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Climate Change and Economic Activity: Evidence from U.S. States

EPRG Working Paper **2208**
Janeway Institute Working Paper Series **2022/03**
Cambridge Working Paper in Economics **2205**

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In earlier work we show that changes in the distribution of weather patterns (i.e., climate change) are not only affecting low-income countries and those in hot climates, but also advanced economies and those in cold climates (albeit to different degrees across climates and income levels). More specifically, using estimates from a panel of 174 countries over the past half century, we conducted a counterfactual study and show that in the absence of global mitigation policies, per-capita GDP of the United States would be 10-17 percent lower by 2100.

Do these cross-country results hold in a within-country context (e.g., in the United States as an advanced economy with a diverse climate and partial resilience-building success against climate change)? How large are the effects of climate change on state-level economic activity in the U.S.? Are there level or growth effects? Are the effects non-linear and/or asymmetrical? What are the channels of impact and which sectors of the U.S. economy are affected the most? What is the role of climate variability and adaptation? Answers to these questions can inform the development of a long-term mitigation and adaptation strategy for the United States (and by extension climate policies in other advanced economies).

While cross-country studies are informative, they also have drawbacks. Averaging temperature and precipitation data at the country level leads to a loss of information, especially in geographically diverse countries such as the United States. Using within-country data for the U.S. and a novel econometric strategy, which links deviations of temperature and precipitation (weather) from their long-term moving-average historical norms (climate) to various state-specific economic performance indicators at the aggregate and sectoral levels, we investigate the long-term macroeconomic effects of weather patterns transformed by climate change across 48 states over the period 1963--2016. The within-country geographic heterogeneity of the U.S. enables one to compare whether economic activity in `hot' or `wet' states responds to a temperature increase in the same way as economic activity does in `cold' or `dry' states. The richness of the United States data also allows for a more disaggregated study of the climate change--growth relationship and enables one to test whether the country at the aggregate level, parts of the country, or particular sectors of the economy have been affected more by climate change. It also allows one to investigate the channels of impact: labour productivity, employment, and output growth in various sectors of the economy.

Additionally, we contribute to the literature along the following dimensions. Firstly, we differentiate between level and growth effects and estimate the long-term macroeconomic impact of persistent increases in temperature and precipitation. Secondly, we use the half-panel Jackknife FE (HPJ-FE) estimator to deal with the possible bias and size distortion of the commonly-used FE estimator. Thirdly, we depart from the literature in focusing on changes in the distribution of weather patterns (not only averages of temperature and precipitation but also their variability) and introducing an implicit model of adaptation. Fourthly, we allow for state-specific and time-varying climate thresholds---a subtle form of nonlinearity – and also test for asymmetric weather effects. Finally, we avoid the econometric pitfalls associated with the use of trended variables, such as temperature, in output growth equations.

Our within-country results provide evidence for the damage that climate change causes in the U.S. using various economic indicators at the state level: growth rates of Gross State Product (GSP), GSP per capita, labour productivity, and employment as well as output in different sectors (e.g., agriculture, manufacturing, services, retail and wholesale trade). We show that if temperature increases by 0.01°C annually above its historical norm across U.S. states persistently, average per-capita real GSP growth will be lower by around 0.03 percentage points per year; a number that is smaller than those obtained in cross-country regressions of Kahn et al. (2021). We show that the impact of climate change on sectoral output growth is broad based, each of the 10 sectors considered is affected by at least one of the four climate variables. Moreover, in contrast to most cross-country results, the within U.S. estimates tend to be asymmetrical with respect to deviations of climate variables from their historical norms (in the positive and negative directions). Finally, while we acknowledge some resilience-building efforts in different states, the evidence seems to suggest that it has not entirely offset the negative effects of climate change at the country level.

Our findings call for a more forceful policy response to the threat of climate change, including more ambitious mitigation and adaptation efforts.

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Publication February 2022
Financial Support Keynes Fund, University of Cambridge