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The Little Ice Age and the Demographic Changes

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Abstract

The Little Ice Age, a period of cooling that occurred from the 14th to the 19th century, had a profound impact on population dynamics across the globe. The colder temperatures led to crop failures and food shortages, which in turn resulted in widespread famine. This was particularly evident in Europe, where the population was heavily dependent on agriculture. The Great Famine of 1315-1317 was directly linked to these climatic changes and led to the death of millions. Moreover, the colder climate weakened the population's resistance to illness, making them more susceptible to epidemics. The most notable example is the Black Death, which swept across Europe in the 14th century, killing 75-200 million people. However, it's important to note that the impact of the Little Ice Age on population dynamics was not uniformly negative. In some regions, the cooler climate provided opportunities for adaptation and survival.

Keywords: Climate, Population, Demography; Famine, Illness, Epidemics

The reality of human-induced climate change and the urgency to respond have become increasingly clear among researchers, policy makers, and the wider population. Heat waves, storms, and other weather events have become more frequent and more extreme, and temperatures rise even faster than predicted only a few years ago (Cheng et al. 2019). Producing reliable estimates of the economic and social effects of climate change is a central and challenging task in the quest for tackling climate change. In this paper, I assess the impact of major climate shocks on several societal and economic outcomes by considering the historic Little Ice Age period, and thus the pre-industrial economy, as a case study. Originally coined in 1939 by Matthes to describe the increased extent of glaciers over the last 4,000 years, the term 'Little Ice Age' now usually refers instead to a climatic shift towards colder weather occurring during the second millennium. While climatologists dismiss the idea of the Little Ice Age as a global event, there is a consensus that much of the Northern Hemisphere above the tropics experienced several centuries of reduced mean summer temperatures. The impacts of climatic change during this period are of special interest today as we debate the threat of climatic change in our near future. Although the Little Ice Age involved cooling rather than the warming predicted for the next century, its history offers numerous examples of the impacts of relatively small changes in climate on human affairs. A historical source on climate is a document, i.e. a unit of information such as a manuscript, a piece of printed matter (book, newspaper, etc.), a picture or an artefact (e.g. a flood mark or an inscription on a house), which refers to weather patterns or impacts of climate. Documentary evidence may include all kinds of man-made sources. Historical climatology deals primarily with documentary evidence. This branch of knowledge is situated at the interface of climatology and environmental history. As such, its goal is to reconstruct weather and climate, as well as nat ural disasters, for the last millennium prior to the creation of national meteorological networks. Historical climatology is also concerned with investigating the vulnerability of past economies and societies to climate variations, climatic ex tremes, and natural disasters, and with exploring past dis courses and social representations related to climate. The database for historical–climatological research can be broadly categorised as being either direct or indirect data. The direct data is descriptive documentary data, e.g. narrative descriptions of weather patterns or early instrumental mea surements. Indirect or documentary proxy data reflects the impact of weather onelements in the hydrosphere (e.g. floods and low water tables), the cryosphere (e.g. duration of snow cover) or the biosphere (e.g. phenological data). According to their origin, indirect data can be either man made or based on natural proxy evidence. Documentary data are the only kind of palaeoclimatic data that are based on direct observations of different meteorological parameters (e.g. temperature, precipitation, snow-cover etc.) in terms of narrative descriptions and/or early instru mental measurements. Most importantly, they are the only evidence that is directly related to the socio-economic im pacts of rare but significant disasters, such as intense storms, severe floods, and long-lasting droughts in the period prior to the organisation of instrumental network observations. The Little Ice Age brought a significantly colder climate to large parts of Europe. It is the most recent climatic episode preceding the current human-induced period of climate change. The main results indicate a significant negative effect of relatively cool temperatures on city size. This finding is consistent with anecdotal historical evidence on the negative economic effects of low temperatures during the Little Ice Age. The synchronicity of the many disorders of mid-seventeenth century Eurasia was no accident. These events were provoked by material pressures caused by a shift of climate, which, in turn, led to violent responses that, through a "fatal synergy" intensifying the always-fearful effects of warfare, brought misery to multitudes and death to many millions. A demographic collapse bearing comparison with the Black Death disordered economies, destabilized States, and transformed cultures. Composite monarchy could propagate rebellion regionally, but only the Little Ice Age could spread disorder across the globe. The concept of 'little ice age' is not well defined; climatologists often invoke it to refer to an epoch of cooler average temperature prevailing generally from the end of "medieval warming"[1] to the beginning of our contemporary era of global warming or climatic conditions between the 1610s and the great winter of 1708/9. In this period three natural forces combined to generate generally cooler temperatures and greater climatic variability - reduced solar energy reaching the earth (the result of an interruption in the normal course of sunspot cycles); increased volcanic activity, which periodically intensified this cooling process; and a greater frequency of the El Niño-Southern Oscillation, which disrupted Asian monsoons as well as North American rain fall and, perhaps, intensified volcanic activity. As a result, almost every decade experienced a "blocked climate" of two or more years of extremely cold winters and either excessive rain or severe drought. A combination of large volcanic eruptions and lower solar irradiance favoured summer cooling in the Northern Hemisphere, which was amplified by feedback processes, such as the increase of sea ice extent in the Arctic. Temperature decrease initiated

[1] For hundreds of years in the 'High Middle Ages' climatic conditions in Europe had been kind; there were few poor harvests and famines were infrequent. The pack ice in the Arctic lay far to the north and long sea voyages could be made in the small craft then in use. Communications between Scandinavia, Iceland and Greenland were easier than they were to be again until the twentieth century. Icelanders.

at high latitudes subsequently expanded to lower latitudes in Europe, with significantly lower temperatures particularly during solar minima, namely the Maunder Minimum[2] (MM, 1645-1715; Luterbacher et al., 2001). Despite the fact that the LIA has been defined as one of the coldest and longer-lasting cold periods during the Holocene (Grove, 2004; Wanner et al., 2011), the temperature decline with respect to present-day annual values was only in the order of 0.5-1°C during the coldest stage recorded during the Maunder Minimum. Solar and volcanic forcing have contributed to episodes of colder summer temperatures and reduced cloudiness that punctuate the Holocene climate history. Holocene climate variability is punctuated by episodic climatic events such as the Little Ice Age (LIA) predating the industrial-era warming. Their dating and forcing mechanisms have however remained controversial. Temperatures started decreasing at around 1400, marking the beginning of the Little Ice Age. At 1500 the Little Ice Age had begun;1600 and 1700 both mark temperature lows. Other world regions besides Europe were also affected - for example, China, Japan, India, and West Africa. The Little Ice Age has been linked to decreases in agricultural productivity and to social unrest. There is debate among climatologists about the causes of the Little Ice Age, but reduced levels of energy emitted by the sun and increases in volcanic activity mattered. (Low levels of solar energy were caused by a reduced number of sunspots (Eddy 1976, 1189). High volcanic eruptions cool the surface of the earth by sending large quantities of sulfate gases into the atmosphere. These scatter solar radiation back to space). Historical evidence shows that many people noticed signs not only of year-to-year temperature change but of long-term temperature change. Glaciers expanded; tree lines in the high Alps fell; high mountain pastures had to be abandoned. Peasants everywhere noticed delays in fruit blossoming and delays in the beginning of growing periods, haymaking seasons, or the grape-ripening period. The North Atlantic is one of the most climatically unstable regions in the world. This is caused by a complex interaction between the atmosphere and the ocean. The main feature of this is the North Atlantic Oscillation (NAO), a seesaw of atmospheric pressure between a persistent high over the Azores and an equally persistent low over Iceland. Sometimes the pressure cells weaken and that has severe consequences for the weather in Europe. People throughout Eurasia faced periods of great hardship, usually in the form of harvest failure, and that the best laid plans of kings and generals were often foiled by foul weather. Little Ice Age, possessing a decisive agency in his narrative and revealing itself in specific, “striking” weather events that intervened in the historical process, influenced the outcome of battles, frustrated State policies, and set in motion more complex chains of events, destroying empires and altering human behaviour. The Little Ice Age caused famines that led to the starvation of millions, and, via the “fatal synergy” of famine interacting with war and rebellion, resulted in a reduction of Eurasia’s population by one-third. Notwithstanding what we do not know about population size in this era, especially outside Europe, there is a broad consensus that the sustained population growth of the long sixteenth century came to an end in the early seventeenth century, and that certain societies - especially China and the Holy Roman Empire - suffered losses of one-third or more of their population. In other areas, such as the entire Mediterranean basin, the losses were smaller, but the recovery was long delayed. In yet others - much of northern and western Europe - losses were more localized, and recovery was both forceful and immediate. Overall, Europe’s mid-seventeenth-century population appears to have been 5 percent below that of 1600, and by 1700, it was 5 to 10 percent higher than in 1600. In Asia,

[2] This absence of sunspots is called the Maunder Minimum. The Maunder Minimum occurred during the coldest period of the Little Ice Age between 1645 and 1715 AD, when the number of sunspots was very low. It is named after British astronomer E.W. Maunder who discovered the dearth of sunspots during that period. In the solar physics literature, the MM is sometimes associated with a period of cooler global temperatures, referred to as the Little Ice Age (LIA), and thus taken as compelling evidence of a large, direct solar influence on climate.

China's population crisis appears to have been unique in its severity. The upshot is that the global Little Ice Age was associated with a highly differentiated demographic performance among states and regions. One might question whether climate change was the primary agent of seventeenth-century demographic change. Indeed, historians have proposed alternatives. Goldstone, in the most recent sustained contribution to the crisis theme, argued that shifts in the level of mortality, driven by largely autonomous patterns of epidemic disease, drove population growth and decline in the early modern world. In a well-known book, the historian Geoffrey Parker (2013) suggests examining the potential links between climate and major disruptions or calamities in human activity (wars, social disturbances, famines, invasions) over the course of the seventeenth century. The dramatic climate changes around the globe in the seventeenth century underpinned the global crises and the high grain and bread prices crises (for example in 1630 and in 1661-1662 in France). The prices of grain increased and wine became difficult to produce in many areas and commercial vineyards vanished in England. It is likely that food riots or some important wars (the Wars of the Three Kingdoms between 1639 and 1651 or the so-called Fronde in France over 1648-1653) are coincident with one significant period identified by my analysis. We can derive a robust strong causality between temperature, grain prices and agricultural production over several decades; thus, climate could have lasting effects, while the adaptation of countries might be relatively slow. A one degree Celsius fall in summer temperature reduced yields of wheat by around 5 per cent, and a one standard deviation rise in summer rainfall reduced yields by around 10 per cent. While yields of the cheaper spring grains on which ordinary people subsisted were less affected by weather, their prices closely followed yields of wheat, the main commercial crop. Epidemic diseases after bad harvests were deadly at all levels of society: a 10 per cent fall in real wages caused by a bad harvest resulted in a 7 per cent rise in mortality among both unfree tenants and the high nobility in the early fourteenth century. Moreover, I investigate whether access to markets mitigated the effects of temperature on crisis mortality. If markets allowed people to purchase products that had become costlier to produce and to sell products that were not affected, then markets could have helped people to mitigate the adverse effects of temperature. The data by Wrigley and Schofield (1989) provide information on the distance between a parish and the nearest market town. For parishes far from a market, agricultural year temperature and growing-season temperatures had significant effects on crisis mortality, indicating that parishes farther away from markets experienced higher crisis mortality when temperatures fell. In parishes close to a market, the effect of temperature had the same sign but was smaller and insignificant. Historical evidence indicates that economic crises (in particular, agricultural crises) increased migration in early modern Europe - for example, after the Great Irish Famine and after times of agricultural crises in Sweden. In the mountains of western Norway, the incidence of mass movements and floods in the 17th and 18th centuries was nearly 2 orders of magnitude greater than that before or after. A striking example of the Little Ice Age's impact on animal populations is afforded by changes in the distribution of cod in the North Atlantic. At the height of the Little Ice Age, cod disappeared from the coasts of Scotland, Norway, Ice- land, and southern Greenland as polar waters penetrated farther south. With the rise of sea-surface temperatures in the late 19th century, cod recolonized its former range and again became a staple of the fisheries. Bad weather was literally a matter of life and death in pre-industrial Europe. Among Big Theories of human development, few are bigger than the idea that human history before the Industrial Revolution was driven by long cycles in climate. The idea is simple and intuitive: a society's division of labour is constrained by its population and by its surplus of resources over biological subsistence; so the greater resources available in times of mild climate can support greater social complexity.

In conclusion, the impact of climate on agricultural production is very clear. The effect of climate on social disturbance is more than plausible. The association between climate and social disturbance is in line with the recent climate-conflict literature. Studies of the Little Ice Age, and also of climatic variations on a similar scale in the more distant past, are very significant for the future. The great importance of the potential for global warming resulting from human activity and particularly the burning of fossil fuels is universally recognized. It is evidently essential to try to distinguish between climatic changes that are essentially natural and those that caused by human activity.

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