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Crime, weather, and climate change

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ABSTRACT

This paper estimates the impact of climate change on the prevalence of criminal activity in the United States. The analysis is based on a 30-year panel of monthly crime and weather data for 2997 US counties. I identify the effect of weather on monthly crime by using a semi-parametric bin estimator and controlling for state-by-month and county-by-year fixed effects. The results show that temperature has a strong positive effect on criminal behavior, with little evidence of lagged impacts. Between 2010 and 2099, climate change will cause an additional 22,000 murders, 180,000 cases of rape, 1.2 million aggravated assaults, 2.3 million simple assaults, 260,000 robberies, 1.3 million burglaries, 2.2 million cases of larceny, and 580,000 cases of vehicle theft in the United States.

Introduction

A small body of research has begun to suggest that civil conflict and warfare are influenced by changes in climate (Burke et al., 2012; Hsiang et al., 2011). However, less is known about the implications of climate change for more common categories of criminal behavior. Studies of the short-term relationship between crime and weather show that higher temperatures cause substantial increases in crime (Horrocks and Menclova, 2011; Brunsdon et al., 2009; Bushman et al., 2005; Cohn, 1990), implying that climate change could have important impacts on criminal activity. However, because crime rates exhibit negative serial correlation over a span of weeks (Jacob et al., 2007), the hour-to-hour or day-to-day relationship between weather and crime is unlikely to be informative about the long-term effects of climate change on criminal behavior.

To address this gap in the literature, this paper develops the first comprehensive estimates of the impact of climate change on US crime rates. My analysis draws on historical data to estimate the causal relationship between weather and crime, and then uses this relationship to predict future crime levels under the weather conditions expected under the IPCC's A1B scenario.[2] To support the analysis, I have constructed a panel dataset that includes monthly crime and weather data for 2997 US counties for the period from 1980 to 2009. My data on criminal activity are drawn from the US Federal Bureau of

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[2] All climate projections cited in this paper are based on the IPCC's A1B scenario. A1B is a "middle-of-the-road" scenario that tends to produce emissions and climate results that are intermediate between high emissions scenarios such as A1FI and low emissions scenarios such as B1. This scenario represents a future world with high rates of economic growth and substantial convergence between developing and developed economies, where rapid technological change is based on a balance of fossil-fuel intensive and non-fossil sources of energy (IPCC, 2000). Under this scenario, the IPCC predicts that global temperatures will rise by about 5 °F (2.8 °C) by the year 2099, compared to baseline temperatures between 1980 and 1999 (IPCC, 2007).

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Investigation's Uniform Crime Reporting (UCR) data. These data, which are based on monthly reports from 17,000 US law enforcement agencies, tabulate offenses in nine major categories: murder, manslaughter, rape, aggravated assault, simple assault, robbery, burglary, larceny, and vehicle theft. I merge these data with temperature and precipitation records from weather stations in the US National Climatic Data Center's Global Historical Climatology Network Daily (GHCN-Daily) dataset. After combining these two data sources, I generate a dataset with 891,000 unique county-by-year-by-month observations.

To identify the effect of daily weather on monthly crime, I use a Poisson regression approach with semi-parametric weather variables (Deschenes and Greenstone, 2011) that measure the number of days per month spent in each of 11 maximum daily temperature bins ($<10\,^{\circ}$F, 10–20 °F,…, 90–100 °F, $\geq 100\,^{\circ}$F) and five daily precipitation bins (0 mm, 1–4 mm, 5–14 mm, 15–29 mm, and ≥ 30 mm). I regress monthly crime on these bin variables, controlling for extensive fixed effects that capture average crime and weather conditions in each county-by-year and state-by-month group of observations. Finally, I use the results from these regressions to predict crime rates under the weather patterns likely to be experienced in each decade between 2010 and 2099, based on projections of future US climate drawn from 15 general circulation models.

My analysis makes two main contributions. First, I document a striking relationship between monthly weather patterns and crime rates. Across a variety of offenses, higher temperatures cause more crime. For most categories of violent crime, this relationship appears approximately linear through the entire range of temperatures experienced in the continental United States. However, for property crimes (such as burglary and larceny), the relationship between temperature and crime is highly non-linear, with a kink at approximately 50 °F. Above this cutoff, changes in temperature have little effect on crime rates. These results improve on past research in several ways: in my use of a semi-parametric specification, which allows for a more flexible functional form than the linear or quadratic specifications imposed in previous work; in my focus on within-year variation as a way to address the measurement error issues created by long-term inter-annual trends in the quality of crime reporting; and in my use of an unusually rich 30-year panel dataset on monthly crime and weather for the entire continental United States, rather than the daily or weekly regional datasets that have been used in most previous analyses of the relationship between crime and weather.

Second, I develop the first detailed predictions of how climate change will affect patterns of criminal activity in the United States. My results suggest that in the year 2090, crime rates for most offense categories will be 1.5–5.5% higher because of climate change. Under the IPCC's A1B climate scenario, the United States will experience an additional additional 22,000 murders, 180,000 cases of rape, 1.2 million aggravated assaults, 2.3 million simple assaults, 260,000 robberies, 1.3 million burglaries, 2.2 million cases of larceny, and 580,000 cases of vehicle theft, compared to the total number of offenses that would have occurred between 2010 and 2099 in the absence of climate change.[3] The present discounted value of the social costs of these climate-related crimes is between 38 and 115 billion dollars.

To put these numbers in perspective, recent research suggests that a 1% increase in the size of a city's police force results in an approximate 0.3% decrease in violent crimes and a 0.2% decrease in property crimes, with some variation across types of offenses (Chalfin and McCrary, 2012). Based on these elasticities, an immediate and permanent 4% increase in the size of the US police force would be required to offset the aggregate climate-related increases in murder, manslaughter, robbery, burglary, and vehicle theft that are likely to occur over the next century.[4] However, even with this additional law enforcement activity, climate change would still cause an additional 120,000 cases of rape, 1.0 million aggravated assaults, 1.5 million simple assaults, and 760,000 larcenies. These rough calculations imply that the most obvious mechanism for adapting to climate-related crime—increasing the size of the police force—would require a substantial public investment in law enforcement activity.

I am aware of only two previous empirical studies of the effects of climate change on crime in the United States: Anderson et al. (1997) and Rotton and Cohn (2003). Both papers are based on annually-averaged data for large geographic units (e.g., Anderson et al. regress average annual US crime rates on average annual US temperatures), and thus may face challenges with empirical identification of how weather affects crime rates. Furthermore, findings from these studies may be biased by the substantial year-to-year reporting inconsistencies in the FBI's UCR crime data. In contrast, by using monthly crime data and daily weather data for a panel that includes almost all US counties, and by using a semi-parametric fixed-effects approach to analyze month-to-month changes in crime rates within each county and year, my analysis solves the potential econometric issues with this previous work.

The remainder of this paper is organized as follows: the first section, "Background on weather and crime," provides background on the relationship between weather and crime; the second section, "Data," describes the primary data sources; the third section, "Methodology," discusses my empirical methodology; the fourth section, "Results," presents my main findings on the relationship between climate change and crime; the fifth section, "Discussion," discusses the results; and the last section, "Conclusion," concludes the paper.

[3] For comparison, I assume that the total baseline number of crimes that will occur in the United States between 2010 and 2099 will be 980,000 murders, 37,000 cases of manslaughter, 5.7 million cases of rape, 52 million aggravated assaults, 189 million simple assaults, 25 million robberies, 135 million burglaries, 429 million cases of larceny, and 72 million cases of vehicle theft. These totals are based on the assumption that crime rates during the next century will be similar to actual crime rates between 2000 and 2009.

[4] Because different crimes have different elasticities with respect to policing, a 4% change in the size of the police force would—in addition to offsetting the climate-related increase in murder, manslaughter, robbery, burglary, and vehicle theft—prevent an additional 300,000 robberies and 400,000 cases of vehicle theft over the next 90 years.