The Intensification Effects of Climate Change on Political Instability in the Long Run, 1400-1900CE*

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Abstract

This study uses historical conflict and weather data for the period of 1400-1900 CE to investigate the long-run effects of climate change on political instability in a context where traditional food production was disrupted by prolonged cooling. The results show that the effects of temperature change is non-linear over time. Large declines in temperature have little effect on conflict if they are isolated events, but consecutive periods of significant cooling are associated with more conflict. The results are consistent with the hypothesis that continued climate change can intensify the adverse consequences on economic activity and lead to political instability.

Keywords: Environment, Development, Political Economy, Economic History.

JEL Classification: D74; Q34; P16; N43; N53.

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1 Introduction

The disruptions that climate change create for economic activity, and that such disruptions can create political instability such as by increasing conflict (Miguel et al., 2004, e.g.,) are central policy concerns. The primary purpose of this paper is to study the long-run effects of climate change on conflict. Specifically, we investigate the cumulative effects of consecutive periods of temperature change, which is unclear *ex ante*. Faced with continued climate change, people can adapt – relocate, or adopt new technologies, production processes, crops, or even social or institutional structures that better suit the new environment. The compounding effects of prolonged climate change can also intensify over time. A year of drought that follows three successive years of drought may have large adverse effects if, for example, food stocks have eroded. Prolonged periods of climate change, over decades or centuries, may also begin to affect more fundamental factors, such as institutions, governance, or even culture.

The period we examine includes an era that is commonly referred to as the "Little Ice Age" by climatologists and historians. This was a period of extreme cooling, when glaciers expanded and seas froze as far south as present-day Turkey. Temperature declines were accompanied by increased variability in precipitation. This significantly reduced agricultural productivity, which, in turn, led to famines and conflicts.

By providing evidence of intensification effects in the long run, our study complements the rapidly growing body of evidence on the effects of climate change. We add to recent evidence from the little Ice Age, such as the relationships between between cooling and urbanization (Waldinger, 2022). We also add to studies documenting the short-run relationship between climate change and conflict (Miguel et al., 2004, e.g.,) and those on the relationship between non-transitory agricultural shocks and conflict in the historical context (Iyigun et al., 2020, e.g.,).

2 Background

Like modern global warming, during the "Little Ice Age", periods of climate change were characterized by high variability in precipitation, particularly in the summer, which in turn reduced agricultural output. Cycles of excessive cold and unusual rainfall often lasted for a decade or longer. The drastic reduction in agricultural productivity typically caused surges in food prices.

The reduction in agricultural productivity that resulted from cooling increased the competition for land and conflict. Belligerent neighbors also sometimes viewed the weakening of state capacity caused by climate change as a good opportunity for invasion. And the effects of climate change on conflict intensified if the disruptions were prolonged. Historical accounts suggest that continued climate change weakened state capacity, which in turn reduced internal political stability and made states vulnerable to external invasion as well as internal strife. At the same time, there are examples to suggest that afflicted populations were able to adapt with time (Fagan, 2000).

3 Data

For our analysis, we construct a new dataset of all wars and each of their battles that were fought between 1400 and 1900 CE in Europe, the Near East, and Northern Africa, and merge these data with historical climate data that were constructed by geologists and climatologists (Mann et al., 2009). Our baseline sample is at the decade and grid-cell level, where each grid-cell is 400km by 400km.

The conflict data are constructed using two sources, Brecke (1999, ming) and Clodfelter (2008), which provide information on known wars, including the locations and dates of all battles fought during a war. We manually digitized the information and geo-referenced each battle (defined as a conflict event during a war) to construct a dataset that records the date and location of over 2,700 conflicts in Europe, North Africa and the Near East between 1400 and 1900 CE. Our main outcome variable is the incidence of conflict, measured with an indicator variable that equals one if at least one conflict occurred in a grid-cell at any time during the decade. Our sample examines all conflicts fought on land. In total, there are 2,792 battles (e.g., a conflict is a battle in a location and a year).

To measure cooling, we use temperature data constructed by Mann et al. (2009). Due to the larger number of climate proxies from this context, the data are most accurate for the post-medieval period in the Northern Hemisphere, where our study takes place. These measures are based on a model that extrapolates across space and over time.

All cells contain some land.[1] The grid-cells are fairly large. For example, modern day France is the same size as approximately four grid-cells. This is important since it captures meaningful variation in the climate data as well as localized spillover effects. For example, disruptions to local agricultural productivity can lead to migration, which can lead to conflict not just in the original location, but also neighboring destinations of the migrants.

Cooling often persisted over long periods of time in our sample. Over a course of 500 years (i.e., 50 decades), the average grid cell experienced 25 decades of cooling. The cell that experienced the least cooling experienced it for 17 decades, whereas the grid cell that experienced the most cooling experienced it 33 decades.

4 Empirical Estimates

We examine the difference in temperature between the current decade and four decades ago (i.e., the fifty-year change), $\Delta_{t-4}^{t} temp_i = temp_{i,t} - temp_{i,t-4}$. To focus on the effect of large changes in cooling, the main explanatory variable is a dummy variable for a cold shock, $\Delta_{t-4}^{t} C_i$, that takes the value of one if the temperature change in the previous five decades is equal to or below the 25th percentile of the grid-cell distribution of fifty-year temperature changes (these are always temperature drops in our sample). Analogously, we create a dummy variable for a warm shock, $\Delta_{t-4}^{t} W_i$, that takes the value of one if the temperature change within the previous fifty years is equal to or above the 75th percentile of the grid-cell distribution of fifty-year

[1] The results are very similar if we exclude cells with only islands. They are available upon request.

temperature changes (these are always temperature increases in our sample). The baseline is

$$\begin{aligned} y_{it} = {} & \beta_1 \Delta_{t-4}^{t} C_i + \beta_2 \Delta_{t-9}^{t-5} C_i + \beta_3 (\Delta_{t-4}^{t} C_i \times \Delta_{t-9}^{t-5} C_i) \\ & + \gamma_1 \Delta_{t-4}^{t} W_i + \gamma_2 \Delta_{t-9}^{t-5} W_i + \gamma_3 (\Delta_{t-4}^{t} W_i \times \Delta_{t-9}^{t-5} W_i) + \Gamma \mathbf{X}_{it} + \alpha_i + \delta_t + \varepsilon_{it}. \end{aligned} \quad (1)$$

Conflict in cell i decade t, y_{it}, is a function of whether there was cooling between four decades ago and the current decade (e.g., during the past fifty years, 49 years ago to the current year), $\Delta_{t-4}^{t} C_i$, between nine decades ago and five five decades ago (e.g, the previous fifty years, 99 to 50 years ago), $\Delta_{t-9}^{t-5} C_i$, and the interaction of the two variables; the analogous variables for warming; a vector of controls $\Gamma \mathbf{X}_{it}$ (that include temperature levels in the current decade t and conflict levels one hundred years ago $(t-9)$, grid cell and time period fixed effects. Because climate change is spatially correlated and our differences contain overlapping decades, we estimate Conley standard errors that allow for spatial and temporal autocorrelation.

	Dependent Variable: Conflict Incidence									
			Suitability for Old World Staples		War Type		Border in Cell, 1401-1450		Mean Temperature, 1401-1450	
	Baseline	Grid-Cells with Climate Proxies	<= Median	> Median	Intra-State	Inter-State	None	Border	<= Median	> Median
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Cold	0.0010	-0.0294	-0.0011	0.0019	-0.0036	-0.0003	0.0009	0.0070	0.0005	0.0081
	(0.0090)	(0.0232)	(0.0050)	(0.0174)	(0.0072)	(0.0084)	(0.0056)	(0.0162)	(0.0146)	(0.0120)
Cold x Lag Cold	0.0386*	0.1545***	-0.0131	0.0766**	0.0277*	0.0145	-0.0019	0.0681**	0.0600**	0.0086
	(0.0204)	(0.0510)	(0.0117)	(0.0348)	(0.0162)	(0.0159)	(0.0100)	(0.0336)	(0.0262)	(0.0304)
Lag Cold	-0.0106	-0.0355	-0.0012	-0.0195	0.0026	-0.0112	-0.0017	-0.0185	0.0009	-0.0147
	(0.0089)	(0.0265)	(0.0072)	(0.0167)	(0.0059)	(0.0077)	(0.0045)	(0.0159)	(0.0141)	(0.0126)
Warm	0.0041	-0.0160	-0.0054	0.0145	-0.0025	0.0043	0.0062	0.0008	0.0112	-0.0012
	(0.0099)	(0.0282)	(0.0080)	(0.0171)	(0.0060)	(0.0091)	(0.0056)	(0.0163)	(0.0145)	(0.0134)
Warm x Lag Warm	-0.0263	-0.0684	-0.0117	-0.0469	-0.0145	-0.0138	-0.0054	-0.0542*	-0.0103	-0.0588**
	(0.0163)	(0.0554)	(0.0119)	(0.0314)	(0.0095)	(0.0137)	(0.0097)	(0.0281)	(0.0234)	(0.0229)
Lag Warm	-0.0034	0.0141	-0.0054	0.0027	0.0079	-0.0086	0.0038	-0.0077	-0.0139	-0.0003
	(0.0096)	(0.0316)	(0.0055)	(0.0190)	(0.0066)	(0.0085)	(0.0052)	(0.0168)	(0.0153)	(0.0135)
Temperature	-0.0549**	-0.0735	-0.0111	-0.1081**	-0.0239*	-0.0306	-0.0203*	-0.0999**	-0.0339	-0.0400
	(0.0217)	(0.0644)	(0.0125)	(0.0512)	(0.0144)	(0.0188)	(0.0110)	(0.0476)	(0.0352)	(0.0287)
Observations	11,200	2,160	5,400	5,360	11,200	11,200	5,200	6,000	5,600	5,600
R-squared	0.288	0.323	0.090	0.264	0.182	0.228	0.124	0.262	0.338	0.227

Notes : The unit of observation is a decade and a 400 km by 400km grid-cell. All regressions control for grid-cell and time period fixed effects, and conflict one hundred years ago. A cold (warm) shock is measured by Cold (Warm), a dummy variable that equals 1 if the temperature change in the past fifty years is <= 25th (>=75th) percentile of the within-cell distrubution of 50-year temperature changes. Lag Cold (Lag Warm) equals 1 if the temperature change 99 to 49 years ago is <= 25th (>=75th) percentile of the within-cell distrubution of 50-year temperature changes. In the sample, cold (warm) shocks are always decreases (increases) in temperature. The standard errors allowing for spatial and temporal autocorrelation.

Table 1 column (1) presents the baseline estimates. The uninteracted variable for temperature is negatively associated with conflict, which implies that the conflict is more likely in colder places. The uninteracted dummy variables for cold shocks in the current and previous fifty years are small and statistically insignificant. Thus, cooling over an isolated 50-year interval is unassociated with conflict. However, the interaction of the two variables shows that a place that experiences two consecutive periods of cooling experiences 3.86 percentage-points higher incidence of conflict. Hence, the adverse effects of cooling intensify over time. The estimates for warming are statistically zero. Column (2) shows that the results are similar if we restrict the analysis to grid-cells with climate proxies. Thus, our results are not an artifact of extrapolations from the Mann et al. (2009) climate model.

In columns (3)-(10), we present heterogeneous treatment effects. They show that the main result on intensification is driven by (i) places that rely on agriculture (measured using a grid-cell's average suitability for the cultivation of wheat, dry rice, wet rice, rye and barley), (ii) where there were more civil conflicts, (iii) cells with a border in 1401-1450, and (iv) places that had below sample median temperatures in 1401-1450. These results suggest that the negative effects of cooling were partly due to disruptions in agricultural production, that these disruptions had a larger effect on smaller conflicts in politically unstable locations, and that cooling was worse for places that were already cold to begin with. Note that the estimates for warming are either small in magnitude or negative in sign, and mostly statistically insignificant. The two exceptions are the interaction of warming in the past fifty years and the previous fifty years in columns (8) and (10), which are negative and statistically significant at the 10% and 5% levels. This suggests that in cells with a border and cells that are warmer to begin with (i.e., that can cultivate agriculture), the benefits of warming intensify over time and reduce conflict.

5 Conclusion

This study shows that large changes in temperature are uncorrelated with conflict, but consecutive and prolonged drops in temperature are positively associated with conflict. This is consistent with conventional wisdom that societies and economies are able to adapt to a certain amount of environmental change. But if climate change is prolonged, then the disruptions that they cause will eventually result in political and economic instability. We also find evidence that in some contexts, prolonged warming is negatively associated with conflict even though isolated periods of warming have no impact. Our estimates are specific to our context. While cooling was deterimental in places that were cold relative to the optimal temperature for economic production as in the context of this study, warming may be detrimental in places that are warm relative to the optimal temperature. The main contribution of this study is to highlight the fact that the effects of climate change are non-linear over time, which is generalizable and important for current policy discussions. A promising avenue for future research is to understand the political economic mechanisms through which prolonged climate change affect conflict.

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