development, 6) Riots/Protests, 7) Violence against civilians, 8) Non-violent transfer of territory, and 9) Remote violence. My main outcome variable of interest is "All Violent Events," which I construct from the ACLED categories involving violent events (as opposed to non-violent sorts of conflict-related events).

ACLED describes "Protests" as "Events involving individuals and groups who peacefully demonstrate..." and "Riots" as "Spontaneous acts of violence by disorganised groups..." (ACLED, 2017, 11). I therefore consider riots to be part of "All Violent Events" and protests not to be. In order to split the Riots/Protests category, I use the actor classification, assigning "Riots/Protests" events in which one actor is denoted as a "Rioter" to a standalone "Riots" category and those with an actor dentoed as"Protestor" to a standalone "Protests" catetory. In between cases that include both actor types are assigned to "Riots." Following this, "All Violent Events" (abbreviated `Viol`) includes categories: 1,2,3,6 - Rioters, 7 and 9.

This leaves me with the following categories, which include the above listed types of events: "All Violent Events" (1,2,3,6 - Riots, 7,9); "Organized Violence" (1,2,3,7,9); "Disorganized Activity" a.k.a. "Riots & Protests" (6); "Battles" (1,2,3); "Violence Against Civilians" (7); "Riots" (6 - Rioters); and "Protests" (6 - Protesters)

[3] a data structure in which geographic space is divided into rectangular grid cells and each grid cell contains a value or vector of values: in this case, monthly mean temperature values

[4] http://www.acleddata.com/data/acled-version-7-1997-2016/

D. Social Capital

My data for measuring social capital come from the Afrobarometer, a collection of surveys conducted in a variety of African countries in six separate rounds. Information on available surveys by country and round is presented in Table 1.

Table 1: Countries included in the Afrobarometer by Round

Round	Years	# of Countries	Countries Added
1	1999-2001	12	Botswana, Ghana, Lesotho, Malawi, Mali, Namibia, Nigeria, South Africa, Tanzania, Uganda, Zambia, Zimbabwe
2	2002-2004	16	Cape Verde, Kenya, Mozambique, Senegal
3	2005-2006	18	Benin, Madagascar
4	2008-2010	20	Burkina Faso, Liberia
5	2011-2013	34	Algeria, Burundi, Cameroon, Cote dIvoire, Egypt, Guinea, Mauritius, Morocco, Niger, Sierra Leone, Sudan, Swaziland, Togo, Tunisia
6	2015-2015	36	Gabon, Sao Tome

All countries listed that were included in a given round were also included in all subsequent rounds (so, e.g., Botswana is sampled six times from the first through sixth rounds). The Afrobarometer utilizes consistent instruction practices for enumerators and asks the same questions across countries within rounds, in local languages. To a degree, questions are asked repeatedly across rounds with no or very little variation in their wording. Different respondents are surveyed in each round, so the data is not longitudinal on an individual level, but it may be considered so at the national scale (a repeated cross-section). Survey responses have been geocoded through a partnership between the Afrobarometer and AIDDATA (BenYishay et al., 2017), and can be mapped using longitude and latitude coordinates.

I construct one general and three specific indices of social capital (one for each type) from questions asked in up to five rounds: two through six. I drop round one because the question text and answer choices are not consistent across countries, and they differ more starkly from the texts of later round's questions. The questions used in each index, including the question and answer text, the rounds in which the questions were asked, the specific question numbers from the Afrobarometer codebooks, and any recoding of the answer choices I performed are detailed in Table 2 below.

Table 2: Social Capital Index Details

Index Name	Index Abbrev.	Variable Label	Question Abbreviation	Rounds Used	Question Number	Shared Text	Text in Blank	Original Values	Recoding
Bonding	Bond_ind	Trust relatives	TruRel	3,4,5	Q84A, Q84A, Q88A	How much do you trust each of the following types of people: ___?	Your relatives?	0=Not at all, 1=Just a little, 2=I trust them somewhat, 3=I trust them a lot, 9=Don't know, 98/998=Refused to answer, -1=Missing	9, 998, -1 = NA
		Trust neighbors	TruNei	3,5	Q84B, Q88B		Your neighbors?		
		Trust other people you know	TruOthKnow	4,5	Q84B, Q88C		Other people you know?		
Bridging	Bridge_ind	Member of community development association	MemComDevAssc	2,3	Q24D, Q28D	Let's turn to your role in the community. Now I am going to read out a list of groups that people join or attend. For each one, could you tell me whether you are an official leader, an active member, an inactive member, or not a member: ___?	A community development or self-help association?	0=Not a Member, 1=Inactive Member, 2=Active Member, 3=Official Leader, 9=Don't Know, 98/998=Refused to Answer, -1=Missing Data	1 = 0; 2,3 = 1; 9,98/998,-1 = NA
		Member of voluntary association or community group	MemComDevAssc	4,5,6	Q22B, Q25B, Q19B		Some other voluntary association or community group?		
		Attend a community meeting	ComMeet	2,3,4,5,6	Q25B, Q31A, Q23A, Q26A, Q20A	Here is a list of actions that people sometimes take as citizens. For each of these, please tell me whether you, personally, have done any of these things during the past year. If not, would you do this if you had the chance: ___?	Attend a community meeting	0=No, would never do this, 1=No, but would do if had the chance, 2=Yes, once or twice, 3=Yes, several times, 4=Yes, often, 9=Don't Know, 98/998=Refused to Answer, -1=Missing Data	1 = 0; 2 = 1; 3 = 2; 4 = 3; 9,98/998,-1 = NA
		Join others to raise an issue	JoinRaise	2,3,4,5,6	Q25C, Q31B, Q23B, Q26B, Q20B		Got together with others to raise an issue		
Linking	Link_ind	Trust your [elected] local [government] council/body	TruLGov	2,3,4,5,6	Q43E, Q55D, Q49D, Q59E, Q52E	How much do you trust each of the following, or haven't you heard enough about them to say: ___?	Your [Elected] Local/ Metropolitan/ Municipal/ District Government Body/ Council/ Assembly?	0=Not at all, 1=A little bit/Just a little, 2=A lot/Somewhat, 3=A very great deal/A lot, 9=Don't Know/Haven't Heard Enough, 98/998=Refused to Answer, -1=Missing Data	9, 98/998, -1 = NA
		Trust traditional leaders	TruTrad	2,4,6	Q43K, Q49I, Q52K		Traditional Leaders [/ Chiefs/ Elders]		
		Contact local government representative/ councilor	ContLGov	2,3,4,5,6	Q29A, Q32A, Q25A, Q30A, Q24A	During the past year, how often have you contacted any of the following persons for help to solve a problem or to give them your views: ___?	A Local Government Representative/ councilor?	0=Never, 1=Only once, 2=A few times, 3=Often, 9=Don't Know, 98/998=Refused to Answer, -1=Missing Data	9, 98/998, -1 = NA
		Contact traditional ruler/ leaders	ContTrad	2,3,4,6	Q29F, Q32F, Q27B, Q24E		A traditional ruler/Traditional Leaders		

I measure bonding social capital with three measures on trust in acquaintances: relatives, neighbors and "Other people you know." Though I have no measure of the actual level of interaction with acquaintances, questions about trust serve as a proxy for level of contact and provide additional information about the respondents' sense of the positive valence of such interactions. My measures of bridging social capital involve individuals' membership in community associations and participation in collective activities like community meetings and "joining others to raise an issue." While it is possible that in a small community, organizations and meetings capture the same sort of social capital, that is, the same sorts of people interact, as my bonding measures, the more persistent and formalized activities of associations and community meetings allow for a different and broader set of individuals to come together. Finally, the linking index is composed of trust in and contact with local government leaders and traditional leaders. This clearly captures information about the degree to which respondents are in contact, in a way that yields a positive valence, with leadership, in a vertical direction.

Admittedly, measures like community meetings and joining others to raise an issue may additionally measure a kind of linking. Meetings may be run by or involve leaders and joining to raise an issue typically involves raising that issue with individuals in some sort of leadership position. Acemoglu et al. (2014) contend that even associations are likely captured by leadership in the case of Sierra Leone, so these too may additionally represent linking. However, these measures, at a minimum, capture actions taken by individuals on a horizontal basis, and so represent proxies for bridging capital, if they may also capture an element of linking. In the final section (VII.B.) I consider the questions that compose the indices on an individual basis which will allow us to gain insights into the particular role they may play as temperature-conflict moderators.

Each of the first three indices are constructed by scaling the responses to each individual question (subtracting the mean and dividing by the standard deviation) and then taking the mean across questions for each unit of analysis. A unit only has an index reported (rather than an `NA`) if it contains a response on each of the component questions, across any of the survey rounds (so, for example, units where the question of trust in local government was asked but trust in traditional leaders was *never* asked, that unit is assigned a missing value for the linking index).[5] This leads to the inclusion of fewer units but more consistency in the type of questions included in the index, when any index value was reported. Along the same lines, for units of analysis that include a response to *every* question (or combined question), I construct an aggregate social capital index using a principal components analysis, after each individual question is scaled, as described above. The first principal component in this analysis generates what I refer to as the "Full PC1" index.

E. Summary Statistics

Summary statistics of the major climate, conflict, and social capital variables, along with the most consistently used controls are shown in Tables 3 and 4 below.

[5] There is one exception. The questions on membership in community development organizations (Rds 2-3) and membership in associations (Rds 4-6) I consider to represent the same question across all 5 rounds, despite the small difference in question text. As such, that combined question: membership in community development organizations *or* associations has coverage across all 5 rounds used.

Table 3: 0.5 Degree Grid-Cell Unit Summary Statistics

Value	Mean	Sd	Min	Median	Max	Nonzero	Has Value/ Variance
				Temperature			
Mean Temp	24.82	3.45	11.25	25.04	31.88	1.000	1.000
				Conflict			
Viol	0.54	7.33	0.00	0.00	1077.00	0.087	0.403
Battles	0.22	3.86	0.00	0.00	701.00	0.047	0.290
Viol Against Civ	0.21	2.60	0.00	0.00	405.00	0.052	0.307
Remote Violence	0.05	1.38	0.00	0.00	184.00	0.011	0.099
Riots	0.07	1.13	0.00	0.00	232.00	0.024	0.169
Protests	0.13	2.04	0.00	0.00	531.00	0.030	0.188
				Transformations of Main Conflict Variable			
Viol Binary	0.09	0.28	0.00	0.00	1.00	0.087	0.401
Viol Inv. Hyp. Sine	0.15	0.57	0.00	0.00	7.68	0.087	0.403
Viol log(x + 0.1)	-2.01	0.98	-2.30	-2.30	6.98	0.087	0.403
				Social Capital (Time Invariant)			
Soc. Cap. All, PC1	0.00	1.00	-2.85	0.01	3.01	0.504	0.155
Bonding Index	-0.00	0.85	-3.88	0.03	2.34	0.517	0.187
Bridging Index	-0.00	0.83	-1.94	0.04	3.87	0.518	0.266
Linking Index	-0.00	0.69	-2.05	0.04	2.80	0.524	0.224
				Basic Controls (Time Invariant)			
Area	3098.00	0.00	3098.00	3098.00	3098.00	1.000	1.000
Population	89492.57	297750.80	0.00	18860.69	15010587.00	0.967	1.000

Notes: The final two columns provide information on the data coverage. "Nonzero" indicates the proportion of unit-years that include non-zero data. For conflict events, this indicates how many unit-years in the dataset included an event: $\frac{unit-years\, with\, an\, event}{all\, unit-years}$. For social capital values, this measure is less meaningful. The "has value/variance" column indicates the proportion of geographic units for where there is variation or data with which to estimate an effect. For *conflict events*, this indicates how many of the *units* have *any* variation: $\frac{units\, with\, variation\, in\, an\, event\, type}{all\, units}$. Some units have *no variance*, usually because they have *zero* events or fatalities of a given type across all 21 years of data. For social capital variables, this column indicates the proportion of *all possible units* that include any survey responses in the Afrobarometer for a given index.

IV. Empirical Framework

A. Reduced Form

Following the strong suggestion of Hsiang et al. (2013), I primarily employ regressions of conflict variables on climate variables with time and geographic unit (two-way) fixed effects. This controls for time-invariant characteristics of geographic units and for common yearly shocks. Intuitively, this approach tests whether higher temperature years in a given location are associated with more or less conflict, and removes concerns about all potential time-invariant confounders. Because relatively higher or lower temperatures in a given location is randomly assigned year to year by the Earth's climate system (although as a general trend, temperature is increasing, which will be

Table 4: Ethnic Area-Country Pair Unit Summary Statistics

Value	Mean	Sd	Min	Median	Max	Nonzero	Has Value/ Variance
				Temperature			
Mean Temp	25.24	3.10	12.43	25.69	31.23	1.000	1.000
				Conflict			
Viol	4.29	32.57	0.00	0.00	1712.00	0.289	0.757
Battles	1.73	16.94	0.00	0.00	1145.00	0.177	0.642
Viol Against Civ	1.66	12.56	0.00	0.00	720.00	0.198	0.669
Remote Violence	0.35	5.49	0.00	0.00	374.00	0.047	0.297
Riots	0.55	6.10	0.00	0.00	629.00	0.106	0.479
Protests	0.98	9.67	0.00	0.00	986.00	0.119	0.491
				Transformations of Main Conflict Variable			
Viol Binary	0.29	0.45	0.00	0.00	1.00	0.289	0.725
Viol Inv. Hyp. Sine	0.63	1.21	0.00	0.00	8.14	0.289	0.757
Viol log(x + 0.1)	-1.21	1.85	-2.30	-2.30	7.45	0.289	0.757
				Social Capital (Time Invariant)			
Soc. Cap. All, PC1	0.00	1.00	-2.73	0.08	2.83	0.522	0.404
Bonding Index	-0.00	0.85	-3.21	0.01	2.04	0.505	0.439
Bridging Index	0.00	0.84	-2.41	0.01	3.07	0.510	0.523
Linking Index	-0.00	0.68	-2.19	0.05	2.62	0.526	0.482
				Basic Controls (Time Invariant)			
Area	23971.32	46861.65	1.00	8134.00	542509.00	1.000	1.000
Population	703955.57	2333332.07	0.00	191542.21	63912229.92	0.999	1.000

Notes: The final two columns provide information on the data coverage. "Nonzero" indicates the proportion of unit-years that include non-zero data. For conflict events, this indicates how many unit-years in the dataset included an event: $\frac{unit-years\,with\,an\,event}{all\,unit-years}$. For social capital values, this measure is less meaningful. The "has value/variance" column indicates the proportion of geographic units for where there is variation or data with which to estimate an effect. For *conflict events*, this indicates how many of the *units* have *any* variation: $\frac{units\,with\,variation\,in\,an\,event\,type}{all\,units}$. Some units have *no variance*, usually because they have *zero* events or fatalities of a given type across all 21 years of data. For social capital variables, this column indicates the proportion of *all possible units* that include any survey responses in the Afrobarometer for a given index.

picked up in year fixed effects), the remaining variation in temperature in a given geographic area is exogenous. As such, we can consider the reduced-form relationship of temperature on conflict, if one exists, to be causal.

For the initial reduced form regressions I employ the following specification,

$$Conflict_{it} = \beta_1 Temp_{it} + \mu_i + \gamma_t + \epsilon_{it} \tag{2}$$

In this equation, i is the geographic unit of analysis, an t is the year. $Conflict_{it}$ is the number of conflict events of a particular type or aggregate category, in a given geographic unit and year. $Temp_{it}$ is the mean annual temperature of that unit-year. μ_i is the set of geographic-unit fixed effects; γ_t is the set of year fixed-effects. ϵ_{it} is the error term by geographic unit and year. The coefficient of interest is β_1 in Equation 2, the effect of temperature on conflict.

B. Interaction with Social Capital

When the a social capital variable is then included, Equation 3 is used:

$$Conflict_{it} = \beta_1 Temp_{it} + \beta_2 SocCap_i \times Temp_{it} + \mu_i + \gamma_t + \epsilon_{it} \tag{3}$$

where $SocCap_i$ is the social capital index value in a given geographic unit. Readers will note that there is no standalone $SocCap$ variable in the equation. That is because, as a time-invariant feature of the geographic unit, the non-interacted version of social capital is absorbed in the geographic-unit fixed effect. In effect, this allows us to explore the heterogeneity in the climate-conflict link, comparing areas of lower and higher levels of social capital. The coefficient of interest is β_2 in Equation 3, when considering the degree to which social capital moderates the temperature-conflict link.

C. Added Controls and Fixed Effects

Finally, in considering whether social capital has a causal moderating effect on $\frac{\partial Conflict}{\partial Temp}$ beyond its statistical association, various additional controls and fixed effects are added.

First, in a fairly stringent test, I control for common features of a region or country that may themselves affect the temperature-conflict relationship using Equation 4

$$Conflict_{it} = \beta_1 Temp_{it} + \beta_2 SocCap_i \times Temp_{it} + \beta_3 \Omega_i \times Temp_{it} + \mu_i + \gamma_t + \epsilon_{it} \tag{4}$$

Here, Ω_i is a set of larger scale geographic unit fixed effects of one of the following types: a) indicators for each region (of five: North, South, East, West and Central Africa) or b) indicators for each country.[6] This restricts the variation in the moderating effect of social capital to *only* within-region or within-country differences in the social capital measure, while controlling for any

[6] Countries are explicitly identified with `MK-ST` units but not with `GID` units, which can intersect with more than one country. I follow a consistent algorithm for assigning grid cells one-to-one to single countries. Details of this assignment process are available upon request

consistent regional or country-level unobservables. As regions and countries are time-invariant, their standalone terms also drop out of the equation, absorbed by the unit fixed effects.

Next, in an even more stringent test, I employ region-by-year and country-by-year fixed effects, using Equation 5

$$Conflict_{it} = \beta_1 Temp_{it} + \beta_2 SocCap_i \times Temp_{it} + \mu_i + \gamma_t + \beta_3 \Omega_i \times \gamma_t + \epsilon_{it} \tag{5}$$

Here, again, Ω_i is a set of larger scale geographic unit fixed effects, either regions or countries. While the baseline region or country fixed effects are absorbed in the unit fixed effects, relative to Equation 3 this approach additionally controls for unobservables common to the region-year or country-year. While the main year fixed effects control for any common shocks to temperature and conflict across the continent, these additionally control for any common shocks to temperature and conflict within the region or country.

Finally, to test the role of other time-invariant covariates, I employ Equation 6

$$Conflict_{it} = \beta_1 Temp_{it} + \beta_2 SocCap_i \times Temp_{it} + \mathbf{X}_i' \beta_3 \times Temp_{it} + \mu_i + \gamma_t + \epsilon_{it} \tag{6}$$

$\mathbf{X}_i$ is the vector of time-invariant covariates. This allows me to control for other factors of grid cells or ethnic-country areas that may affect the temperature-conflict relationship and that could confound the effect of social capital.

V. Main Results

A. Reduced Form: Temperature affects Conflict

The results in Table 5 employ Equation 2 with a different geographic unit of analysis in each column. In each main regression in this text, unless otherwise specified, standard errors are clustered at the unit of analysis level to address autocorrelation in the panel model. Across these units of different size and shape, the temperature to conflict relationship is substantial. The "1 SD % Change" line of the table indicates that a one standard deviation increase in the

Table 5: Effect of Mean Annual Temperature on All Violent Events for 6 Geographic Unit Types

	Violent Events					
	States	Eth.Areas	Eth-St	Grd 0.5 Deg	Grd 1 Deg	Grd 2 Deg
	(1)	(2)	(3)	(4)	(5)	(6)
Mean Temperature	54.04	3.42**	2.13**	0.11**	0.42*	1.71*
	(41.77)	(1.70)	(1.07)	(0.05)	(0.22)	(0.94)
Baseline Rate	117.99	6.69	4.28	0.54	2.07	7.66
1 SD % Δ, Same	13.5	15.15	14.91	6.82	6.98	7.59
Unit Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Unit of Observation	St-Yr	Mk-Yr	Mk-St-Yr	Gd.5-Yr	Gd1-Yr	Gd2-Yr
Observations	1,008	17,535	27,279	221,760	56,700	15,225
R^2	0.50	0.46	0.46	0.45	0.46	0.47
Adjusted R^2	0.46	0.43	0.43	0.43	0.43	0.44
Residual Std. Error	201.40	30.19	24.13	5.48	12.27	27.66

Notes: Dependent variable is: All Violent Events. Standard errors clustered by geographic unit. Units of observation are as follows: St-Yr = State-Year; Mk-Yr = Murdock Ethnic Area-Year; Mk-St-Yr = Murdock Ethnic Area-State unit-Year; Gd-Yr = Grid Cell-Year, 0.5, 1, and 2 indicate the size of the grid cells: 0.5, 1 and 2 degree of latitude and logitude per side, respectively. "Baseline Rate" is the mean of the dependent variable within the given dataset. "1 SD % Change" is the percent change in the level of the dependent variable associated with a one standard deviation increase in Mean Temperature."Same" indicates temperature measured in the same, contemporaneous year (rather than lagged).

***Significant at the 1 percent level.
**Significant at the 5 percent level.
*Significant at the 10 percent level.

Mean Temperature value induces a 13% increase (the "standardized effect size") in the number of conflict events in country units, though this relationship (for the 48 countries in the sample) is not statistically significant at conventional levels. However, the relationship is statistically significant at the $\alpha = 0.10$ level or smaller for all other unit types. The standardized effect sizes are around 15% for ethnic area and ethnic area-country units, and around 7% for grid cell units of varying size (0.5 degrees, 1 degree and 2 degree). These estimates are in the range of the median estimates from Hsiang et al. (2013)'s benchmark meta-analysis, which found a standarized effect size of 13.6% for intergroup conflict (p8).

Before moving on to explore the role of social capital, I check for the robustness of these reduced form effects to two tests. First, temperature's affect on can the level of violence could manifest in one of two ways: a displacement effect or a net effect (Burke et al., 2015). A displacement effect would indicate that conflict events shifted in time, but that the overal quantity of events did not change. While such displacement may separately be of interest, this study is concerned with changes to the net level of violence. To make this distinction, I employ Equation 7:

$$Conflict_{it} = \beta_1 Temp_{it} + \beta_2 Temp_{it-1} + \mu_i + \gamma_t + \epsilon_{it} \tag{7}$$

If β_1 and β_2 are of opposite sign, this will imply a displacement effect: conflict events that may have occurred later, instead occurred this year due to the temperature increase, but the overall level would not change. This is not what we find in Table A.1. Rather, the coefficient on β_2 is also positive and *even larger*, by about 50-100% than the coefficients on β_1. This suggests the temperature-conflict effect is a net effect, rather than a displacement effect.

Second, the presence of an effect may be an artifact of the form of the dependent variable: a count of the number of conflict events in a unit-year. Table A.2 considers a range of transformations of the dependent variable for the main geographic unit types: 0.5 degree grid cells and ethnic area-country units. Generally, the effect appears robust to the modeling choice of the dependent variable. For grid cells, coefficients remain statistically significant at the same or lower levels. For `MK-ST` units, one transformation, the binary dependent variable, loses significance altogether (Column 7). This is a source of concern and suggests that for those units, the relationship may be dependent on measuring the level of violence, rather than just measuring the presence or lack of violence in a unit-year. However, `MK-ST` units are generally (relative to grid cells) larger and there are many fewer of them, so it may be quite common for them to have at least one riot, battle, or other act of violence in any year, limiting the scope of variation. Outside the one source of concern around the binary outcome measure for ethnic area-country units, the temperature-conflict reduced form relationship appears robust to these two sets of tests.

B. Heterogeneity by location

Having established a reduced form relationship, we now consider heterogeneity in the temperature conflict-link. I consider a more formal test of heterogeneity in this link below (by demonstrating that there are clearly statistically significant moderators of the relationship in Section A.*2*); Figures 1 above and A.1 below provide visual evidence of this. The former, as noted above, reveals a great deal of variation in the raw temperature - conflict association within individual units. Many areas show a correlation between higher temperatures and more conflict events (red units), but many others suggest a negative one (blue units).

Figure A.1 reveals measurements from under the hood of the reduced form regression, Equation 2. Here, before the individual unit regressions are run, unit and year fixed effects are partialled out of the temperature and conflict event measures. Then regressions of the form: $ConflictResid_{it} = \beta_0 + \beta_1 TempResid_{it} + \epsilon_{it}$ are run, where $ConflictResid_{it}$ and $TempResid_{it}$ are the residuals of conflict and temperature after the partialling out. Deeper red colors again indicate large positive coefficients while deeper blues show large negative coefficients. Again there are many in both directions.

If these differences are significant, what sort of social, political, or economic conditions on the ground differentiate places where higher temperatures makes conflict more likely from those where temperature makes conflict less likely?

C. Social Capital Moderation of Temperature-Conflict Link

I argue that features of social capital moderate this temperature-conflict link. The main results in Table 6 support this claim. The coefficients on β_2 from Equation 3 show statistically and substantively significant negative moderation of the temperature-conflict relationship for the Full PC1, Briding and Linking indices, for both types of geographic units. Only the bonding effect, while still negative, is too small and imprecise to be statistically significant. Areas with high social capital experience relatively less conflict when temperature increases, compared to areas with low social capital under similar temperature increases. Compared to the overall standardized effect for 0.5 degree grid cells of around 7%, moving from a grid cell at the 25th percentile of the Full PC1

Table 6: Social Capital Interactions: Main Results

	All Violent Events							
	0.5 Grid Cell Units				Ethnic Area - Country Units			
	Full PC1	Bond	Bridge	Link	Full PC1	Bond	Bridge	Link
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Mean Temperature	−0.19	0.03	−0.05	−0.07	−0.07	0.69	−0.18	0.28
	(0.14)	(0.13)	(0.09)	(0.10)	(0.94)	(1.17)	(0.60)	(0.87)
Mean Temp. x Social Cap.	−0.57***	−0.11	−0.27***	−0.44***	−2.66**	−0.36	−1.95*	−2.31**
	(0.14)	(0.07)	(0.09)	(0.10)	(1.04)	(0.49)	(1.03)	(0.91)
Baseline Rate	1.33	1.17	0.94	1.06	4.86	4.60	4.01	4.23
+1 SD Mean Temp. % Δ:								
At 25th %ile Social Cap.	5.33	2.73	4.58	7.21	12.35	6.06	7.80	13.57
At Mean Social Cap.	-4.55	0.76	-1.82	-2.07	-0.43	4.49	-1.31	1.98
At 75th %ile Social Cap.	-15.18	-1.41	-7.98	-11.13	-13.64	2.81	-11.11	-9.48
Unit Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Unit of Observation	Gd-Yr	Gd-Yr	Gd-Yr	Gd-Yr	Mk-St-Yr	Mk-St-Yr	Mk-St-Yr	Mk-St-Yr
Observations	34,671	41,349	58,863	49,896	11,025	11,949	14,238	13,146
R^2	0.36	0.36	0.36	0.36	0.38	0.38	0.39	0.38

Notes: ***Significant at the 1 percent level.
**Significant at the 5 percent level.
*Significant at the 10 percent level.

index (Column 1, "At 25th %ile Social Cap." row) to one at the 75th (Column 1, "At 75th %ile Social Cap." row) causes a shift of more than 2x the overall effect size. The shifts for Bridging and Linking social capital are more modest, if still substantial. Places with low social capital are generally more dangerous (in terms of violent conflict events) when they experience hotter years, whereas places with high social capital are less dangerous in their hotter years.

Notably, the results in Table 6 support Hypothesis H1: Overall social capital moderates the temperature-conflict link, and is associated with relatively less violence in hotter years. It also offers suggestive evidence of Hypothesis H2: among the types of social capital, the moderating association of linking social capital is the strongest (although it is relatively close to that of bridging).

VI. Robustness Tests and Concerns

Having established the basic relationship of interest, this section considers a suite of robustness tests to address a series of major concerns with the Afrobarometer data and the empirical approach taken here. It first considers some basic checks of outcome variable transformations and linearity of the moderating relationship (which was assumed in the basic linear models employed in Table 6). Next it explores issues with the measurement of social capital and the use of a time-invariant moderator. Then it tackles concerns of endogeneity between conflict and social capital and issues of reverse causality. Finally it begins to consider approaches toward identification, to determine whether social capital moderates with independent causal force, or simply proxies for or is confounded by other factors that differentiate high $\frac{\partial Conflict}{\partial Temp}$ areas from low ones.

A. Basic Checks

A.*1* Dependent Variable Transformations

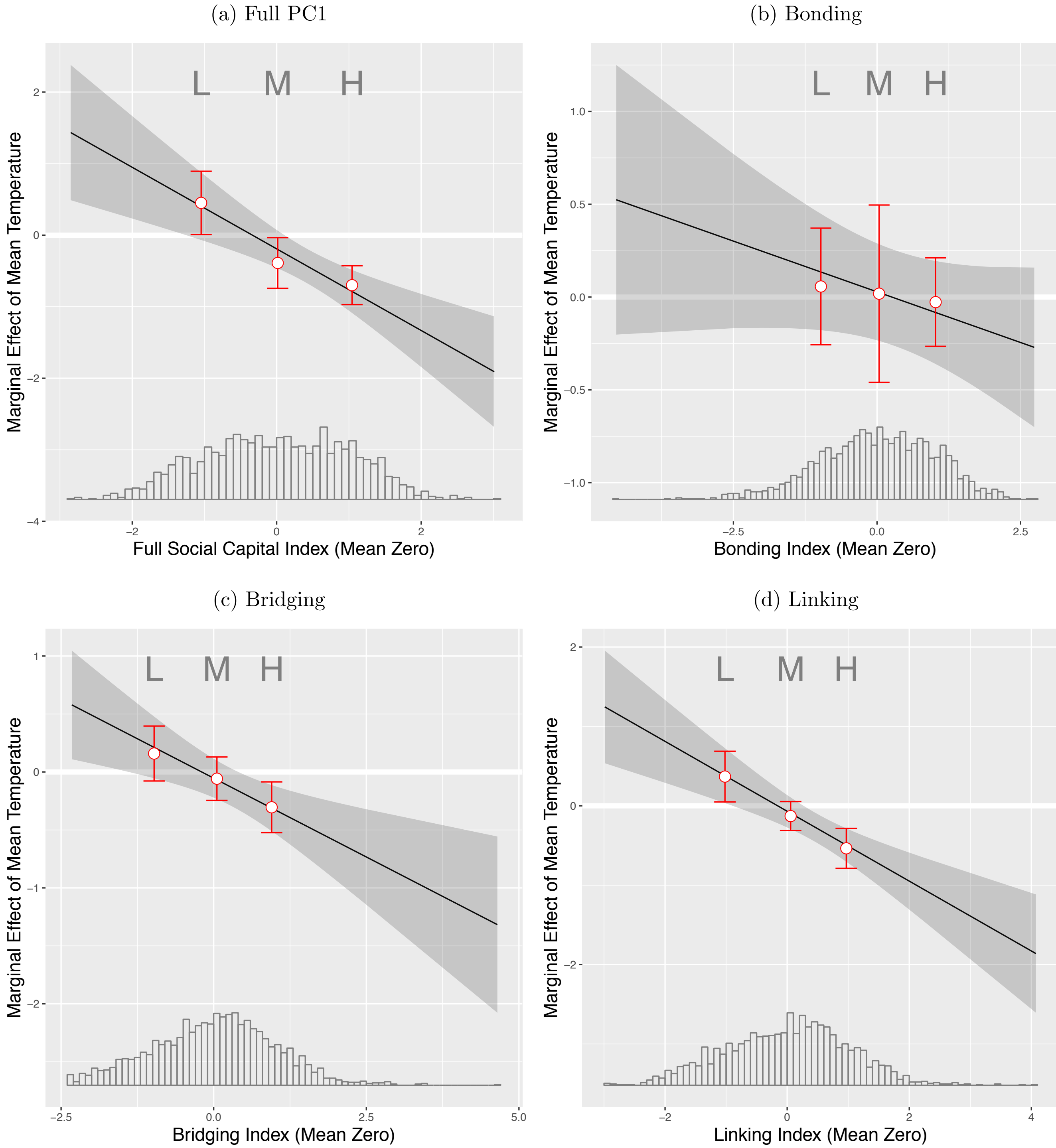
Very briefly, transformations of the dependent variable do not appear to be a source of concern. Tables A.3 and A.4 show the same four sets of regressions as in Table 6, but with different transformations of the outcome variable. In no case does a coefficient that was significant for the count of violent events outcome decrease by a standard level of statistical significance when using a different outcome. The effect sizes, which are challenging to compare due to the different sorts of outcomes also generally appear similar.

A.*2* Linearity and Fragility of the Moderators

Recent work by Hainmueller et al. (2018) addresses the exact modeling structure used here in Equation 3, which they refer to as a "multiplicative interaction model," and suggests a series of best practice steps for working with such models. In particular they note: 1) that such models make a "linear interaction effect assumption" that should be checked and then relaxed, and 2) that papers using such models often suffer from a lack of common support across the range of the moderator. I check my main results models against their tests and find that they consistently pass.

In particular, the results of the Hainmueller et al. (2018) tests indicate that the linear interaction effect assumption is a reasonable assumption in the case of my data, that the distribution of the moderator values is not particularly skewed, and most importantly: values of $\frac{\partial Conflict}{\partial Temp}$ taken from the high and low terciles of the moderator distributions are statistically distinguishable from one another. This essentially adds support to the main results in Table 6: that the climate-conflict link is heterogeneous, that social capital moderates the link and that places with higher levels of social capital have statistically lower $\frac{\partial Conflict}{\partial Temp}$ than places with lower levels of social capital. These results are represented visually in Figures 2 below and A.2 in the Appendix. The formal tests along with more detailed descriptions of the Hainmueller et al. (2018)-recommended approach are in Appendix Section: A.2.

Figure 2: Moderation of Temperature Effect on Number of Violent Events - Grid Cell Units



Conditional marginal effects plots for Grid Cell units. Outcome: number of conflict events; treatment: temperature; moderators: various social capital indices. Y axes show the marginal effect of temperature on conflict, x-axes show the level of the moderators (each of which is set to mean = zero, standard deviation = 1). Black lines show the slope of β_2 across the range of the moderator and grey shaded areas show 95% confidence bands. Histograms at the bottom show the histogram of the moderator across its range. White dots with red whiskers explained in the text

As a final basic check, I explore whether clustering standard errors at a higher level of aggregation removes the statistical significance of the moderator coefficients. Results shown in the Appendix, Section A.*3*, suggest that besides the bridging social capital in grid cell units, the main effects are robust to this change, which I consider to be overly-conservative, but still informative.

B. Measuring Social Capital

I use time-invariant indicators of social capital and assign indicator values to whole grid cells or ethnic area-country units. I rely on the assumptions then, that my measurements are both temporally and spatially representative of those units. That is, they must capture some persistent social features of the place, and the respondents' answers must be reasonably representative of the place broadly speaking.[7] We would be worried to find, for example, that areas that report high percentile social capital in one round report low percentile social capital in the next.

B.*1* Temporal Consistency

There are empirical and theoretical reasons to believe that characteristics of locations like their social capital *do* persist through time and act as consistent features of those places. Considerable literature in economics and political science has demonstrated the persistence of social and cultural features of societies (Nunn, 2008; Fouka and Schlaepfer, 2017; Guiso et al., 2016). Specifically, social capital, and the associated concept of trust, are strong candidates for such persistence (Nunn and Wantchekon, 2011; Putnam et al., 1993; Dell et al., 2018). Such variation may be driven by experience with the Slave Trade in Africa (Nunn and Wantchekon, 2011), historical imperial and local governance structures (Dell et al., 2018; Putnam et al., 1993; Guiso et al., 2016), agro-climatic conditions (Fouka and Schlaepfer, 2017) and other factors. Work summarizing recent attempts to change social capital and collective action capacity, at least in the short term suggests weak or highly contextual effects, if any, of such interventions (Fearon et al., 2015).[8] Theoretically, this persistence may be transmitted through one or both of at least two channels: within people and their communities (through norms held and passed on from parents to children) (Fouka and

[7] or at least not mis-representative in a way that can bias results

[8] which may make the policy implications of this study more limited but lends credence to the measurement strategy used here.

Schlaepfer, 2017; Nunn and Wantchekon, 2011) or through political and economic institutions and their effects (Putnam et al., 1993; Guiso et al., 2016; Dell et al., 2018; Nunn and Wantchekon, 2011). These past results all provide strong evidence that there is a *latent* level of social capital that varies cross-sectionally and that I can exploit to explore heterogeneity in $\frac{\partial Conflict}{\partial Temp}$. My empirical tests below support the notion that there are persistent differences in the *measured* levels of social capital across places, and that this yields results that are independent of *when* social capital was measured.

First, I consider the correlation in measured social capital across rounds of the survey for each specific index.[9] I measure bonding in rounds 3,4 and 5; bridging in 2,3,4,5 and 6 and linking in 2,4, and 6. For bridging and linking all of the questions are asked in all of those rounds, so the composition remains consistent [10]. For bonding the composition changes somewhat between rounds. The composite index for round 3 includes: TruRel and TruNei ; for round 4: TruRel and TruKnow; and for round 5: all three (these abbreviations are identified in Table 2).

For each permutation of pairs of available rounds, I explore the correlation between all units of analysis that were sampled in both those two rounds in Figure A.4. The correlation coefficients range from 0.26 to 0.57 and all are statistically significant at the 0.01 level. This provides an initial indication that my social capital measurements are picking up persistent differences across places.

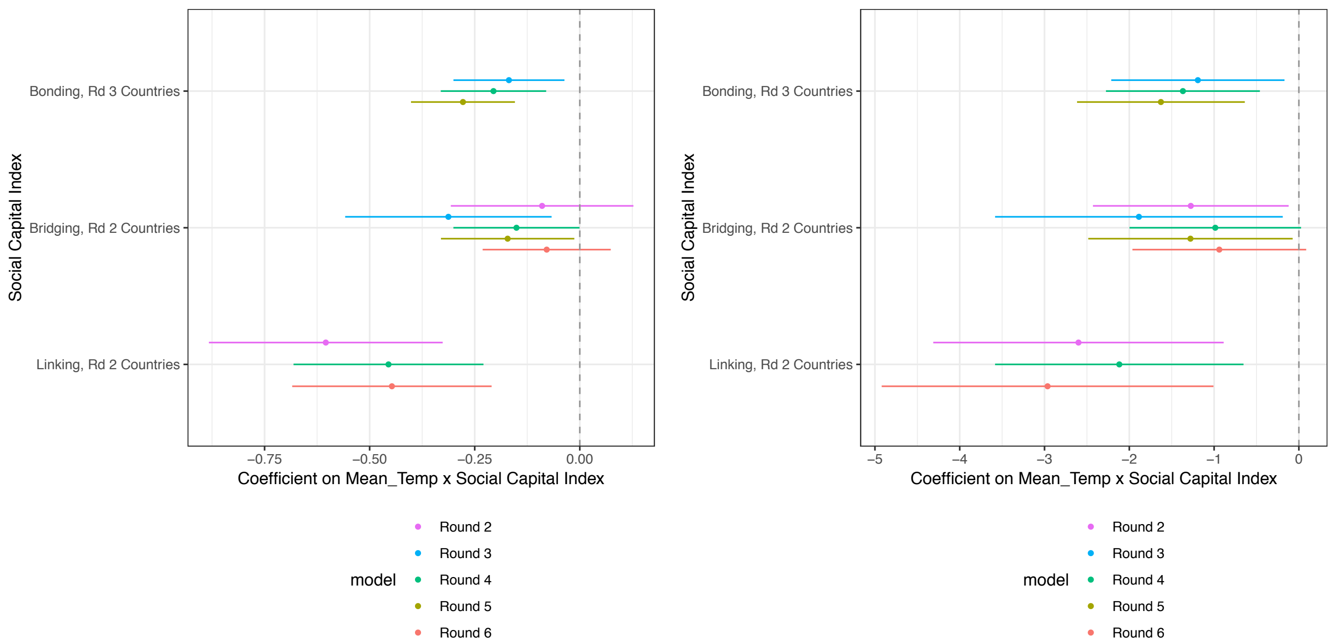
Next, I consider whether the actual measured interaction coefficients (β_2 in Equation 3) are robust to the choice of round in which the index was measured. Because the composition of countries varies across rounds, and this compositional change could change the coefficients, I subset the data to countries that were measured across all rounds for any given index. The results are shown in Table 3. With one exception, all coefficient pairs are statistically indistinguishable from one another for any given index and qualitative results are largely the same. The one worrying coefficient is that on bridging social capital in Round 3, which is clearly distinguishable from coefficients from many of the other rounds. This one concern suggests a need for further

[9]Here I'm unable to measure the Full PC1 index over time because the 11 component questions were not asked consistently across rounds

[10]except for the fact that the question on membership in community groups varies between rounds 2 & 3 and rounds 4,5, and 6

Figure 3: Consistency of Coefficients Across Rounds in the Same Sample of Countries

(a) Grid Cell Units (b) Ethnic Area-State Units



Dot/whiskers plot β_2 coeffients in Equation 3. Colors indicate different models. Each model was run with a different social capital index where the measurements that composed the index were drawn from the round indicated by the color of the dot/whisker. Bonding social capital indices were subset to only countries included in Round 3 of the Afrobarometer. Bridging and Linking social capital indices were subset to only countries included in Round 2

exploration, but the bulk of these results support the notion that social capital is being consistently measured and that the overall results are robust to round-to-round mis-measurement of the latent cross-sectional differences in social capital.

B.2 Area Representativeness

Besides temporal consistency, by gathering climate and conflict data to certain, occasionally quite large geographic units, we are relying on using opinions and stated practices of a very small number of respondents to represent the social capital characteristics of whole areas.[11] If measured social capital values are characteristics of places, then those places themselves ought to be able to predict variance in the social capital measures. I test how much of the variance in the responses to the

[11] In future work I need to more formally test how the results change if I drop units with particularly low response rates. Robustness checks of minimum response rates for individual index component questions suggests that coefficients are more strongly negative when the smallest respondent number units are dropped. These are available upon request.

questions that that compose my indices[12] can be explained by the unit of analysis fixed effects. I then compare those R^2 values to the amount explained by other characteristics of the individual respondents and their immediate surrounding areas. When I regress responses to specific questions by individuals within given rounds on unit of analysis fixed effects, I find R^2 values ranging from 15% to 24% for grid cell units and 10% to 19% for ethnic area-country units (which are much larger on average, Tables A.6 and A.7). So, a substantial portion of the variance in responses to the relevant questions, in given rounds, can be explained just by where the respondents are located.

I then compare these levels of variance explained to what can be explained by other factors from the Afrobarometer surveys. I group these other factors into 7 categories: demographic characteristics of the individual; economic proxies for their household; educational and occupational characteristics of the individual; security conditions in their enumeration area (measured by enumerators); development level proxies and public goods conditions in their enumeration area (measured by enumerators); whether they were sampled in an urban or rural enumeration area; and the country in which they reside. I then regress the same index component question responses on the fixed effects *and* these other factors, adding the additional factors incrementally for each subsequent regression.[13] Of the total variance explained (R^2) in these regressions (excluding those employing country fixed effects, which are themselves a different measure of these places) on average, *at least half* of the variance is explained by grid cell fixed effects and *at least 40%* of the variance is explained by `MK-ST` fixed effects (Table 7). This suggests that the geographic unit in which someone is sampled explains a substantial proportion of the variance in their response about proxies for social capital, above and beyond the characteristics of the person themselves, or their immediate (enumeration) area. Further, this lends support to the notion that the Afrobarometer is able to pick up conditions of social capital that indicate something about the place (the grid cell or ethnic area-country unit) in which the questions are asked.

[12] e.g. "How much do you trust each of the following types of people: Your neighbors?", one of the components of the Bonding index.

[13] e.g., the first regression includes just fixed effects, the next fixed effects and demographic characteristics, the third fixed effects, demographic and household economic features, etc.

Table 7: Minimum Percentage of Total Variance Explained of Index Component Responses by Grid Cell or MK-ST Unit Fixed Effects, Average by Index

Index	None	Demographic	Household Economic	Individual Educ. Econ.	Observed EA Security	Observed EA Development	Urban/ Rural	Country
				0.5 Degree Grid Cell Units				
Bonding	100.0	78.4	68.8	65.1	64.6	62.6	62.2	41.2
Bridging	100.0	66.2	58.4	54.6	54.0	51.0	50.4	33.3
Linking	100.0	73.9	62.1	57.6	56.9	55.1	54.4	36.3
				Ethnic Area-Country Units				
Bonding	100.0	72.4	60.5	56.0	55.4	53.3	52.8	26.3
Bridging	100.0	57.8	48.6	44.2	43.5	40.3	39.7	18.4
Linking	100.0	66.6	52.7	47.2	46.3	44.2	43.5	20.7

C. Reverse Causality with Conflict

Checks of the general consistency across time and representativeness within geographic units of analysis of the Afrobarometer measures provides initial reassurance that these measures pick up latent characteristics of social capital in those units. However, when discussing relationships between social features and conflict, another particular major concern arises: could social capital simply be endogenous to conflict and could this endogeneity bias our results?

Certainly, there is evidence and logic to suggest that occurrences as dramatic as violent conflict events will shift features (measured and/or latent) of trust, community participation, cooperation, and connections between leaders and the people they lead. A number of recent studies use similar or identical Afrobarometer and ACLED data to test this relationship in certain contexts. Rohner et al. (2013) finds a decrease in trust and increase in ethnic identification following conflict in Uganda. De Luca and Verpoorten (2015) finds *initial* decreases in trust and community organization participation, but then detects a bounce-back in these measures in the medium term, also in Uganda. The bulk of the evidence according to a recent review suggests that in general *war increases cooperation*, largely involving increases to the kinds of social features I identify as social capital. These increases may be stronger for in-group rather than out-group cooperation (Bauer et al., 2016).

The concern this conflict-social capital connection generates for this study is of a particular form. While conflict and social capital may be endogenous, we are concerned about the relationship between social capital and $\frac{\partial Conflict}{\partial Temp}$. We may expect that places that experience more conflict experience more shifts to their social capital measures due to that conflict. If those places that experience more conflict also differ in their $\frac{\partial Conflict}{\partial Temp}$ (if experience of conflict is correlated with $\frac{\partial Conflict}{\partial Temp}$) this could generate bias in our results. A particular worry comes from the fact that our temperature-conflict relationship is measured for the years 1997 to 2017. However for 44% of the countries in our sample, social capital was not measured at all until 2011. Could these post-2011 social capital measures be mis-measuring social capital due to experience of conflict in a way that leads to bias, and how much should we be concerned about such bias for our overall results? To answer this question, I need to gain information about two relationships. First: do I find that experience of violence varies with $\frac{\partial Conflict}{\partial Temp}$. Second: do I find that experience of violence moves social capital measures?

Table 8: The effect of Conflict on Social Capital and the Temperature-Conflict Marginal Effect, Grid Cell Units, Scaled Independent Variables

	Violence effect on Social Capital									Violence as Moderator	
	Bonding Index		Trust Relatives	Trust Neighbors	Trust Known	Bridging Index		Linking Index		Violent Events	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Recent Violence Rate	−0.042 (0.040)	−0.049 (0.038)	−0.041 (0.037)	−0.055 (0.071)	−0.055 (0.039)	0.001 (0.022)	−0.007 (0.022)	0.082** (0.033)	0.058 (0.035)		
Mean Temp.										0.007 (0.032)	0.110** (0.053)
Mean Temp. x Pre-2011 Violence										0.452 (0.277)	
Mean Temp. x Full Violence History											2.755*** (0.620)
Unit Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Round Fixed Effects	Yes	No	Yes	Yes	Yes	Yes	No	Yes	No		
Year Fixed Effects	No	Yes	No	No	No	No	Yes	No	Yes	Yes	Yes
Unit of Observation	Gd.5-Yr	Gd.5-Yr	Gd.5-Yr	Gd.5-Yr	Gd.5-Yr	Gd.5-Yr	Gd.5-Yr	Gd.5-Yr	Gd.5-Yr	Gd.5-Yr	Gd.5-Yr
Observations	4,268	4,268	4,268	2,998	3,160	7,089	7,089	4,041	4,041	141,918	141,918
R^2	0.783	0.787	0.741	0.867	0.854	0.646	0.651	0.778	0.780	0.349	0.359

Notes: ***Significant at the 1 percent level.
**Significant at the 5 percent level.
*Significant at the 10 percent level.

To the first question, I find evidence that greater experience of violence is associated with greater $\frac{\partial Conflict}{\partial Temp}$. Column 11 of Tables 8 and 9, using mean violence in the unit as the moderator *instead* of social capital in Equation 3, indicate that across all years, the average level of violence in a place is a *positive* moderator of the temperature-conflict link. This relationship is still positive, though statistically significant only at higher α levels for violence that occurred prior to 2011 (Column 10). This suggests that places with high $\frac{\partial Conflict}{\partial Temp}$ also tend to be places that have

Table 9: The effect of Conflict on Social Capital and the Temperature-Conflict Marginal Effect, Ethnic Area - Country Units, Scaled Independent Variables

	Violence effect on Social Capital									Violence as Moderator	
	Bonding Index		Trust Relatives	Trust Neighbors	Trust Known	Bridging Index		Linking Index		Violent Events	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Recent Violence Rate	−0.061	−0.074	−0.083*	−0.118	−0.014	0.018	0.003	0.084**	0.067		
	(0.058)	(0.052)	(0.049)	(0.115)	(0.098)	(0.032)	(0.029)	(0.037)	(0.045)		
Mean Temp.										0.682	0.950
										(0.674)	(0.608)
Mean Temp. x Pre-2011 Violence										2.820*	
										(1.572)	
Mean Temp. x Full Violence History											12.847***
											(4.036)
Unit Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Round Fixed Effects	Yes	No	Yes	Yes	Yes	Yes	No	Yes	No		
Year Fixed Effects	No	Yes	No	No	No	No	Yes	No	Yes	Yes	Yes
Unit of Observation	Gd.5-Yr	Gd.5-Yr	Gd.5-Yr	Gd.5-Yr	Gd.5-Yr	Gd.5-Yr	Gd.5-Yr	Gd.5-Yr	Gd.5-Yr	Gd.5-Yr	Gd.5-Yr
Observations	1,213	1,213	1,213	849	911	2,034	2,034	1,181	1,181	19,677	19,677
R^2	0.805	0.810	0.763	0.878	0.879	0.617	0.624	0.759	0.760	0.379	0.391

Notes: ***Significant at the 1 percent level.
**Significant at the 5 percent level.
*Significant at the 10 percent level.

experienced *more* conflict. We know that such high $\frac{\partial Conflict}{\partial Temp}$ places also tend to express *lower* levels of measured social capital. If we find evidence that the measurement of social capital in those places was *artificially* low, due to experience with conflict (in other words, that social capital measured without the endogenous influence of conflict would have in fact been higher) this would lead us to worry that the *negative* moderating effect of social capital on the temperature-conflict link was biased downward by the experience with conflict, and the true moderating relationship is not as strong.

Interestingly, my results indicate that experience with conflict moves social capital differently for different types. I employ the same round-specific measures of the social capital indices as described in Section B.*1* (and employed in Figures A.4 and 3). I then generate values of recent and contemporaneous conflict rate for each survey round/year. For example, the survey for Ghana in Round 3 was conducted in 2005. I attach to the geographic units located in Ghana in Round 3 the mean number of violent events in those units from 2003, 2004 and 2005. This is the measure referred to as "Recent Violence Rate" in Tables 8 and 9. I then regress the round-specific social capital indices on recent violence rate, with unit and time fixed effects, to determine whether recent experience of violence increases or decreases measured social capital within units (Equation

8).

$$SocCap_{itr} = \beta_1 mean(Conflict_{it} + Conflict_{it-1}[+Conflict_{it-2}]) + \mu_i + \gamma_{r/t} + \epsilon_{irt} \tag{8}$$

$SocCap_{itr}$ is the social capital index in unit i round r and year t. μ_i is the usual unit fixed effect. $\gamma_{r/t}$ is a round or year fixed effect. For all units I include the mean conflict level in t and $t-1$. Depending on the gap between survey rounds, if there are at least 3 years between rounds I also include in that mean the conflict level in $t-2$.

The results in Tables 8 and 9 indicate that, if anything, the bonding index is lower following and around the time of conflict (Columns 1-2), the bridging index is not affected by conflict (Columns 6-7) and the Linking index increases following conflict (Columns 8-9). Because the components of the bonding index vary between rounds, I separately test the responses to bonding index questions individually and find that these all have negative point estimates and the most commonly available question, Trust in Relatives, shows a negative effect of conflict.

The fairly precise zero measures on β_1 for the bridging index, suggest that we should not be concerned about bias due to conflict-social capital endogeneity for that index. However, it appears that conflict experience reduces bonding capital and increases linking capital. What does this mean for bias in our main estimates?

First, consider bonding social capital. The results suggests that bonding measures may be artificially low in high conflict places. High conflict places are also high $\frac{\partial Conflict}{\partial Temp}$ places. So, bonding measures may be artificially low (biased downward) in high $\frac{\partial Conflict}{\partial Temp}$ places. In other words, without the influence of conflict on bonding social capital, the true level of bonding is higher than measured in high $\frac{\partial Conflict}{\partial Temp}$ places. Given that our main results suggest (if anything) that bonding social capital is associated with *lower* $\frac{\partial Conflict}{\partial Temp}$, this downward bias from conflict experience *helps* to drive down the negative coefficient on β_2 in Equation 3 and is biased *for* our main result. This is concerning. It suggests that the negative moderating of bonding social capital (in point estimate, if not with statistical signficance) could be an artifact of experience with conflict.

For linking social capital, the bias from experience with conflict appears to be the opposite. Linking measures may be artificially high in high conflict and high $\frac{\partial Conflict}{\partial Temp}$ places, with the true levels of linking social capital being even lower, so *even lower than measured* levels of linking capital are associated with high $\frac{\partial Conflict}{\partial Temp}$. If experience with conflict causes an upward bias in the linking measurement, this is biased *against* us finding a negative moderating effect of linking capital (negative β_2 in Equation 3). This all suggests that the moderation of linking capital is *in fact* negative for the temperature-conflict relationship, and that the bias from experience with conflict may have caused us to miss just how negative that moderation is. In other words, we should not be concerned that the main negative results for linking social capital are caused by a bias due to conflict-social capital endogeneity.

This collection of results rules out the major endogeneity concerns for the two indices that show strong and significant moderation of $\frac{\partial Conflict}{\partial Temp}$. I only test this concern further for bonding capital, in Appendix Section Appendix E:. The results there suggest that even for bonding social capital we should not be especially concerned about bias from potential endogeneity.

D. Identification of Social Capital Impact

The final major concern to address involves determining whether social capital *per se*, as opposed to some other confounding variable, plays a causal role in moderating the temperature-conflict link. First, I employ increasingly restrictive fixed effects to detect whether unobserved characteristics at the regional and country level might be confounding the social capital effect on $\frac{\partial Conflict}{\partial Temp}$. Then I consider the impacts of controlling for a range of covariates at the grid cell and ethnic area-country, as well as country levels. This latter exercise remains preliminary at this time.

D.*1* Within-Region and Within-Country

Table 10 shows regressions using a series of different types of fixed effects with the Full PC1 index as the moderator. The coefficient of interest is "Mean Temp x Full PCA Index." All countries, and thereby grid cell and ethnic area-country units, are assigned to one of five broad regions on the continent. After controlling for all time-invariant characteristics of these regions, by interacting region fixed effects with `Mean_Temp`, coefficients on the interaction term grow (`GID`) or gain precision (`MK-ST`). Employing region-by-year fixed effects to control for common yearly shocks at the regional

Table 10: Within-Region and Within-Country Results, Full PC1 Social Capital Index

	All Violent Events									
	Grid Cell Units					Ethnic Area-Country Units				
	Unit	Region	Reg x Yr	Country	Co x Yr	Unit	Region	Reg x Yr	Country	Co x Yr
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Mean Temp.	−0.192	1.254	−0.186	−1.271**	−0.437*	−0.070	−0.805	−0.216	−3.525***	−2.514*
	(0.135)	(1.035)	(0.145)	(0.496)	(0.226)	(0.943)	(1.186)	(1.458)	(1.258)	(1.440)
Mean Temp. x Full PCA Index	−0.570***	−0.651***	−0.596***	−0.345**	−0.299**	−2.663**	−2.451***	−2.822***	−1.307*	−0.970
	(0.144)	(0.126)	(0.127)	(0.158)	(0.133)	(1.040)	(0.558)	(0.813)	(0.681)	(0.737)
Unit Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Region X Temp Interaction	No	Yes	No	No	No	No	Yes	No	No	No
Region X Year Fixed Effects	No	No	Yes	No	No	No	No	Yes	No	No
Country X Temp Interaction	No	No	No	Yes	No	No	No	No	Yes	No
Country X Year Fixed Effects	No	No	No	No	Yes	No	No	No	No	Yes
Unit of Observation	Gd.5-Yr	Gd.5-Yr	Gd.5-Yr	Gd.5-Yr	Gd.5-Yr	Mk-St-Yr	Mk-St-Yr	Mk-St-Yr	Mk-St-Yr	Mk-St-Yr
Observations	34,671	34,650	34,650	34,629	34,629	11,025	11,025	11,025	11,025	11,025
R^2	0.363	0.364	0.370	0.366	0.481	0.384	0.384	0.393	0.389	0.559

Notes: Dependent variable is: All Violent Events. Standard errors clustered by geographic unit. Units of observation are: Mk-St-Yr = Murdock Ethnic Area-State unit-Year; 0.5 Gd-Yr = 0.5 Degree Grid Cell-Year. Columns 1-5 use grid cell units; 6-10 use ethnic area-country units. Columns 1 and 5 use Equation 3; 2 and 7 use Equation 4 with region fixed effects for Ω; 3 and 8 use Equation 5 with region fixed effects for Ω; 4 and 9 use Equation 4 with country fixed effects for Ω; and 5 and 10 use Equation 5 with country fixed effects for Ω.
***Significant at the 1 percent level.
**Significant at the 5 percent level.
*Significant at the 10 percent level.

level yields similar strengthening of the main effect. Evidently, the main effect is not confounded by any fixed regional characteristics, or any region-specific common yearly shocks.

This helps to remove concerns that the effect is driven by major regional events like the Arab Spring, which was focused in the North Africa region. For example, we might be concerned that Arab countries express a consistent level of social capital due to their shared history and culture, that the relationship between temperature and conflict there differed from other regions, and that differences between that and other regions drive the results. This is clearly not the case - the results still hold for within-region differences. This persistence, and in some cases growth or increase in precision, of the moderating effect, when using regional and region-by-year fixed effects can be seen for all types of social capital (Tables A.9, A.10, A.11)

Next, we consider the use of much more restrictive country and country-by-year fixed effects. Countries range from 9 (Swaziland) to 303 (South Africa) with a median of 48 `GID`s, and 2 (Swaziland) to 89 (Nigeria) with a median of 16 `MK-ST`s, within the Afrobarometer country sample. Hence, these controls remove an especially large portion of the variation for `MK-ST` units. Nonetheless, controlling for country fixed effects (Columns 4 and 9) leaves statistically and substantively significant moderating effects at the 0.05 and 0.01 levels for `GID` and `MK-ST` respectively. This implies that there are no unobserved country-level characteristics that can explain away the main effect.

The coefficients drop by about half in each case, suggesting that unobserved country-level characteristics may explain about half of the moderation effects of social capital. Even losing half of the size of the coefficients, the moderating effect is still large: about the same size as the main standardized effect of temperature on conflict, rather than twice its size. While much of the degree to which reported social capital moderates the temperature-conflict relationship may be associated with differences in social capital across countries, a substantial portion is apparently driven by variation within countries.

The most restrictive test used here, with country-by-year fixed effects, shrinks the coefficients another 13 and 25% for the two unit types respectively and removes the statistical significance at 0.10 for `MK-ST` units. Yet, even controlling for all country-specific yearly shocks, a substantially and statistically significant difference in $\frac{\partial Conflict}{\partial Temp}$ exists (for grid cell units) between places with high and low social capital.

Briefly considering the different social capital types (Tables A.9, A.10, A.11) and focusing on grid cells (Columns 4 and 5), for which the main effect of the full index remains significant, we find some interesting differences. Bonding social capital actually *gains* in coefficient size and statistical significance (at the 0.05 level) when country characteristics are controlled for. This suggests that while bonding capital may not have an affect when comparing areas across the continent, differences in bonding may be associated with differences in $\frac{\partial Conflict}{\partial Temp}$ *within* countries. In stark contrast, the effect for bridging social capital completely disappears when we control for country characteristics - suggesting that these moderate only at the cross-country level. Linking results remain similarly persistent to the full results - decreasing by about half when countries are controlled for and by a bit more when using country-by-year fixed effects, but remaining significant nonetheless. This suggests that differences in linking social capital are associated with differences in $\frac{\partial Conflict}{\partial Temp}$ both across and within countries.

D.*2* Controls

In a final effort to identify possible confounding variables, some operating at the sub-national level, I run regressions with a series of covariates, using Equation 6. These results should be viewed as preliminary, because my addition of covariates is done a-theoretically and does not involve serious consideration of which sort of variables might be considered pre- as opposed to post-treatment (which may constitute useful controls and which may act as "bad" controls (Angrist and Pischke, 2009, 64-68)). In addition, the set of covariates available differs between `GID` and `MK-ST` units so their robustness to these added variables is challenging to compare. However, for the time being, they may provide a sense of what sources of possible confounding should be investigated further. For brevity, I only include regressions with covariates using the Full PC1 index as the moderator.

In Appendix section Appendix H:, I include four tables of regressions that include various covariates, employing Equation 6. The first two use grid cell units and the last two use ethnic area-country units. The first in each pair considers non-economic variables as covariates only, while the second set explores a range of economic proxies in detail. I report my detailed interpretation of these preliminary results in that appendix section. The most prominent takeaways from these excercise are: 1) results may be confounded somewhat by population measures, though the selection of the specific population measure, and whether or not it is taken in logs, can have a large difference on the results; 2) otherwise, the results are largely robust to the inclusion of a considerable range of covariates; 3) with the important exception of nigtlights, commonly used as a proxy for economic development. This suggests the need to explore the relationships between social capital, economic development and $\frac{\partial Conflict}{\partial Temp}$ much more closely before strong causal claims can be justified.

D.*3* Future efforts at identification

By the conclusion of this project, I intend to be in a position to state not only that social capital is *associated* with heterogeneity in the temperature-conflict relationship, but also that the link between social capital $\frac{\partial Conflict}{\partial Temp}$ *is* or *is not* causal. At this time, the results following the use of region and country fixed effects suggest that any confounders must exist at the subnational level.

The exploration of included covariates suggests that measures of economic development are likely to be good candidates as variables that confound the main effect. However, determining the causal relationships between social capital, economic development and $\frac{\partial Conflict}{\partial Temp}$ will require more work.

First, as noted above, I plan to make a more careful examination of available covariates and construct new covariates to employ a selection-on-observables approach to identification. Adding urban-ness measures to the `MK-ST` units, and exploring in detail the relationships between nightlights, $\frac{\partial Conflict}{\partial Temp}$ and social capital will be particularly important. I also plan to run analysis that splits the conflict data and the social capital data into urban and rural locations, to explore whether the differences between these types of areas are substantial.

I constructed the dataset of `MK-ST` units in order to take advantage of historical data used by two major influences on this study: Nunn and Wantchekon (2011) and Michalopoulos and Papaioannou (2013). I expect, especially because I use some of the same measures from the Afrobarometer, that historical experience with the Slave Trade influenced variation in social capital today. Given the results of Dell et al. (2018) and the other literature previously discussed on the persistence of political culture and social capital, it seems likely that measures of historical state or local level organization, or others from Murdock (1967) (used in Michalopoulos and Papaioannou (2013)) will be associated with current social capital. This will potentially allow me to employ an instrumental variables strategy, which would help with identification in a number of ways: removing endogeneity concerns, addressing some of the measurement error, removing a good degree of the concern about whether I may be capturing latent rather than ephemeral and time-varying qualities of social capital with the Afrobarometer data, etc..

The challenge with such a strategy is that these same sources suggest that economic development, the most likely confounder of my social capital results, is itself associated with many of these same historical experiences (in most cases, the studies were by economists an the outcome of interest was just that: economic development). Hence, exclusion restrictions for potential instruments will be challenging to justify. The fact (interesting in its own right) that by my measures social capital is *negatively* correlated with development, as proxied by nightlights (as opposed to positively correlated) may leave an opening for a workable strategy. Even though a proper instrumental variables strategy will be challenging to justify, I will attempt to put such historical data to use in valuable ways that can add causal leverage to my results and reduce some of the concerns about measurement error.

VII. Heterogeneity of Moderation

In this final section before concluding, I consider heterogeneity in the degree to which social capital moderates temperature-conflict links. I first consider the moderation of more specific types of violence outcomes from ACLED, including paying particular attention to Violence Against Civilians in light of hypotheses from Kaplan (2017). I then consider variation in the moderating effects measured using the particular questions that constitute my main social capital indices. Finally, I note alternative hypotheses worthy of testing in future work.

A. Violence Types

Table 11: Moderation of Temperature-Conflict relationship by Full Social Capital Index for Various Types of Violence, for Grid Cell Units

	All Types	Organized				Un-Organized		
	All Viol. Events	Organized Viol.	Battles	Viol. Against Civilians	Remote Viol.	Un-Organized Actions	Riots	Protests
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Mean Temperature	−0.19	−0.22**	−0.12**	−0.11**	0.01	−0.13	0.03	−0.16*
	(0.14)	(0.10)	(0.05)	(0.06)	(0.01)	(0.14)	(0.06)	(0.09)
Mean Temp. x Full PCA Index	−0.57***	−0.30***	−0.16***	−0.09	−0.05**	−0.93***	−0.27***	−0.66***
	(0.14)	(0.09)	(0.04)	(0.06)	(0.02)	(0.20)	(0.06)	(0.15)
Baseline Rate	1.33	1000	0.36	0.58	0.06	0.91	0.33	0.57
+1 SD Mean Temp. % Δ:								
At 25th %ile Social Cap.	5.33	-0.10	-0.62	-2.55	26.34	19.10	21.61	17.65
At Mean Social Cap.	-4.55	-7.04	-10.68	-6.27	7.49	-4.66	2.88	-9.04
At 75th %ile Social Cap.	-15.18	-14.49	-21.50	-10.26	-12.77	-30.19	-17.24	-37.72
Unit Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Unit of Observation	Gd.5-Yr	Gd.5-Yr	Gd.5-Yr	Gd.5-Yr	Gd.5-Yr	Gd.5-Yr	Gd.5-Yr	Gd.5-Yr
Observations	34,671	34,671	34,671	34,671	34,671	34,671	34,671	34,671
R^2	0.36	0.39	0.34	0.35	0.24	0.30	0.24	0.32

Notes: ***Significant at the 1 percent level.
**Significant at the 5 percent level.
*Significant at the 10 percent level.

The degree of social capital moderation varies with the type of violence and conflictual action. In Tables 11 and A.16 I test Equation 3 with the Full PC1 index as the moderator but vary the outcome variable by the specific type of violence (described in Section C.). I find that the moderator effect size is considerably larger for "Un-Organized Actions": Riots and Protests, than for "Organized Violence": Battles, Remote Violence and Violence Against Civilians (VAC). Among organized types, Remote Violence has the largest effects sizes but partly this is because these events are so rare, and in the `MK-ST` case the coefficient is indistinguishable from zero. The effect size for Battles is considerable and the coefficient is consistent across unit types. This is the subtype of violence that likely drives the effect for organized violence in general. Notably, social capital *does not* significantly moderate the temperature-VAC relationship.

In contrast to some of the organized categories, the moderating of social capital for un-organized conflict activities is *very large*. The size for Riots is larger than for any organized category and the size for Protests is even larger. This organized/un-organized contrast may lend some support to the notion that temperature can affect mood, trigger aggressive mistakes (Shaver and Bollfrass, 2018), and generate "noise" in the Fearon and Laitin (1996) model. It also indicates that for such temperature triggers of conflictual action, social capital can be particularly important (as discussed in Section C.*2*).

The null result for VAC is of particular interest because of how it relates to a recent major work on the connection between social capital and violence in conflict: *Resisting War* by Oliver (Kaplan, 2017). Kaplan demonstrates a number of ways in which civilian efforts, largely reliant upon social capital, can affect the degree to which they are harmed by armed actors in the context of the civil war in Colombia. Some of his proposed mechanisms tap into all three types of social capital I articulate: bonding: social cohesion and monitoring and sancitoning; bridging: providing value through community organizations and associations that facilitate collective activity and decisionmaking; and linking: the value of leaders in negotiating with armed actors or recruiting support from NGOs on behalf of and in connection with their constituents. It is not a given that temperature should play a role in any of these processes, but to the extent that temperature can drive conflict in general it is interesting that social capital, as a whole, plays no clear moderating role. It is also quite possible that the level of aggregation I use for conflict outcomes simply cannot capture the community-by-community variation that Kaplan describes, and it would be interesting to test my effects on more community-level data, where it can be found, in future work.

Table 12: Violence Against Civilians and Resisting War

	All Violent Events							
	0.5 Grid Cell Units				Ethnic Area - Country Units			
	Full PC1	Bond	Bridge	Link	Full PC1	Bond	Bridge	Link
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Mean Temperature	-0.11^{**}	-0.05	-0.05	-0.06	-0.13	0.06	-0.15	-0.11
	(0.06)	(0.05)	(0.04)	(0.05)	(0.26)	(0.33)	(0.26)	(0.29)
Mean Temp. x Social Cap.	-0.09	0.03	-0.05	-0.13^{***}	-0.38	0.23	-0.42	-0.65^{**}
	(0.06)	(0.05)	(0.03)	(0.04)	(0.57)	(0.48)	(0.26)	(0.33)
Baseline Rate	0.58	0.50	0.41	0.47	2.14	2.03	1.78	1.87
+1 SD Mean Temp. % Δ:								
At 25th %ile Social Cap.	-2.55	-4.31	-1.02	1.59	2.42	-1.39	1.91	5.66
At Mean Social Cap.	-6.27	-2.99	-3.49	-4.37	-1.77	0.93	-2.48	-1.72
At 75th %ile Social Cap.	-10.26	-1.53	-5.87	-10.19	-6.10	3.42	-7.20	-9.03
Unit Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Unit of Observation	Gd-Yr	Gd-Yr	Gd-Yr	Gd-Yr	Mk-St-Yr	Mk-St-Yr	Mk-St-Yr	Mk-St-Yr
Observations	34,671	41,349	58,863	49,896	11,025	11,949	14,238	13,146
R^2	0.35	0.35	0.35	0.35	0.37	0.37	0.37	0.37

Notes: ***Significant at the 1 percent level.
**Significant at the 5 percent level.
*Significant at the 10 percent level.

Here, I probe the null result for VAC further by determining whether it holds across the types of social capital in Table 12. I find that it does for bonding (Columns 2 and 6) and bridging (3 and 7) but that for linking we find a fairly typical, if slightly smaller than typical, negative moderator coefficient (4 and 8). Interesting also, the point estimate for bonding is *positive*, though it doesn't approach statistical significance. This suggests that trust in and contact with leaders can still differentiate high and low $\frac{\partial VAC}{\partial Temp}$ places but bonding and bridging cannot. The actions of leaders in their interactions with armed actors may play a more important role than these other features in the case of climate-related conflict, but it is not immediately clear why bonding and briding would not also matter. Exploring this overall lack of moderation and the differences in the roles played by different features of social capital would be a valuable future pursuit.

B. Social Capital Types

Finally, I consider differences in moderating across the questions that compose the social capital indices, as well as a few additional trust questions that were not included in Tables 13 and A.17. The omitted questions ask about trust in "People from your own ethnic group" (`TruOwn`), "[Ghanaian/Kenyan/etc.] from other ethnic groups" (`TruOth`) and "Other [Ghanaians/Kenyans/etc.]" (`TruOthNat`) using the same language as in Table 2.

Table 13: Moderation of Temperature-Conflict relationship by Specific Social Capital Indices for Various Types of Violence, for Grid Cell Units

	All Violent Events												
	TruRel	TruNei	TruKnow	TruOwn	TruOth	TruOthNat	MemComDevAssc	ComMeet	JoinRaise	TruLGov	TruTrad	ContLGov	ContTrad
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
Mean Temperature	0.02	0.04	0.04	−0.07	−0.06	−0.04	−0.01	−0.03	−0.04	−0.04	−0.03	−0.01	−0.04
	(0.13)	(0.13)	(0.14)	(0.08)	(0.08)	(0.08)	(0.09)	(0.09)	(0.09)	(0.10)	(0.11)	(0.11)	(0.11)
Mean Temp. x Soc. Cap.	-0.13^{**}	−0.08	−0.07	-0.18^{***}	-0.20^{***}	-0.14^{**}	-0.15^{**}	-0.30^{***}	-0.22^{***}	-0.33^{***}	-0.32^{***}	-0.28^{***}	-0.26^{***}
	(0.06)	(0.07)	(0.08)	(0.07)	(0.07)	(0.07)	(0.06)	(0.09)	(0.07)	(0.10)	(0.06)	(0.08)	(0.07)
Baseline Rate	1.05	1.10	1.11	0.95	0.95	1.09	0.94	0.94	0.94	0.95	1.05	0.94	1.01
+1 SD Mean Temp. % Δ:													
At 25th %ile Social Cap.	2.83	2.58	2.56	1.73	2.52	2.03	3.36	5.88	3.79	6.93	5.58	7.18	5.28
At Mean Social Cap.	0.5	1.05	1.22	-2.5	-2.11	-1.07	-0.36	-0.97	-1.27	-1.25	-0.77	-0.19	-1.31
At 75th %ile Social Cap.	-2.70	-0.77	-0.14	-7.23	-6.84	-4.13	-3.34	-7.85	-5.87	-9.26	-7.95	-5.25	-6.35
Unit Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Rounds Included	345	35	45	3	3	4	123456	123456	123456	23456	246	23456	2346
Unit of Observation	Gd.5-Yr	Gd.5-Yr	Gd.5-Yr	Gd.5-Yr	Gd.5-Yr	Gd.5-Yr	Gd.5-Yr	Gd.5-Yr	Gd.5-Yr	Gd.5-Yr	Gd.5-Yr	Gd.5-Yr	Gd.5-Yr
Observations	41,349	41,349	41,349	22,995	22,995	26,334	58,863	58,863	58,863	49,896	49,896	49,896	49,896
R^2	0.36	0.36	0.36	0.40	0.40	0.42	0.36	0.36	0.36	0.36	0.36	0.36	0.36

Notes: ***Significant at the 1 percent level.
**Significant at the 5 percent level.
*Significant at the 10 percent level.

The results in Tables 13 and A.17 gesture at a number of interesting results worthy of consideration in future work. Notably, regarding any of these comparisons, care needs to be taken in comparing effects for questions sampled in different rounds, because this implies that the set of countries included differs (the rounds included are indicated near the bottom of the table). First, the moderating effects of these trust in other co-nationals measures (Columns 4-6) show considerably stronger and more statistically significant moderating effects than do the components of the bonding index (Columns 1-3). It is possible that this supports again the importance of bridging-type social capital over bonding-type social capital, a topic that could be explored further.

Second, I have ordered the table, somewhat arbitrarily, as a continuum from questions that are most relevant only to interactions at a horizontal level (on the left), regarding fellow civilians, to those that are increasingly relevant to information about the vertical level, between civilians and leaders (on the right). As noted in Section D., questions on community meetings and joining others to raise an issue, which I assign to the bridging index, also clearly have a component of linking in that community meetings are often lead by community leaders and raising an issue usually has as it's object the actions of some leader. In general, the strength of the moderator coefficients is considerably stronger to the right of the table regarding interactions with leaders. Future work could explore this leader/civilian disparity in more detail and potentially consider more and different mechanisms associated with the role of leadership in managing climatic conditions. It is possible, for example, that a study framed around leadership legitimacy or responsiveness, rather than social capital *per se* could shed additional light on temperature-conflict moderation. In my own extensions of this project, as I identify opportunities to further explore mechanisms that could explain the moderation this paper shows, I will have this alternate frame in mind.

VIII. Conclusion

This study has shown that in 36 countries in Africa, local level features of social networks, trust and associations, generally described as social capital, moderate the connection between high temperature and high levels of conflict. In areas with high levels of social capital, temperature is less associated with the number of violent conflict events. This moderator is strongest for proxies of linking social capital: measures of connections between citizens and their local leaders; followed by proxies of bridging social capital: measures of participation in community meetings, associations and collective advocacy actions. Proxies of bonding social capital (measures of trust between relatives, neighbors and acquaintances) do not consistently generate significant moderation. This negative association between social capital and the marginal effect of temperature on conflict is robust to different transformations of the conflict variable, measurement of social capital from different rounds of the Afrobarometer survey, and different types of geographic units of analysis. The strongest social capital moderators are also robust to controlling for geographic region and country fixed effects, suggesting that these relationships hold at the subnational level and cannot be confounded by country-level characteristics. However, some evidence suggests that this relationship may be confounded by subnational variation in economic development, so ascribing causal force to social capital is not yet merited. Even with our current state of certainty: that there is a strong and consistent association, these results indicate that conflict-prevention and general climate resilience efforts should be targeted towards areas with low measured social capital, in order to reduce the potentially violent impacts of a warming climate.

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A. Dataset Construction

For each geographic unit, I use the same procedures for aggregating climate, conflict and social capital data. For climate, I first downloaded the `NetCDF` file into `R`, extracted the temperature values to identify them with my geographic units, and aggregated the mean monthly temperature data up to the annual level. Taking means this provides an annual temperature mean for each grid cell or ethnic area.

For conflict, I first linked every individual event (a vector of points) to a geographic unit of analysis, using a spatial overlap command. I then aggregated these specific event data by geographic unit and year. I summed the number of conflict events for each event type and each category of event type (described in Section C.), in each year. This provides an event count for each unit-year.

For social capital, I used the same linking procedure as with the conflict data (using point locations of survey respondents) to `GID` and `MK-ST` units. After dropping missing values and recoding where appropriate, I found the mean response to each given question within the geographic unit, across whichever rounds of the survey was included in a given index. Note that these are time-invariant in most of my analysis, with exceptions being explicitly identified below. Ultimately my three primary variables of interest: mean annual temperature, number of conflict events, and mean respondents' levels of social capital were compiled for each geographic unit in each year (with the same level of social capital being assigned to all years within the geographic unit).

Appendix A: Main Reduced-Form Results, Robustness

Table A.1: Effect of Mean Annual Temperature, Contemporaneous and Lagged, on All Violent Events for 6 Geographic Unit Types

	Violent Events					
	States	Eth.Areas	Eth-St	Grd 0.5 Deg	Grd 1 Deg	Grd 2 Deg
	(1)	(2)	(3)	(4)	(5)	(6)
Mean Temperature	49.03	3.16**	2.00*	0.10**	0.41*	1.66*
	(39.11)	(1.60)	(1.02)	(0.05)	(0.21)	(0.92)
Mean Temp Lag	101.53*	4.75**	2.97**	0.19***	0.73**	2.83**
	(56.13)	(1.96)	(1.25)	(0.07)	(0.30)	(1.26)
Baseline Rate	117.99	6.69	4.28	0.54	2.07	7.66
1 SD % Δ, Same	12.25	13.98	14	6.64	6.77	7.36
1 SD % Δ, Lag	25.37	21.01	20.83	11.75	12.13	12.56
Unit Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Unit of Observation	St-Yr	Mk-Yr	Mk-St-Yr	Gd.5-Yr	Gd1-Yr	Gd2-Yr
Observations	1,008	17,535	27,279	221,760	56,700	15,225
R^2	0.50	0.46	0.46	0.45	0.46	0.47
Adjusted R^2	0.47	0.43	0.43	0.43	0.43	0.44
Residual Std. Error	200.29	30.18	24.12	5.48	12.27	27.65

Notes: Dependent variable is: All Violent Events. Standard errors clustered by geographic unit. Units of observation are as follows: St-Yr = State-Year; Mk-Yr = Murdock Ethnic Area-Year; Mk-St-Yr = Murdock Ethnic Area-State unit-Year; Gd-Yr = Grid Cell-Year, 0.5, 1, and 2 indicate the size of the grid cells: 0.5, 1 and 2 degree of latitude and logitude per side, respectively. "Baseline Rate" is the mean of the dependent variable within the given dataset. "1 SD % Change" is the percent change in the level of the dependent variable associated with a one standard deviation increase in Mean Temperature."Same" indicates temperature measured in the same, contemporaneous year; "Lag" indicates temperature measured n the prior year.

***Significant at the 1 percent level.

**Significant at the 5 percent level.

*Significant at the 10 percent level.

Table A.2: Effect of Mean Annual Temperature on Various Transformations of All Violent Events for Grid Cell and Ethnic Area-Country Units

	Grid 0.5 Degree Cells					Ethnic Area - Country				
	Viol	Viol Bin.	Viol IHS	ln(0.1 + Viol)	Viol (Int)	Viol	Viol Bin.	Viol IHS	ln(0.1 + Viol)	Viol (Int)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Mean Temperature	0.11**	0.004**	0.01***	0.02***	0.48***	2.13**	0.01	0.06**	0.07**	2.97**
	(0.05)	(0.002)	(0.003)	(0.01)	(0.17)	(1.07)	(0.01)	(0.02)	(0.04)	(1.45)
Baseline Rate	0.54	0.09	0.15	0.29	1.35	4.28	0.29	0.63	1.09	5.68
1 SD % Δ, Same	6.82	1.4	2.63	2.07	12.24	14.91	0.96	2.62	1.94	15.68
Unit Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Unit of Observation	Gd.5-Yr	Gd.5-Yr	Gd.5-Yr	Gd.5-Yr	Gd.5-Yr	Mk-St-Yr	Mk-St-Yr	Mk-St-Yr	Mk-St-Yr	Mk-St-Yr
Observations	221,760	221,760	221,760	221,760	89,271	27,279	27,279	27,279	27,279	20,580
R^2	0.45	0.39	0.47	0.45	0.45	0.46	0.48	0.60	0.59	0.46

Notes: Standard errors clustered by geographic unit. Units of observation are as follows:Mk-St-Yr = Murdock Ethnic Area-State unit-Year; Gd-Yr = 0.5 Degree Grid Cell-Year. "Baseline Rate" is the mean of the dependent variable within the given dataset. "1 SD % Change" is the percent change in the level of the dependent variable associated with a one standard deviation increase in Mean Temperature. The Dependent variable in columns 1 and 6 is is: All Violent Events. In columns 2 and 7 it is a binary version: 1 if the unit-year included at least one violent event and 0 otherwise. Columns 3 and 8 transform the violent events count using the inverse hyperbolic sine (IHS) function. Columns 4 and 9 take the natural log after adding 0.1. Columns 5 and 10 subset the data to only those units with some variation (at least one conflict event in *any* year, similar to considering the "intensive" margin of conflict events

***Significant at the 1 percent level.

**Significant at the 5 percent level.

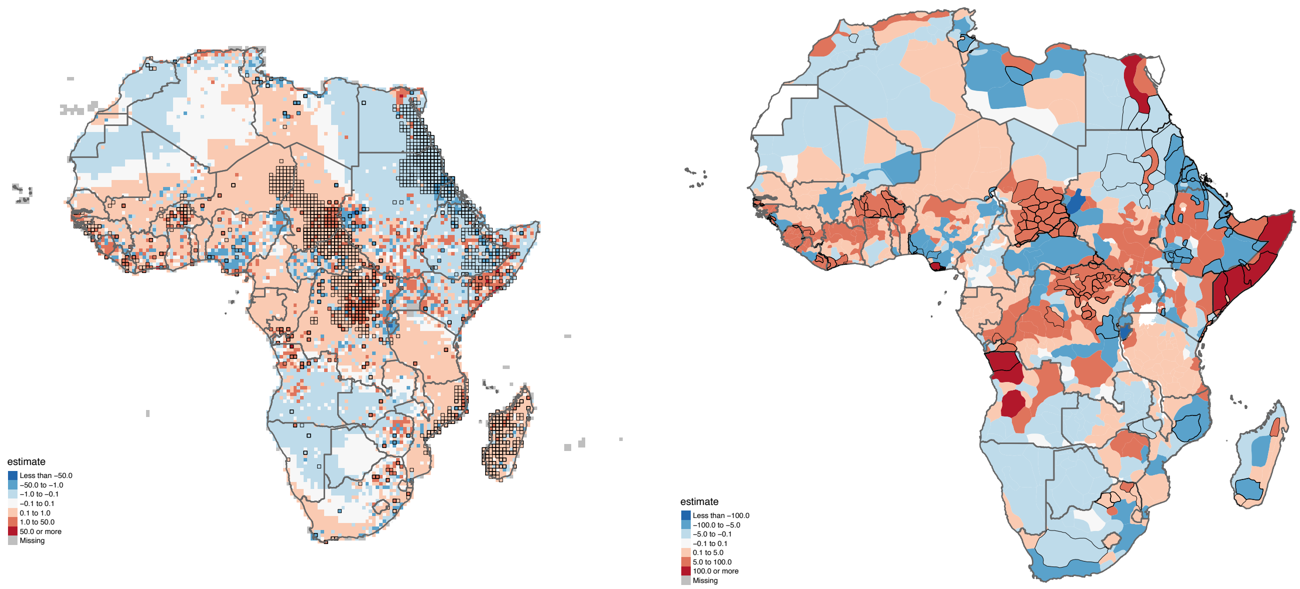
*Significant at the 10 percent level.

Appendix B: Climate-Conflict Heterogeneity

Figure A.1: Climate-Conflict Coefficients - Residualized - Violent Events on Temperature

(a) 0.5 Deg Grid Cells

(b) Murdock Area - Country Units



Prior to analysis, violent events and temperature values were residualized on unit and year fixed effects, similar to the process undertaken in the main specification in this paper. For each geographic unit, a regression was run, one unit at a time, of the residuals of *Viol* on the residuals of *Mean Annual Temperature* across the 21 years of the dataset. Reds indicate a positive coefficient on `Mean Temperature`; blues indicate a negative coefficient; darker colors indicate greater magnitude. Thin black unit area outlines indicate that the individual unit's coefficient was significant at the 0.10 level; thicker black outlines indicate significant at the 0.05 level. Figure A.1b uses Murdock ethnic area - Country units; Figure A.1a uses 0.5x0.5 degree grid cells.

Appendix C: Main Interaction Results, Robustness

A. Basic Robustness

A.*1* DV Transformations

Table A.3: Moderation of Temperature-Conflict relationship by Social Capital for Various Transformations of All Violent Events, for Grid Cell Units

	Viol Bin.				Viol IHS				Viol (Int)			
	Full PC1	Bond	Bridge	Link	Full PC1	Bond	Bridge	Link	Full PC1	Bond	Bridge	Link
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Mean Temperature	-0.02^{**}	-0.003	-0.01^{**}	-0.01^{**}	-0.03^{**}	0.004	-0.01	-0.01	-0.18	0.15	-0.01	-0.05
	(0.01)	(0.01)	(0.005)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.18)	(0.19)	(0.13)	(0.14)
Mean Temp. x Social Cap.	-0.04^{***}	-0.02^{***}	-0.02^{***}	-0.03^{***}	-0.11^{***}	-0.04^{***}	-0.05^{***}	-0.08^{***}	-0.74^{***}	-0.17	-0.41^{***}	-0.62^{***}
	(0.01)	(0.005)	(0.004)	(0.005)	(0.01)	(0.01)	(0.01)	(0.01)	(0.19)	(0.11)	(0.14)	(0.14)
Baseline Rate	0.21	0.19	0.17	0.18	0.38	0.34	0.29	0.32	1.78	1.65	1.42	1.51
+1 SD Mean Temp. % Δ:												
At 25th %ile Social Cap.	1.89	1.31	0.45	1.79	4.21	3.02	2.67	4.53	6.32	4.94	6.27	8.09
At Mean Social Cap.	-2.37	-0.46	-1.91	-1.77	-2.62	0.42	-1.19	-1.09	-3.23	2.79	-0.17	-1.02
At 75th %ile Social Cap.	-6.94	-2.40	-4.19	-5.25	-9.97	-2.46	-4.91	-6.59	-13.49	0.42	-6.37	-9.93
Unit Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Unit of Observation	Gd.5-Yr	Gd.5-Yr	Gd.5-Yr	Gd.5-Yr	Gd.5-Yr	Gd.5-Yr	Gd.5-Yr	Gd.5-Yr	Gd.5-Yr	Gd.5-Yr	Gd.5-Yr	Gd.5-Yr
Observations	34,671	41,349	58,863	49,896	34,671	41,349	58,863	49,896	25,956	29,274	38,955	34,755
R^2	0.43	0.42	0.41	0.42	0.53	0.52	0.50	0.51	0.36	0.36	0.36	0.36

Notes: ***Significant at the 1 percent level.
**Significant at the 5 percent level.
*Significant at the 10 percent level.

Table A.4: Moderation of Temperature-Conflict relationship by Social Capital for Various Transformations of All Violent Events, for Ethnic Area-Country Units

	Viol Bin.				Viol IHS				Viol (Int)			
	Full PC1	Bond	Bridge	Link	Full PC1	Bond	Bridge	Link	Full PC1	Bond	Bridge	Link
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Mean Temperature	-0.03	-0.02	-0.04^{**}	-0.02	-0.09^{***}	-0.04	-0.09^{***}	-0.05^{*}	0.09	0.99	-0.17	0.33
	(0.02)	(0.02)	(0.01)	(0.01)	(0.03)	(0.03)	(0.03)	(0.03)	(1.10)	(1.36)	(0.69)	(1.00)
Mean Temp. x Social Cap.	-0.04^{***}	-0.01	-0.04^{***}	-0.03^{***}	-0.20^{***}	-0.07^{***}	-0.13^{***}	-0.16^{***}	-2.93^{**}	-0.55	-2.26^{*}	-2.71^{**}
	(0.01)	(0.01)	(0.01)	(0.01)	(0.03)	(0.03)	(0.03)	(0.03)	(1.14)	(0.53)	(1.22)	(1.06)
Baseline Rate	0.38	0.36	0.34	0.35	0.83	0.79	0.72	0.75	5.52	5.34	4.74	4.91
+1 SD Mean Temp. % Δ:												
At 25th %ile Social Cap.	0.28	-1.08	-1.01	-0.13	2.36	0.14	-0.12	2.50	12.87	7.67	7.85	13.77
At Mean Social Cap.	-2.08	-1.4	-3.13	-2.02	-3.23	-1.69	-3.64	-2.12	0.49	5.56	-1.08	2.02
At 75th %ile Social Cap.	-4.52	-1.75	-5.42	-3.90	-9.01	-3.66	-7.44	-6.70	-12.30	3.30	-10.69	-9.60
Unit Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Unit of Observation	Mk-St-Yr	Mk-St-Yr	Mk-St-Yr	Mk-St-Yr	Mk-St-Yr	Mk-St-Yr	Mk-St-Yr	Mk-St-Yr	Mk-St-Yr	Mk-St-Yr	Mk-St-Yr	Mk-St-Yr
Observations	11,025	11,949	14,238	13,146	11,025	11,949	14,238	13,146	9,702	10,290	12,054	11,340
R^2	0.48	0.48	0.48	0.48	0.61	0.61	0.61	0.61	0.38	0.38	0.38	0.38

Notes: ***Significant at the 1 percent level.
**Significant at the 5 percent level.
*Significant at the 10 percent level.

A.2 Hainmueller et al. Recommendations

First, employing Hainmueller et al. (2018)'s R package I generate graphs of the main interaction effects that provide visual evidence of linearity and common support of the moderators. Figure 2 shows the typical conditional marginal effects plots of my main interaction effects for each index for grid cell units (Table 6, Columns 1-4) in black lines with grey 95% confidence bands. They then add two additional pieces of information. First, they include a histogram of the moderator along the bottom to help check for common support. As my treatment (temperature) is continuous, we do not see a distinction between treated and un-treated units: all are "treated" more in some years than others. The histogram clearly suggests there is a considerable level of common support across a wide range of the moderator and that we should be relatively unconcerned about unwarranted extrapolation or interpolation. Notably, for all three graphs that have statistically significant moderator coefficients (Full PC1, Bridging and Linking), there are clear areas within the extremes of the moderator distribution where the confidence bands clear the zero line above *and* below the line. This suggests that there are substantial porportions of units at the higher and lower ends of the social capital distribution that experience statistically significant negative and positive climate-conflict effects, respectively.

Second, they offer a model that relaxes the assumption that the interaction effect be linear. Rather than use a linear moderator coefficient, they split the moderator into terciles and use dummy variables for each tercile in interactions with the treatment. These coefficients are plotted as the white dots and red whiskers in Figure 2. First, visually it appears, and results in Table A.5 support, that the social capital moderation is statistically indistinguishable from linear. In the case of Bridging and Linking social capital, the point estimates of the tercile dummies appear to fall almost precisely on the linear moderator line. This suggests that to the extent that the model is extrapolating to areas of weak support along the moderator, we should be less concerned about that extrapolation than we might otherwise be. The same sets of graphs for ethnic area-country units are shown in Figure A.2 and reveal broadly similar results, though with less areas of the moderator showing statistically significant positive and negative values (as we would expect from the results in the table)

Table A.5: Linearity and Moderation Checks for Main Social Capital Indices

units	moderator	monotonic	p.1v2	p.2v3	p.1v3*	p.wald*	L_Kurtosis*	score
Grid Cell	Full PC1	TRUE	0.0001	0.1286	0.0000	0.069	0.069	0
Grid Cell	Bonding	TRUE	0.8657	0.8476	0.6371	0.915	0.107	1
Grid Cell	Bridging	TRUE	0.0777	0.0302	0.0003	0.994	0.121	0
Grid Cell	Linking	TRUE	0.0007	0.0006	0.0000	0.427	0.108	0
Ethnic Area-Country	Full PC1	FALSE	0.0034	0.6980	0.0042	0.229	0.072	0
Ethnic Area-Country	Bonding	FALSE	0.5967	0.2186	0.1572	0.815	0.113	1
Ethnic Area-Country	Bridging	TRUE	0.0339	0.0537	0.0004	0.866	0.147	0
Ethnic Area-Country	Linking	TRUE	0.0108	0.2457	0.0031	0.707	0.109	0

Lastly, I check the formal tests that Hainmueller et al. (2018) suggest. I find that for each moderating coefficient that was statistically significant in its linear form in Table 6 (Full PC1, Bridging and Linking for both unit types), it passes all three tests in Table A.5. The "p.1v3" column shows the p-value of the test of the hypothesis that the coefficient on the first tercile dummy and the coefficient on the third are the same. These all reject the null at the 0.01 levels. Next, the “p.wald” column shows the p-value of a wald test of the hypothesis that the tercile dummies are arranged linearly. Though one comes close, these all fail to reject the null, suggesting that the nonparametric models are not distinguishable from a linear model. Finally, the L_Kurtosis column checks the skewness of the moderator distribution and finds that none are worryingly skewed, as none exceed their cutoff of 0.16. Hence, each of these six models earns a best possible score of zero. That there are statistically significant linear moderators of the climate-conflict relationship *and* that the suggested non-parametric version of the same relationship shows statistically significant differences between high and low levels of the moderator, provides two different formal tests of the heterogeneity of the climate-conflict relationship. In both cases the null that there is no heterogeneity is rejected.

A.3 Standard Error Clustering Choices

As a final basic check, I explore whether clustering standard errors at a higher level of aggregation removes the statistically significance of the moderator coefficients. These coefficients are plotted in Figure A.3. The standard errors types used in all tables in the paper are shown in blue on the graphs: cluster robust standard errors for clustering at the unit of analysis (grid cell or ethnic area-country) level. For grid cell units, clustering at the country, year, or country-year level (in addition to the unit level) all expand the standard errors considerably. In the case of Bridging social capital, this expansion causes the coefficient to lose statistical significance at the 0.05 level, but the Full PCA and Linking indices are robust to this expansion. Clustering at higher levels for `MK-ST` units, which already have relatively large standard errors given their smaller sample size, and fewer units per country, generates relatively little expansion in standard errors and little qualitative change to the results.

Figure A.3: Robustness to Standard Error Clustering Changes

(a) Grid Cell Units (b) Ethnic Area-State Units

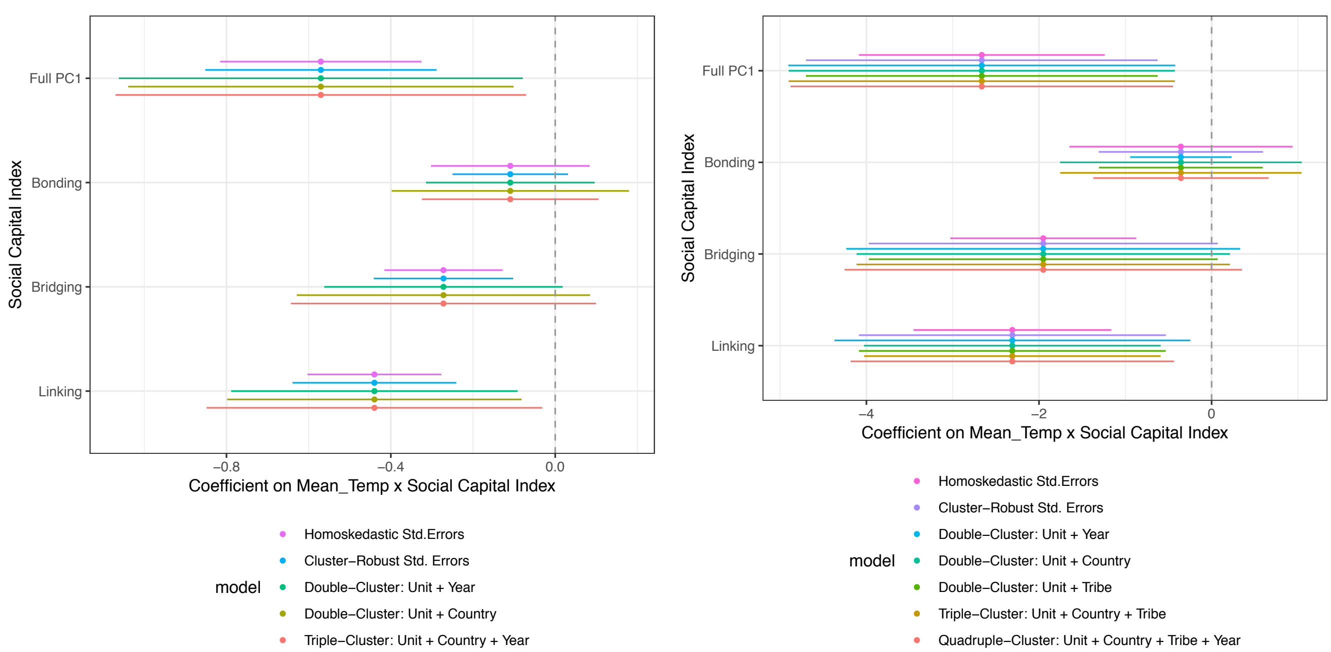
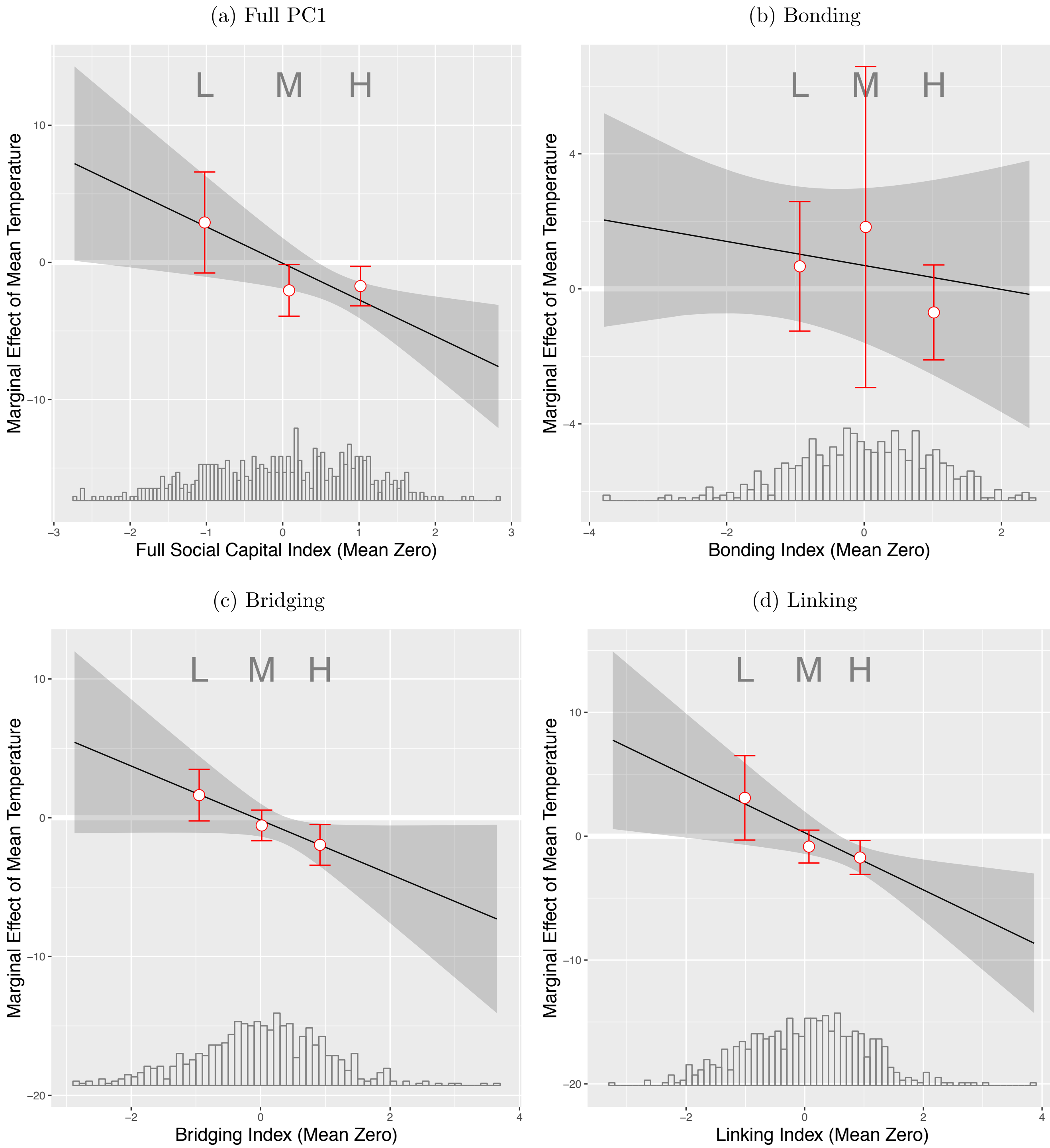


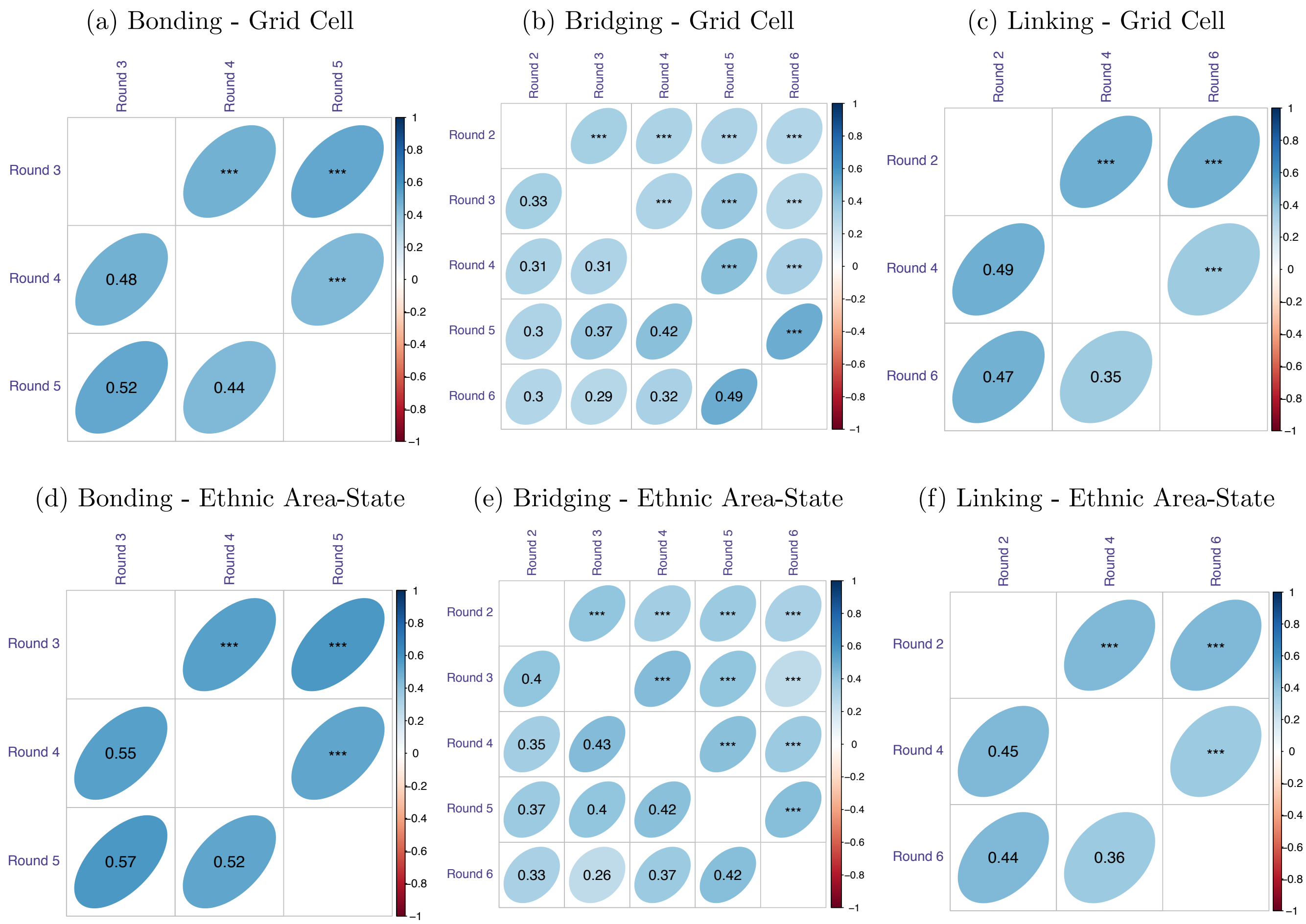
Figure A.2: Moderation of Temperature Effect on Number of Violent Events - Ethnic Area-Country Units



Conditional marginal effects plots for Ethnic Area - Country units. Outcome: number of conflict events; treatment: temperature; moderators: various social capital indices. Y axes show the marginal effect of temperature on conflict, x-axes show the level of the moderators (each of which is set to mean = zero, standard deviation = 1). Black lines show the slope of β_2 across the range of the moderator and grey shaded areas show 95% confidence bands. Histograms at the bottom show the histogram of the moderator across its range. White dots with red whiskers explained in the text

Appendix D: Social Capital Measurement Concerns

Figure A.4: Correlation in Social Capital Index Measures Over Time



Plots show visualizations of correlations between social capital indices measured in different rounds of the Afrobarometer survey. Darker blues and more elongated ellipses indicate stronger correlation coefficients. The coefficients themselves are noted in the left-lower triangle of all plots. Levels of statistical significance are marked with stars in the upper-right triangle of plots. *Significant at the 10 percent level; **Significant at the 5 percent level;***Significant at the 1 percent level

Table A.6: Variance Explained of Index Component Questions by Unit Fixed Effects and Other Characteristics - Grid Cell Units

Index	Question	Rounds	Value	None	Demographic	Household Economic	Individual Educ. Econ.	Observed EA Security	Observed EA Development	Urban/Rural	Country
			Total Explained	19.1%	20.2%	21.2%	21.4%	21.5%	21.6%	21.6%	21.7%
	TruKnow	45	Maximum Explained	19.1%	19.2%	19.6%	19.6%	19.7%	19.8%	19.8%	19.8%
			Minimum Explained	19.1%	16.6%	15.5%	15.2%	15.2%	15.0%	14.8%	10.0%
			Total Explained	23.5%	24.8%	25.6%	26.1%	26.3%	26.7%	26.8%	26.8%
Bonding	TruNei	35	Maximum Explained	23.5%	23.8%	24.2%	24.3%	24.4%	24.7%	24.7%	24.7%
			Minimum Explained	23.5%	18.4%	15.8%	14.7%	14.7%	14.2%	14.2%	9.8%
			Total Explained	21.0%	21.7%	22.2%	22.4%	22.5%	22.8%	22.8%	23.0%
	TruRel	345	Maximum Explained	21.0%	21.2%	21.4%	21.4%	21.5%	21.6%	21.6%	21.6%
			Minimum Explained	21.0%	17.3%	16.1%	15.5%	15.5%	15.4%	15.3%	9.7%
			Total Explained	21.8%	26.1%	27.2%	28.1%	28.2%	28.7%	28.8%	28.9%
	ComMeet	23456	Maximum Explained	21.8%	21.5%	21.7%	21.8%	21.9%	22.0%	22.0%	22.0%
			Minimum Explained	21.8%	14.7%	12.8%	12.7%	12.6%	11.8%	11.6%	8.0%
			Total Explained	19.7%	23.4%	24.6%	25.8%	25.9%	26.4%	26.4%	26.5%
	JoinRaise	23456	Maximum Explained	19.7%	19.6%	19.8%	20.2%	20.2%	20.4%	20.4%	20.4%
Bridging			Minimum Explained	19.7%	15.3%	14.4%	14.2%	14.1%	13.5%	13.4%	7.8%
			Total Explained	15.9%	18.3%	20.0%	20.5%	20.6%	20.9%	21.0%	21.0%
	MemAssc	456	Maximum Explained	15.9%	16.1%	16.6%	16.7%	16.7%	16.7%	16.7%	16.7%
			Minimum Explained	15.9%	13.0%	12.4%	12.4%	12.3%	11.8%	11.7%	8.2%
			Total Explained	15.7%	17.5%	18.5%	20.4%	20.6%	21.5%	21.5%	21.6%
	MemComDev	23	Maximum Explained	15.7%	15.5%	15.8%	16.3%	16.4%	16.8%	16.8%	16.8%
			Minimum Explained	15.7%	13.5%	13.2%	12.5%	12.5%	12.5%	12.5%	8.7%
			Total Explained	14.7%	16.5%	17.8%	18.6%	18.7%	19.1%	19.2%	19.3%
	ContLGov	23456	Maximum Explained	14.7%	12.7%	13.0%	13.2%	13.2%	13.3%	13.3%	13.3%
			Minimum Explained	14.7%	11.4%	11.4%	11.2%	11.2%	10.9%	10.9%	7.8%
			Total Explained	20.6%	24.2%	25.1%	25.8%	25.9%	26.5%	26.7%	26.8%
	ContTrad	2346	Maximum Explained	20.6%	21.0%	21.3%	21.4%	21.4%	21.6%	21.6%	21.6%
Linking			Minimum Explained	20.6%	17.7%	16.2%	15.7%	15.5%	14.8%	14.6%	9.6%
			Total Explained	21.9%	22.1%	23.6%	24.0%	24.1%	24.3%	24.4%	24.5%
	TruLGov	23456	Maximum Explained	21.9%	21.6%	21.8%	21.8%	21.9%	22.0%	22.0%	22.0%
			Minimum Explained	21.9%	18.0%	15.3%	14.2%	14.1%	14.0%	13.9%	8.5%
			Total Explained	24.0%	24.9%	25.9%	26.3%	26.3%	25.9%	25.9%	26.0%
	TruTrad	246	Maximum Explained	24.0%	24.0%	24.1%	24.0%	24.0%	23.5%	23.5%	23.5%
			Minimum Explained	24.0%	17.7%	14.6%	13.5%	13.3%	13.0%	12.9%	9.2%

Appendix E: Social Capital Endogeneity Concerns

If recent or past history of conflict could be driving bonding social capital measured later in time, then we should not be concerned about this issue if we use bonding capital measures from prior to the sample of climate and conflict (we wouldn't be facing the possibility of mis-measurement in social capital because we will be placing the social capital measurement at the start of the sample period). In Table A.8, Columns 2-4 and 6-8 I use Equation 9.

$$\begin{aligned} Conflict_{it} = {} & \beta_1 Temp_{it} + \beta_2 SocCap_i \times Temp_{it} + \beta_3 PostDummy \times Temp_{it} + \\ & \beta_4 PostDummy \times SocCap_i + \beta_5 PostDummy \times SocCap_i \times Temp_{it} + \\ & \mu_i + \gamma_t + \epsilon_{it} \end{aligned} \quad (9)$$

The only new variable here is a dummy variable that = 1 in the year in question and all following, and = 0 in all prior years. The value of interest in this case, which indicates the moderating role of social capital, specifically in the latter years of the sample (when the dummy is turned on), is $\beta_2 + \beta_5$ (the sum of rows 2 and 5 in the table). I report this sum in the row labeled "Post-Year Coefficient" and the p-value of the hypothesis test with null: $\beta_2 + \beta_5 = 0$ in the row labeled 'Post-Year p-value". I use this estimation strategy, rather than simply splitting the sample in two and only running the regression on the latter half, in order to include in the calculation of unit fixed effects the longer history of climate and conflict from the 21 year sample. [14]

For the grid cell units, the coefficient of interest remains rather stable for the 2007 and

[14] Note: Columns 1 and 5 should match precisely with Columns 2 and 6 in Table 6, but do not. I need to take a closer look and figure our what the discrepancy is, although it is not a large difference.

Table A.7: Variance Explained of Index Component Questions by Unit Fixed Effects and Other Characteristics - Ethnic Area-Country Units

Index	Outcome_all	Rounds	Value	None	Demographic	Household Economic	Individual Educ. Econ.	Observed EA Security	Observed EA Development	Urban/Rural	Country
Bonding	TruKnow	45	Total Explained	14.0	15.3	16.3	16.6	16.7	16.9	17.0	17.0
			Maximum Explained	14.0	14.1	14.4	14.4	14.5	14.6	14.6	14.6
			Minimum Explained	14.0	11.6	10.6	10.4	10.4	10.2	10.1	5.2
	TruNei	35	Total Explained	18.2	19.7	20.7	21.3	21.5	22.0	22.1	22.1
			Maximum Explained	18.2	18.6	18.7	18.8	18.9	19.2	19.2	19.2
			Minimum Explained	18.2	13.3	10.8	9.8	9.8	9.4	9.4	4.9
	TruRel	345	Total Explained	16.5	17.2	17.7	17.9	18.0	18.3	18.3	18.3
			Maximum Explained	16.5	16.6	16.7	16.7	16.8	16.9	16.9	16.9
			Minimum Explained	16.5	12.8	11.7	11.0	11.0	10.8	10.7	5.0
Bridging	ComMeet	23456	Total Explained	16.6	21.4	22.5	23.4	23.6	24.1	24.3	24.3
			Maximum Explained	16.6	16.1	16.1	16.2	16.2	16.3	16.3	16.3
			Minimum Explained	16.6	10.1	8.3	8.2	8.1	7.4	7.3	3.6
	JoinRaise	23456	Total Explained	14.9	19.0	20.1	21.2	21.4	21.9	22.0	22.0
			Maximum Explained	14.9	14.9	14.9	15.1	15.2	15.3	15.3	15.3
			Minimum Explained	14.9	11.1	10.2	9.9	9.8	9.4	9.3	3.5
	MemAssc	456	Total Explained	11.5	13.9	15.4	15.8	16.0	16.4	16.5	16.5
			Maximum Explained	11.5	11.5	11.8	11.8	11.8	11.9	11.9	11.9
			Minimum Explained	11.5	8.6	7.8	7.8	7.7	7.3	7.3	3.8
	MemComDev	23	Total Explained	10.9	13.1	14.0	15.7	15.9	16.7	16.7	16.7
			Maximum Explained	10.9	11.0	11.0	11.2	11.3	11.6	11.6	11.6
			Minimum Explained	10.9	9.1	8.7	7.7	7.8	7.8	7.7	3.8
Linking	ContLGov	23456	Total Explained	10.5	12.4	13.6	14.3	14.4	14.8	14.9	14.9
			Maximum Explained	10.5	8.4	8.6	8.6	8.5	8.6	8.6	8.6
			Minimum Explained	10.5	7.3	7.2	6.9	6.8	6.6	6.6	3.4
	ContTrad	2346	Total Explained	15.2	19.3	20.4	21.0	21.2	21.8	22.0	22.0
			Maximum Explained	15.2	15.7	15.9	15.9	15.9	16.1	16.1	16.1
			Minimum Explained	15.2	12.8	11.5	11.0	10.7	10.1	9.9	4.7
	TruLGov	23456	Total Explained	16.8	17.2	18.9	19.3	19.4	19.6	19.7	19.7
			Maximum Explained	16.8	16.6	16.7	16.6	16.6	16.6	16.6	16.6
			Minimum Explained	16.8	13.0	10.5	9.4	9.4	9.2	9.2	3.6
	TruTrad	246	Total Explained	18.6	19.9	21.2	21.4	21.4	21.1	21.1	21.1
			Maximum Explained	18.6	18.6	18.5	18.2	18.1	17.6	17.6	17.6
			Minimum Explained	18.6	12.6	9.8	8.6	8.5	8.2	8.1	4.3

2010 splits (columns 2 and 3), relative to the full index and full sample (Column 1). It moves considerably for the final split but: a) moves in the negative direction, towards the main effect and gains statistical significance, and b) this last split uses only a very small sample of four years from 2014 to 2017 and so has to be interpreted with caution. For the Ethnic Area-Country units, the coefficient moves only negative or stays relatively the same (Columns 6-8) compared to the full index and sample (Column 5) and only gains in statistical significance. Hence, even for bonding social capital, where the conflict - social capital endogeneity issue is of greatest concern, this alternative test using only social capital data from prior to the temperature and conflict years does not indicate that taking the social capital data from later years biases the result downwards. Instead, if anything, the results from earlier-year social capital yield more negative moderator coefficients for bonding capital.

Table A.8: Pre-year Index, Post-year Dummy Endogeneity Check, Bonding Social Capital

	All Violent Events							
	Full	Pre/Post 2007	Pre/Post 2010	Pre/Post 2014	Full	Pre/Post 2007	Pre/Post 2010	Pre/Post 2014
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Mean Temp.	0.022	−0.006	−0.041	−0.007	0.626	−0.238	−0.095	0.487
	(0.113)	(0.077)	(0.061)	(0.127)	(1.082)	(0.616)	(0.505)	(1.128)
Mean Temp. x Pre-year Index	−0.107*	−0.120**	−0.098**	−0.114*	−0.371	−1.269**	−0.826**	−0.555
	(0.057)	(0.057)	(0.039)	(0.061)	(0.492)	(0.522)	(0.332)	(0.615)
Mean Temp. x Pre/Post Dummy		−0.025	0.020	−0.044		−0.229	0.001	−0.429
		(0.032)	(0.028)	(0.049)		(0.335)	(0.317)	(0.446)
Pre-year Index x Pre/Post Dummy		−0.500	−0.575	3.722**		−8.632	−13.838**	22.255
		(0.563)	(0.424)	(1.637)		(6.928)	(6.206)	(24.284)
Mean Temp. x Pre-year Index x Pre/Post Dummy		0.012	0.016	−0.151**		0.329	0.500**	−0.832
		(0.023)	(0.018)	(0.059)		(0.269)	(0.234)	(0.867)
**Post-Year Coefficient	-0.107	-0.108	-0.083	-0.265	-0.371	-0.941	-0.325	-1.387
**Post-Year P-Value	0.062	0.029	0.017	0.017	0.451	0.013	0.194	0.318
Unit Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Unit of Observation	Gd.5-Yr	Gd.5-Yr	Gd.5-Yr	Gd.5-Yr	Mk-St-Yr	Mk-St-Yr	Mk-St-Yr	Mk-St-Yr
Observations	50,190	22,995	33,327	50,190	12,978	6,342	8,316	12,978
R^2	0.361	0.396	0.423	0.362	0.384	0.406	0.454	0.386

Notes: Dependent variable is: All Violent Events. Standard errors clustered by geographic unit. Units of observation are as follows: Mk-St-Yr = Murdock Ethnic Area-State unit-Year; 0.5 Gd-Yr = 0.5 Degree Grid Cell-Year. Columns 1 and 5 report the results from the baseline regression using the full year sample and Equation 3. Columns 2-4 and 6-8 use Equation 9, setting *PostDummy* to 1 for 2007 and later in columns 2 and 6, 2010 and later in columns 3 and 7, and 2014 and later in columns 4 and 8; and zero otherwise. "Post-Year Coefficient" is β_2 and "Post-Year P-Value" is the p-value of the hypothesis test with null: $\beta_2 = 0$, from Equation 3 for columns 1 and 5. "Post-Year Coefficient" is $\beta_2 + \beta_5$ and "Post-Year P-Value" is the p-value of the hypothesis test with null: $\beta_2 + \beta_5 = 0$, from Equation 9 for columns 2-4 and 6-8

***Significant at the 1 percent level.
**Significant at the 5 percent level.
*Significant at the 10 percent level.

Appendix F: Additional Fixed Effects

Table A.9: Within-Region and Within-Country Results - Bonding Social Capital Index

	All Violent Events									
	Grid Cell Units					Ethnic Area-Country Units				
	Unit	Region	Reg x Yr	Country	Co x Yr	Unit	Region	Reg x Yr	Country	Co x Yr
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Mean Temp.	0.028	0.811	0.038	-0.641^{**}	-0.436^{**}	0.691	-0.518	0.465	-1.820^{**}	-2.598^{*}
	(0.133)	(0.730)	(0.131)	(0.308)	(0.189)	(1.168)	(0.988)	(1.523)	(0.810)	(1.468)
Mean Temp. x Bonding Index	-0.109	-0.157^{**}	-0.107	-0.195^{**}	-0.191^{**}	-0.356	-0.471	-0.455	-0.439	-0.373
	(0.072)	(0.075)	(0.067)	(0.088)	(0.087)	(0.486)	(0.583)	(0.503)	(0.540)	(0.591)
Unit Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Region X Temp Interaction	No	Yes	No	No	No	No	Yes	No	No	No
Region X Year Fixed Effects	No	No	Yes	No	No	No	No	Yes	No	No
Country X Temp Interaction	No	No	No	Yes	No	No	No	No	Yes	No
Country X Year Fixed Effects	No	No	No	No	Yes	No	No	No	No	Yes
Unit of Observation	Gd.5-Yr	Gd.5-Yr	Gd.5-Yr	Gd.5-Yr	Gd.5-Yr	Mk-St-Yr	Mk-St-Yr	Mk-St-Yr	Mk-St-Yr	Mk-St-Yr
Observations	41,349	41,307	41,307	41,286	41,286	11,949	11,949	11,949	11,949	11,949
R^2	0.363	0.363	0.369	0.366	0.479	0.384	0.384	0.392	0.389	0.557

Notes: Dependent variable is: All Violent Events. Standard errors clustered by geographic unit. Units of observation are: Mk-St-Yr = Murdock Ethnic Area-State unit-Year; 0.5 Gd-Yr = 0.5 Degree Grid Cell-Year. Columns 1-5 use grid cell units; 6-10 use ethnic area-country units. Columns 1 and 5 use Equation 3; 2 and 7 use Equation 4 with region fixed effects for Ω; 3 and 8 use Equation 5 with region fixed effects for Ω; 4 and 9 use Equation 4 with country fixed effects for Ω; and 5 and 10 use Equation 5 with country fixed effects for Ω.

***Significant at the 1 percent level.
**Significant at the 5 percent level.
*Significant at the 10 percent level.

Table A.10: Within-Region and Within-Country Results - Bridging Social Capital Index

	All Violent Events									
	Grid Cell Units					Ethnic Area-Country Units				
	Unit	Region	Reg x Yr	Country	Co x Yr	Unit	Region	Reg x Yr	Country	Co x Yr
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Mean Temp.	−0.054	0.749*	−0.048	−0.480**	−0.256**	−0.175	0.074	−0.442	−1.663	−1.892
	(0.086)	(0.413)	(0.089)	(0.212)	(0.129)	(0.605)	(0.802)	(1.089)	(1.017)	(1.215)
Mean Temp. x Bridging Index	−0.272***	−0.276***	−0.292***	−0.024	−0.006	−1.951*	−1.708***	−2.110**	−0.334	−0.424
	(0.087)	(0.062)	(0.073)	(0.058)	(0.049)	(1.032)	(0.470)	(0.858)	(0.394)	(0.415)
Unit Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Region X Temp Interaction	No	Yes	No	No	No	No	Yes	No	No	No
Region X Year Fixed Effects	No	No	Yes	No	No	No	No	Yes	No	No
Country X Temp Interaction	No	No	No	Yes	No	No	No	No	Yes	No
Country X Year Fixed Effects	No	No	No	No	Yes	No	No	No	No	Yes
Unit of Observation	Gd.5-Yr	Gd.5-Yr	Gd.5-Yr	Gd.5-Yr	Gd.5-Yr	Mk-St-Yr	Mk-St-Yr	Mk-St-Yr	Mk-St-Yr	Mk-St-Yr
Observations	58,863	58,800	58,800	58,590	58,590	14,238	14,238	14,238	14,238	14,238
R^2	0.361	0.361	0.365	0.364	0.470	0.385	0.385	0.393	0.390	0.544

Notes: Dependent variable is: All Violent Events. Standard errors clustered by geographic unit. Units of observation are: Mk-St-Yr = Murdock Ethnic Area-State unit-Year; 0.5 Gd-Yr = 0.5 Degree Grid Cell-Year. Columns 1-5 use grid cell units; 6-10 use ethnic area-country units. Columns 1 and 5 use Equation 3; 2 and 7 use Equation 4 with region fixed effects for Ω; 3 and 8 use Equation 5 with region fixed effects for Ω; 4 and 9 use Equation 4 with country fixed effects for Ω; and 5 and 10 use Equation 5 with country fixed effects for Ω.

***Significant at the 1 percent level.
**Significant at the 5 percent level.
*Significant at the 10 percent level.

Table A.11: Within-Region and Within-Country Results - Linking Social Capital Index

	All Violent Events									
	Grid Cell Units					Ethnic Area-Country Units				
	Unit	Region	Reg x Yr	Country	Co x Yr	Unit	Region	Reg x Yr	Country	Co x Yr
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Mean Temp.	−0.068	0.555	−0.050	−0.757***	−0.236	0.280	−0.923	0.196	−1.706*	−1.500
	(0.104)	(0.489)	(0.106)	(0.262)	(0.146)	(0.873)	(0.942)	(1.322)	(0.949)	(1.274)
Mean Temp. x Linking Index	−0.440***	−0.454***	−0.444***	−0.214**	−0.178**	−2.309**	−2.044***	−2.344***	−0.664	−0.452
	(0.102)	(0.087)	(0.092)	(0.089)	(0.078)	(0.907)	(0.551)	(0.752)	(0.623)	(0.599)
Unit Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Region X Temp Interaction	No	Yes	No	No	No	No	Yes	No	No	No
Region X Year Fixed Effects	No	No	Yes	No	No	No	No	Yes	No	No
Country X Temp Interaction	No	No	No	Yes	No	No	No	No	Yes	No
Country X Year Fixed Effects	No	No	No	No	Yes	No	No	No	No	Yes
Unit of Observation	Gd.5-Yr	Gd.5-Yr	Gd.5-Yr	Gd.5-Yr	Gd.5-Yr	Mk-St-Yr	Mk-St-Yr	Mk-St-Yr	Mk-St-Yr	Mk-St-Yr
Observations	49,896	49,854	49,854	49,686	49,686	13,146	13,146	13,146	13,146	13,146
R^2	0.361	0.362	0.366	0.364	0.472	0.385	0.385	0.392	0.389	0.546

Notes: Dependent variable is: All Violent Events. Standard errors clustered by geographic unit. Units of observation are: Mk-St-Yr = Murdock Ethnic Area-State unit-Year; 0.5 Gd-Yr = 0.5 Degree Grid Cell-Year. Columns 1-5 use grid cell units; 6-10 use ethnic area-country units. Columns 1 and 5 use Equation 3; 2 and 7 use Equation 4 with region fixed effects for Ω; 3 and 8 use Equation 5 with region fixed effects for Ω; 4 and 9 use Equation 4 with country fixed effects for Ω; and 5 and 10 use Equation 5 with country fixed effects for Ω.

***Significant at the 1 percent level.
**Significant at the 5 percent level.
*Significant at the 10 percent level.

Appendix G: Covariates

Table A.12: OLS Regressions with Non-Economic Covariates - Grid Cell Units

	All Violent Events										
	None	Pop	Pop+Area	Geog. Dist.	Geog. Nat	Landcov	Resour.	Agric.	Political	Soc.	All
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Mean Temp.	−0.192	−0.297**	−1.742***	−3.636**	−5.091***	35.145**	−2.601***	−4.177***	−1.023	0.481	−12.310
	(0.135)	(0.148)	(0.626)	(1.732)	(1.523)	(13.869)	(0.769)	(1.246)	(1.009)	(1.105)	(11.498)
Mean Temp. x Full PCA Index	−0.570***	−0.513***	−0.573***	−0.216**	−0.686***	−0.413***	−0.411***	−0.433***	−0.717***	−0.742***	−0.081
	(0.144)	(0.140)	(0.141)	(0.104)	(0.149)	(0.090)	(0.119)	(0.108)	(0.154)	(0.192)	(0.121)
Unit Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Covariate Types											
Population	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Area	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Geog. Distance	No	No	No	Yes	No	No	No	No	No	No	Yes
Geog. Natural	No	No	No	No	Yes	No	No	No	No	No	Yes
Landcover	No	No	No	No	No	Yes	No	No	No	No	Yes
Resources	No	No	No	No	No	No	Yes	No	No	No	Yes
Agricultural	No	No	No	No	No	No	No	Yes	No	No	Yes
Political	No	No	No	No	No	No	No	No	Yes	No	Yes
Societal	No	No	No	No	No	No	No	No	No	Yes	Yes
Unit of Observation	Gd.5-Yr	Gd.5-Yr	Gd.5-Yr	Gd.5-Yr	Gd.5-Yr	Gd.5-Yr	Gd.5-Yr	Gd.5-Yr	Gd.5-Yr	Gd.5-Yr	
Observations	34,671	34,671	34,671	33,726	34,545	34,671	33,747	33,453	29,085	31,395	25,725
R^2	0.363	0.363	0.363	0.368	0.364	0.365	0.365	0.359	0.365	0.341	0.346
Notes:	***Significant at the 1 percent level. **Significant at the 5 percent level. *Significant at the 10 percent level.										

I split the covariates into two types: “Economic” and “Non-Economic.”[15]. For grid cells, beginning with non-economic covariates, after adding population[16] and land area controls for all regressions in columns 3-11, the category that most strongly reduces the main effect is the set of Geographic Distance variables (Table A.12). These include distance to country borders, capitals, travel time to major urban areas, and the proportion of the grid cell itself that is urban. They therefore stand in for urban-ness as well as proximity to central state resources or state capacity. This suggests urban-ness is a potential confounder to explore further, as there may be general differences in social capital between urban and rural areas. Besides these, landcover, natural resources, and agricultural variables diminish the coefficient while climatological and natural geographical features (e.g. mountains) political and social features (mostly measured at the national level) enhance it. However, including every one of these covariates (Column 11), does remove the main effect almost entirely, and renders it statistically insignificant.

Regarding various economic proxies, and starting with the inclusion of population, area, and the geographic distance/urban-ness covariates as a baseline, I find that different proxies for substate economic development have different effects on the main coefficient. The ones that diminish it most substantially, to the point of removing statistical significance at conventional levels are the calibrated mean of Nightlights taken from the PRIO-GRID framework (Foro Tollefsen et al., 2012) and my own construction of mean 2013 stable nightlights done in `QGIS`, taken from

[15]Detailed descriptions of these data are available upon request and will be provided in a data appendix in the final version of this paper

[16]One reason why these results are preliminary is that a different choice for the population variable (here I use one constructed in `QGIS` from the Gridded Population of the World dataset) drastically changes these coefficients. This choice will need to be investigated further

Table A.13: OLS Regressions with Economic Covariates - Grid Cell Units

	All Violent Events										
	None	Baseline	GCP	Health	NL Calib.	NL 2013	Log(NL Cal+.01)	Log(NL 2013+.01)	GPDcap	NonEcon + NL Calib.	NonEcon + NL 2013
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Mean Temp.	−0.192	−3.636**	−4.084***	−2.918*	−6.071***	−5.666***	−3.133	−3.691***	−1.437	−30.210**	−11.974
	(0.135)	(1.732)	(1.147)	(1.727)	(1.640)	(1.577)	(2.233)	(1.247)	(1.460)	(13.363)	(10.041)
Mean Temp. x Full PCA Index	−0.570***	−0.216**	−0.201**	−0.259**	−0.143	−0.148	−0.159**	−0.211***	−0.342***	−0.087	−0.085
	(0.144)	(0.104)	(0.082)	(0.110)	(0.102)	(0.102)	(0.077)	(0.075)	(0.096)	(0.119)	(0.110)
Unit Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Covariate Types											
Population	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Area	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Geog. Distance	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Grid Cell Product	No	No	Yes	No	No	No	No	No	No	No	No
Infant, Child Health	No	No	No	Yes	No	No	No	No	No	No	No
Nlights Calib. Mean	No	No	No	No	Yes	No	No	No	No	Yes	No
Nlights 2013 Mean	No	No	No	No	No	Yes	No	No	No	No	Yes
Log NL Calib.+ 0.01	No	No	No	No	No	No	Yes	No	No	No	No
Log NL 2013 + 0.01	No	No	No	No	No	No	No	Yes	No	No	No
Country GDP/capita	No	No	No	No	No	No	No	No	Yes	No	No
All from Non-Econ	No	No	No	No	No	No	No	No	No	Yes	Yes
Unit of Observation	Gd.5-Yr	Gd.5-Yr	Gd.5-Yr	Gd.5-Yr	Gd.5-Yr	Gd.5-Yr	Gd.5-Yr	Gd.5-Yr	Gd.5-Yr	Gd.5-Yr	Gd.5-Yr
Observations	34,671	33,726	33,306	33,348	33,726	33,726	33,726	33,726	32,823	25,725	25,725
R^2	0.363	0.368	0.349	0.368	0.368	0.368	0.368	0.368	0.368	0.346	0.346

Notes: ***Significant at the 1 percent level.
**Significant at the 5 percent level.
*Significant at the 10 percent level.

the Version 4 DMSP-OLS Nighttime Lights Time Series.[17] However, this loss of significance only holds for nightlights and not for other economic proxies like infant mortality and child malnutrition rates "Health," for "gross cell products" from (Nordhaus, 2006) (both also from PRIO-GRID), for national level lnGDP per capita from Fearon and Laitin (2003)'s dataset (2013 vintage), or for log transformations of those same nightlight variables (ln(nightlights + 0.01)). After adding back in the full suite of non-economic controls, the addition of nightlights makes essentially no difference and the main moderator coefficient remains insignificant (Columns 10 and 11). This all adds to the concern that measures of urban-ness and economic development at the subnational level may be confounders and require further exploration.

The main effects are more broadly robust to the addition of some of the same and some similar covariates in the case of `MK-ST` units. Interestingly, for these units, population is the factor that most decreases the strength of the main coefficient, which recovers only somewhat when then normalized by area (Table A.14). Geographic distance measures actually make the main result stronger but these differ from the `GID` distance measures in important ways. They still include distance from the unit's centroid to the country border and capital but now also include the presence of the country capital in the unit and the distance to the ocean and do not include a proportion of the unit that is urban land. Such an urban-ness measure equivalent to that use for `GID` units can be constructed in future work. Also important for distinguishing `MK-ST` from `GID` results here is that geographic distance, along with natural, resource, and agricultural measures are taken from Michalopoulos and Papaioannou (2013)'s dataset which uses a subset of the total `MK-ST` units I employ and thereby reduces the sample considerably. Notably, when all of the available covariates are included, the coefficient on `Mean_Temp x Full PCA Index` remains large, even larger than when controlling for certain smaller collections of covariates, and statistically significant.

Finally, Table A.15 shows the results when various economic covariates are added. Here it takes the inclusion of all of the non-economic controls *and* nightlights to remove the statistical

[17] Image and data processing by NOAA's National Geophysical Data Center. DMSP data collected by US Air Force Weather Agency.

Table A.14: OLS Regressions with Non-Economic Covariates - Ethnic Area - Country Units

	All Violent Events									
	None	Pop	Pop+Area	Geog. Dist.	Geog. Nat	Resour.	Agric.	Political	Soc.	All
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Mean Temp.	−0.070	−2.500***	−2.155***	−6.958***	−5.282	−1.591	−1.328	−1.252	−1.271	−3.359
	(0.943)	(0.611)	(0.642)	(1.949)	(4.191)	(0.987)	(1.221)	(1.657)	(3.142)	(9.814)
Mean Temp. x Full PCA Index	−2.663**	−0.953**	−1.007***	−1.565***	−1.664***	−1.341**	−1.215**	−1.018***	−1.033**	−1.239**
	(1.040)	(0.383)	(0.385)	(0.565)	(0.637)	(0.585)	(0.565)	(0.378)	(0.421)	(0.616)
Unit Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Covariate Types										
Population	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Area	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Geog. Distance	No	No	No	Yes	No	No	No	No	No	Yes
Geog. Natural	No	No	No	No	Yes	No	No	No	No	Yes
Resources	No	No	No	No	No	Yes	No	No	No	Yes
Agricultural	No	No	No	No	No	No	Yes	No	No	Yes
Political	No	No	No	No	No	No	No	Yes	No	Yes
Societal	No	No	No	No	No	No	No	No	Yes	Yes
Unit of Observation	Mk-St-Yr	Mk-St-Yr	Mk-St-Yr	Mk-St-Yr	Mk-St-Yr	Mk-St-Yr	Mk-St-Yr	Mk-St-Yr	Mk-St-Yr	Mk-St-Yr
Observations	11,025	11,025	11,025	6,846	6,846	6,846	6,846	10,563	9,891	6,279
R^2	0.384	0.396	0.396	0.371	0.371	0.371	0.371	0.397	0.373	0.370

Notes: ***Significant at the 1 percent level.
**Significant at the 5 percent level.
*Significant at the 10 percent level.

significance of the main effect, although the inclusion of nightlights along the intensive margin from Michalopoulos and Papaioannou (2013) and lnGDP per capita from Fearon and Laitin (2003) leave coefficients that are significant only at the 0.10 level. This all confirms the need to consider economic development and various proxies thereof as confounders of the main social capital moderating effect, but suggests that the main effect may be more robust to the inclusion of such controls for `MK-ST` units.

Table A.15: OLS Regressions with Economic Covariates - Ethnic Area - Country Units

	All Violent Events									
	None	Baseline	NL 2007-8	NL 2013	Log(NL 07-08+.01)	lnNL Intsnv	Log(NL 2013+.01)	GPDcap	NonEcon + NL 07-08	NonEcon + lnNL 07-08
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Mean Temp.	−0.070	−6.958***	−7.465***	−7.357***	−6.559***	−5.739***	−6.304***	−14.524**	−3.040	−7.293
	(0.943)	(1.949)	(1.933)	(1.924)	(1.935)	(1.848)	(1.908)	(5.872)	(9.724)	(10.833)
Mean Temp. x Full PCA Index	−2.663**	−1.565***	−1.238**	−1.323**	−1.240**	−1.052*	−1.176**	−1.093*	−0.969	−0.801
	(1.040)	(0.565)	(0.586)	(0.586)	(0.545)	(0.539)	(0.572)	(0.616)	(0.651)	(0.700)
Unit Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Covariate Types										
Population	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Area	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Geog. Distance	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Nlights 2007-8	No	No	Yes	No	No	No	No	No	No	Yes
Nlights 2013 Mean	No	No	No	Yes	No	No	No	No	No	No
Log NL 2007-8	No	No	No	No	Yes	No	No	No	No	Yes
Log NL Intensive	No	No	No	No	No	Yes	No	No	No	No
Log NL 2013 + 0.01	No	No	No	No	No	No	Yes	No	No	No
Country GDP/capita	No	No	No	No	No	No	No	Yes	No	No
All from Non-Econ	No	No	No	No	No	No	No	No	Yes	Yes
Unit of Observation	Mk-St-Yr	Mk-St-Yr	Mk-St-Yr	Mk-St-Yr	Mk-St-Yr	Mk-St-Yr	Mk-St-Yr	Mk-St-Yr	Mk-St-Yr	Mk-St-Yr
Observations	11,025	6,846	6,846	6,846	6,363	6,846	6,846	6,510	6,279	5,796
R^2	0.384	0.371	0.371	0.371	0.372	0.371	0.371	0.372	0.370	0.371

Notes:
***Significant at the 1 percent level.
**Significant at the 5 percent level.
*Significant at the 10 percent level.

Appendix H: Heterogeneity in Moderator Relationships

Table A.16: Moderation of Temperature-Conflict relationship by Full Social Capital Index for Various Types of Violence, for Ethnic Area - Country Units

	All Types	Organized				Un-Organized		
	All Viol. Events	Organized Viol.	Battles	Viol. Against Civilians	Remote Viol.	Un-Organized Actions	Riots	Protests
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Mean Temperature	-0.07	-0.35	-0.35	-0.13	0.13	-0.13	0.28	-0.40
	(0.94)	(0.54)	(0.24)	(0.26)	(0.14)	(1.22)	(0.53)	(0.71)
Mean Temp. x Full PCA Index	-2.66^{**}	-1.46^{**}	-0.83^{**}	-0.38	-0.25	-3.84^{***}	-1.20^{**}	-2.63^{***}
	(1.04)	(0.60)	(0.40)	(0.57)	(0.19)	(1.32)	(0.49)	(0.86)
Baseline Rate	4.86	3.72	1.34	2.14	0.25	3.06	1.14	1.92
+1 SD Mean Temp. % Δ:								
At 25th %ile Social Cap.	12.35	6.38	6.63	2.42	39.00	28.04	31.93	25.73
At Mean Social Cap.	-0.43	-2.78	-7.8	-1.77	15.6	-1.24	7.27	-6.28
At 75th %ile Social Cap.	-13.64	-12.24	-22.72	-6.10	-8.59	-31.50	-18.22	-39.35
Unit Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Unit of Observation	Mk-St-Yr	Mk-St-Yr	Mk-St-Yr	Mk-St-Yr	Mk-St-Yr	Mk-St-Yr	Mk-St-Yr	Mk-St-Yr
Observations	11,025	11,025	11,025	11,025	11,025	11,025	11,025	11,025
R^2	0.38	0.41	0.35	0.37	0.21	0.29	0.24	0.31

Notes: ***Significant at the 1 percent level.
**Significant at the 5 percent level.
*Significant at the 10 percent level.

Table A.17: Moderation of Temperature-Conflict relationship by Specific Social Capital Indices for Various Types of Violence, for Ethnic Area - Country Units

							All Violent Events						
	TruRel	TruNei	TruKnow	TruOwn	TruOth	TruOthNat	MemComDevAssc	ComMeet	JoinRaise	TruLGov	TruTrad	ContLGov	ContTrad
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
Mean Temperature	0.57	0.75	0.74	-0.70	-0.66	-0.41	0.18	0.10	0.02	0.44	0.53	0.63	0.45
	(1.12)	(1.16)	(1.15)	(0.59)	(0.59)	(0.54)	(0.75)	(0.69)	(0.66)	(0.91)	(0.95)	(1.00)	(0.92)
Mean Temp. x Soc. Cap.	-0.67^{**}	-0.002	-0.24	-1.01^{**}	-1.48^{***}	-1.25^{**}	-1.21^{*}	-2.00^{*}	-1.59^{*}	-2.03^{**}	-1.60^{**}	-1.59^{***}	-1.11^{*}
	(0.34)	(0.52)	(0.58)	(0.47)	(0.44)	(0.53)	(0.71)	(1.03)	(0.85)	(0.83)	(0.67)	(0.57)	(0.62)
Baseline Rate	4.32	4.51	4.41	3.95	3.95	4.18	4.01	4.01	4.01	4.02	4.23	4.02	4.18
+1 SD Mean Temp. % Δ:													
At 25th %ile Social Cap.	6.54	4.98	6.10	0.32	3.27	3.01	7.98	9.59	7.47	14.06	11.02	13.23	8.79
At Mean Social Cap.	3.93	4.97	5.01	-5.51	-5.21	-2.99	1.32	0.77	0.14	3.3	3.77	4.7	3.24
At 75th %ile Social Cap.	0.63	4.95	3.87	-11.63	-14.13	-10.37	-4.26	-8.88	-6.53	-7.98	-4.16	-1.78	-0.49
Unit Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Rounds Included	345	35	45	3	3	4	123456	123456	123456	23456	246	23456	2346
Unit of Observation	Gd.5-Yr	Gd.5-Yr	Gd.5-Yr	Gd.5-Yr	Gd.5-Yr	Gd.5-Yr	Gd.5-Yr	Gd.5-Yr	Gd.5-Yr	Gd.5-Yr	Gd.5-Yr	Gd.5-Yr	Gd.5-Yr
Observations	11,949	11,949	11,949	6,342	6,342	7,644	14,238	14,238	14,238	13,146	13,146	13,146	13,146
R^2	0.38	0.38	0.38	0.40	0.40	0.45	0.38	0.39	0.39	0.38	0.38	0.38	0.38

Notes: ***Significant at the 1 percent level.
**Significant at the 5 percent level.
*Significant at the 10 percent level.