The Effect of Climate Change on Economic Decision Making

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Abstract: As climate change becomes an increasingly inescapable reality, the impact of rising temperatures on society has become a top research priority. A growing body of literature aims to understand the consequences of global warming, such as freshwater depletion, soil degradation, and sea level rise. However, the direct effects of temperature on human behavior are often overlooked, although temperature plays a significant role in how humans interact with their environment and one another. This paper aims to provide a concise overview of the direct effects of temperature on human behavior.

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1. Climate Change in Developing World

Because much of the developing world lies between the tropic of Cancer and Capricorn, earth's warmest latitudes, these parts will have to face the roughest weather changes as tropical climates are expected to experience the most intense temperature increase (Arnell et al. 2019) and temperature variation as a result of decreased soil moisture (Bathiany et al. 2018). This is further multiplied for these developing countries due to their lack of technological protection from heat, either because they are unavailable or unaffordable. As a result, these nations bear the burden of uncomfortable and dangerous temperatures more directly than wealthier and more temperate locales. As such, examining the effect of the increased temperature is especially salient for developing countries.

2. Temperature and Human Behavior

The association between temperature and aggression has been noted and studied thoroughly (Craig et al. 2016). The General Aggression Model and Routine Activity Theory are the predominant theories explaining this relationship (Van Lange, Rinderu, and Bushman 2017). The General Aggression Model outlines two categories of determinants of aggression. These include the individuals' personal and situational variables. Personal variables are individual-level predictors such as genetic dispositions, sex, and personal attitudes about violence. Situational variables include alcohol consumption, cultural influence regarding the permissibility of violence, and environmental factors like temperature.

The theory is that high temperature directly contributes to a higher propensity for violence. High temperatures may cause an increase in aggressive motivation, which under

certain circumstances can manifest in the behavior of the same kind (Craig et al. 2016). Researchers analyzing data from Major League Baseball games found that higher temperatures increased the probability of an HTP event (where the batter is Hit by The Pitch) (Larrick et al. 2011). This action could suggest that higher temperature increases the likelihood of retaliatory actions. Furthermore, an analysis of NFL (National Football League) data revealed a similar result, where the temperature had a positive relationship with aggressive penalties, such as unnecessary roughness (Craig et al. 2016). Such effects are especially pronounced in correctional facilities as high temperatures increase daily violent interactions by 20% and the probability of any violence by 18%, according to a study in Mississippi (Mukherjee and Sanders 2021).

The second theory connecting temperature and aggression, Routine Activity Theory, posits a more indirect effect. Under this theory, warmer temperatures increase the general activity level of the population, increasing all types of violent and nonviolent interactions (Sutherland, Cressey, and Luckenbill 1992). Since some proportion of interactions results in conflict, an increase in all kinds of interactions also increases violent interactions. For example, during the winter, in temperate climates, much of the time is spent indoors at home. As a result, fewer individuals are out in public, and fewer people cross paths. A review of the studies concludes that temperature fluctuations and climate change might increase crime rates (Chersich et al. 2019). Most of the studies find some positive effect of the increased temperature on assaults and crimes in general [Bushman, Wang, and Anderson (2005)](M. N. Williams, Hill, and Spicer 2015)(Sommer, Lee, and Bind 2018), but not homicide (Trujillo and Howley 2021). Interestingly some studies find that at high temperatures (90 F), the relationship reverses, possibly because it becomes so hot people seek shelter in cool spaces

(Gamble and Hess 2012). Nonetheless, a review of the data of 15 US cities has not found significant correlations between temperature from climate change and crime rates (Lynch et al. 2022). Most of the studies are conducted on municipalities or wealthy countries (such as New Zealand, the USA, and Australia), which might question generalizability. Mechanisms behind such temperature effects are unclear potential causes might be economic instability, migration, and conflicts within and between groups (Miles-Novelo and Anderson 2019).

A different theoretical finding led by experimental psychologists proposes that warmth-primes-prosociality. The theory is based on the research of Williams and Bargh (2008) (L. E. Williams and Bargh 2008), who found that people who briefly interacted with a warm object were more likely to act prosocially toward others. This is because physical warmth is thought to unconsciously activate concepts associated with interpersonal warmth, leading people to act more prosocially. This theory has been supported by subsequent studies showing a link between higher temperature, positive affect, and prosocial behaviors. For example, studies have found that participants handling a warm object are more likely to show trust, cooperate with others, and act prosocially in general compared to those holding a cold object(Storey and Workman 2013). However, more recent studies failed to replicate the effects [Bargh and Melnikoff (2019)](Lynott et al. 2017).

To sum up, a recent meta-analysis of temperature-behavior-links studies finds no statistically significant effect of temperature on aggression or prosociality (Lynott et al. 2023). Moreover, the research concludes that the results support the lack of such a relationship and speculates that the reported outcomes result from p-hacking or faulty causal modeling. While there might be a connection between temperature and human behavior, it is likely

mediated through something else.

2.1. Temperature and Productivity

Let us examine the labor supply decision of an individual whose work is not climate controlled, a common situation for most of the developing world. This worker chooses between supplying their labor for a wage or enjoying free time to pursue leisure. As temperature increases, the disutility of supplying labor relative to the utility of leisure is increased, which should result in the agent choosing less labor and more leisure. If this decision happens at scale, it will correspond to a contraction in labor supply and a reduction in output.

This result has been observed in microdata from Indian manufacturing firms, which estimated reduced productivity and absenteeism on hot days (Somanathan et al. 2021). This study lends credence to the theory that excess temperature not only reduces willingness to work but also suggests that even when work is supplied, the quality and quantity suffer. This argument is further supported by a study conducted on office workers in which they found that for every degree above 89 degrees Fahrenheit, productivity decreased by approximately 2% (Seppanen, Fisk, and Lei 2006). For those in developing nations, the mechanism at work may be less important than its consequence. What is salient is that an increase in temperature could further reduce economic activity in countries that already struggle to compete.

Most studies look at low-skilled workers' productivity as the most affected by the temperature, and their productivity is easier to measure. A recent study examined professional decision makers (US immigration judges) who have access to climate control and found that hotter temperatures decrease the likelihood of favorable decisions for US immigration court

cases, with a 10°F increase reducing such decisions by 6.55% (Heyes and Saberian 2019). This finding prompts other researchers to examine other effects of temperature on cognitive work besides productivity.

As firms look to maximize employees' productivity, the temperature is seen as an influential factor. Modern offices are built with climate control to help maintain optimal temperatures throughout the building. For a person not familiar with the effects of temperature on employee productivity, the million-dollar investments might seem excessive. A recent systematic review of the connection between "Thermal Comfort and Productivity in Building" concluded that the ideal temperature for productivity is around 22-24 °C, and temperatures above 24-26 °C and below 20 °C hinder performance. However, the effects of temperature are highly subjective, task and context-specific (Bueno, de Paula Xavier, and Broday 2021).

Several recent papers examined the effects of industrial production in connection to temperature changes. Higher summer temperatures significantly negatively impact China's industrial output, though the result is less pronounced in warmer regions, possibly because of previous adaptations (Chen and Yang 2019). Studies conducted in the USA (Isen, Rossin-Slater, and Walker 2017) and Equador (Fishman, Carrillo, and Russ 2019) find that above-average in-utero temperature can lead to reduced education and lower earning for adults 30 years later. However, the effects seem to be mitigated by air conditioning availability for mothers.

2.2. Temperature and Mental Function

Uncomfortable temperature affects not only the body but also the mind. The excessive temperature has been associated with two concerning results: cognitive impairment and risk-seeking behavior. Excessively high temperature is unpleasant and distracting, and it also stresses the body. When the body is excessively hot, it spends a lot of its resources maintaining homeostasis (Rochais et al. 2019). This depletes glucose levels which can lead to lower cognitive abilities. High temperatures stress the body, consuming glucose in the brain and negatively affecting cognition (Cedeño Laurent et al. 2018).

(H. Wang et al. 2014)Although the brain comprises only 2% of the body's mass, it utilizes 25% of glucose and 20% of oxygen (Squire et al. 2012). It is a metabolically demanding organ that produces heat [howarthUpdatedEnergyBudgets2012] and is sensitive to temperature fluctuations (Kiyatkin, Brown, and Wise 2002). The brain's thermal regulatory capacity may affect its anatomical and physiological structure, influencing its processing capacity due to its temperature-dependent energy expenditure efficiency (Yu, Hill, and McCormick 2012).

A study of United States Naval officers found that hot and moist environments significantly degraded their performance in morse decoding (Mackworth 1946). Results such as these were not limited to the lab. In a study using data from the National Longitudinal Survey of Youth (NLSY) combined with random weather fluctuations, researchers found evidence for decreases in cognitive performance in the short run on math tests when temperatures exceeded 78.8 degrees Fahrenheit (Graff Zivin, Hsiang, and Neidell 2018). Other studies have found that temperature can have a significant impact on high-stakes cognitive performance on tests according to studies from the USA (Park 2016), China(Graff Zivin et

al. 2020), India (Garg, Jagnani, and Taraz 2020), potentially affecting equitable access to higher education.

It is not inconceivable that the long-run effect of increased temperature may not be mitigated in the developing world. During this study, strategies for coping with excessive heat available in the United States may only be possible in some developing countries. While a school in the United States could install an air conditioning system, this option is expensive and likely unavailable to schools in developing nations. As a result, long-term negative cognitive consequences could still be felt in developing countries. In addition to reductions in cognition, there is some evidence that increased temperature can lead to more risk-seeking behaviors.

Laboratory experiments have shown that individuals trend towards high-risk and high-yield options when ambient temperatures are higher (X. Wang 2017). Another research suggests that higher temperatures harm decision-making and risk-taking abilities by draining mental resources, reducing the prevalence of gambling (lotteries), and especially complex gambling (Cheema and Patrick 2012). While taking risks may not always be negative, these two taken in conjunction could be worrisome. After all, high-risk behavior, which may coincide with a reduction in cognitive abilities (if temperature causes both a decrease in cognition and an increase in risk-seeking behavior), is doubtful to produce positive results.

The effects of climate change go far beyond temperature as these global processes increase the frequency of catastrophic events such as tornados, earthquakes, draughts, and floods. We are not looking at these consequences of temperature change.

One of the effects of temperature is the exacerbation of mental illnesses. High tem-

peratures associated with climate change may increase the risk of heat stroke and death among individuals taking certain psychotropic medications and may also negatively impact the mental health of vulnerable populations such as the elderly, youth, Indigenous peoples, and those living in low- and middle-income countries. The literature review (Charlson et al. 2021) found a significant positive association between high temperatures and various mental health outcomes, including distress, hospital admissions for mental and neurological disorders, mortality attributed to mental and behavioral disorders, self-harm, and suicide rates. The susceptibility to these outcomes varies based on demographic variables such as age and type of disorder. While studies attempting to quantify the burden of mental disorders attributable to climate change are sparse, the available evidence suggests that the burden of disease related to climate change for mental disorders is not insignificant.

On the one hand, the available research paints a fairly bleak picture. The direct effect of temperature rise on individuals in the developing world could be extremely detrimental for equatorial developing nations. While some countries in the colder regions might welcome these increased temperatures (though the losses still outweigh the benefits), the evidence suggests excess heat may increase the propensity for violence, decrease productivity, and impair cognition. On the other hand, the results of the studies do not seem to be reliable and likely temperature effects can be negated with adaptation.

While, for many, the ultimate results of increased temperature will undoubtedly be more important than the causal mechanisms at play, understanding these mechanisms could offer insight into how humanity might address this problem.

3. Lorem Ipsum

3.1. Main Section 1

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3.1.1. Subsection 1

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A. Frequently Asked Questions

A.1. How do I change the colors of links?

Pass in `urlcolor:` in yaml. Or set these in the include-in-header file.

If you want to completely hide the links, you can use:

{`\hypersetup{allcolors=.}`}, or even better:

{`\hypersetup{hidelinks}`}.

If you want to have obvious links in the PDF but not the printed text, use:

{`\hypersetup{colorlinks=false}`}.