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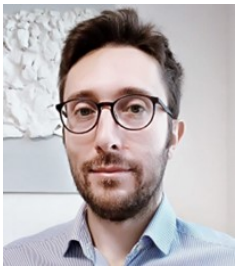
The effect of extreme temperatures on the US economy and on the conduct of monetary policy*



By Filippo Natoli (Bank of Italy)

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The question of how high-frequency variations in temperatures affect the economy is key to understand whether the conduct of monetary policy might be shaped by a changing climate. I show that an unexpectedly high number of very hot or cold days in a quarter had negative impact on the United States economy in the last 50 years. US-wide temperature shocks, constructed by weighting unexpected county-level extremes, reduce GDP, consumer prices and interest rates, suggesting a slowdown in aggregate demand and an expansionary reaction by the Federal Reserve.

*The opinions expressed in this paper are those of the author and do not necessarily reflect the views of the Banca d'Italia or the Eurosystem.

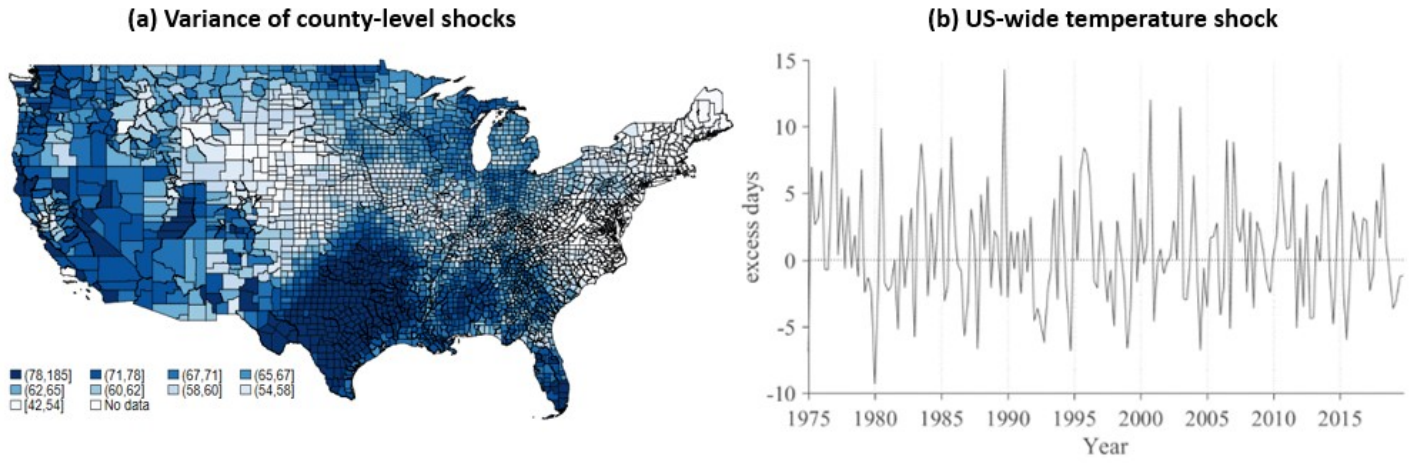
Climate change is a threat for current and future economic performance, not only in emerging but also in advanced countries like the United States (see Dell et al., 2014 and Carleton and Hsiang, 2016 for a review). In order to design appropriate adaptation and mitigation measures, policymakers need to have a clear picture of the overall implications of temperature variations on the economy. While there is evidence on the medium-run effects on output growth, less is known about how temperature swings at *higher frequencies* affect economic outcomes; moreover, the final repercussions on consumer prices, which concur to determine the response of monetary policy, are still unclear.

In a new study (Natoli 2023), I take up this issue by quantifying the impact of extreme temperatures in the United States at business cycle frequency. I investigate how GDP, private consumption and investment are affected, how the Consumer Price Index responds and, in turn, how these effects propagate to short and long-term interest rates on government bonds. For this purpose, I propose a new way to identify the unpredictable component of extreme temperature realizations, in line with the notion of a shock in macroeconomics.

Using daily average temperatures in each US county since the 1970s, quarterly county-level shocks are computed as the difference between the actual number of very hot and cold days within the quarter and their average incidence in the same county and quarter in the past five years. Such formulation reflects the idea that, based on their most recent experience, economic agents learn over time about the distribution of daily temperatures and update their beliefs accordingly: if the number of - unhealthy and unpleasant - hot and cold days in one quarter differs from expectations, it represents an economically relevant "surprise". This approach stresses the importance of *unexpected* temperature variations - beyond any possible adaptive measure put in place in the short run - in driving the effects of weather on the economy. US-wide shocks are then obtained by weighting surprises in each county by their population shares.

Figure 1 displays the variance of the shocks across counties (panel a) and the evolution over time of the US-wide shocks (panel b). The first picture reveals that, between 1975 and 2019, surprises (both positive and negative) have been largest in southern and western counties; the second one shows that, at the national level, adjustments in the shape of the temperature distribution have been largest – inducing bigger shocks – in the early part of the sample than in recent times. This implies that very hot and cold days have become more the normality today, somewhat less surprising than in the past.

Figure 1: Variance of county-level shocks and US-wide temperature shocks



The effect of temperatures on the US economy and monetary policy

The constructed US-wide shock is then used to study the average response of key economic variables to temperature variations between 1975q1 to 2019q4, using local projections. Figure 2 shows the impacts on the US economy up to 16 quarters after the shock: exceptional temperatures have a negative effect on GDP, which increases over time reaching a trough after 2 years, with a strong impact coming from private investment. Moreover, shocks reduce the Consumer Price Index (although with a lag), suggesting that demand-side effects are predominant. Temperatures also induce a significant reaction by the Federal Reserve and financial markets, displayed in Figure 3: in line with the response of GDP, the Fed's economic nowcasts (produced within the set of Greenbook Forecasts) are also revised down, tracking the downturn as time passes (first picture). This induces an expansionary monetary policy reaction as short rates also fall, with effects spreading out to the long-end of the yield curve (second and third picture).

Figure 2: The effects of temperatures on the US economy, up to 16 quarters after the shock

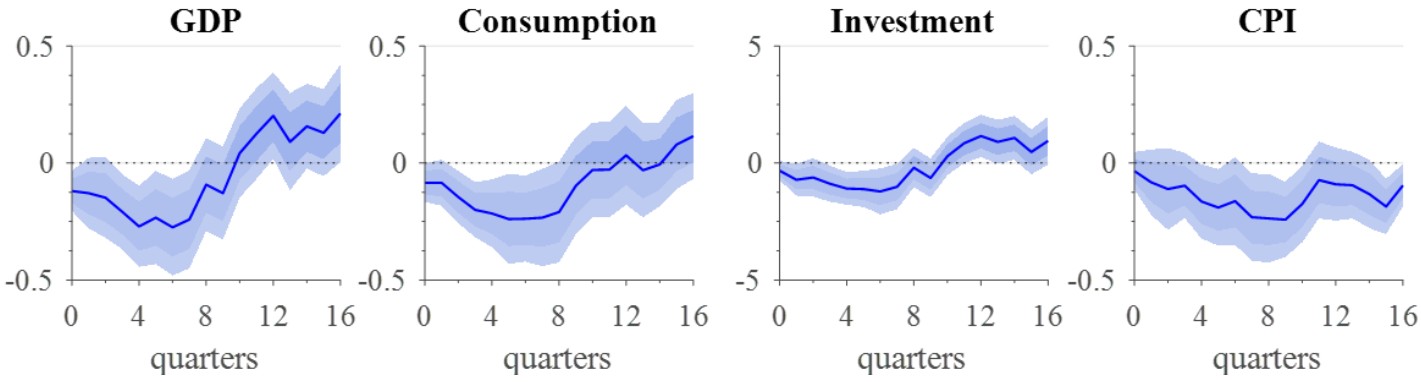
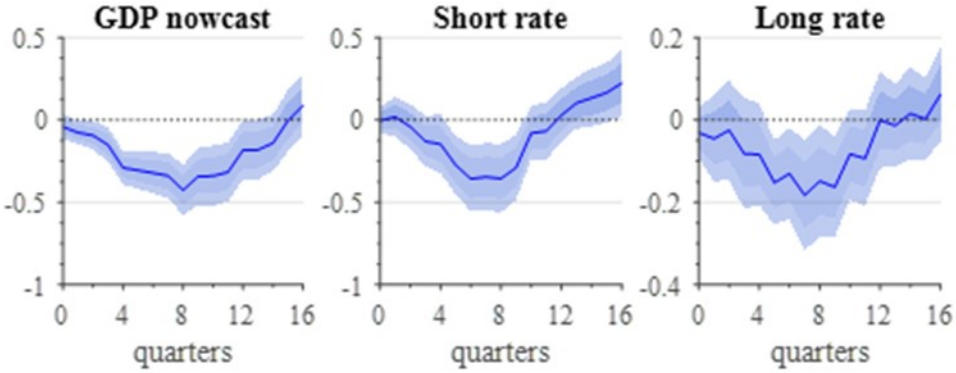


Figure 3: Federal Reserve and financial markets reactions, up to 16 quarters after the shock



All in all, these findings suggest that climate-related shocks within the year are able to significantly damage economic output and to reduce consumer prices, influencing the conduct of US monetary policy. The technique used to construct the US temperature shock can be applied to other economies and can serve as a reference to obtain other weather-related shocks under the same logic.

References

Carleton, T.A., Hsiang, S.M., 2016. Social and economic impacts of climate. Science 353, Issue 6304.

Dell, M., Jones, B.F., Olken, B.A., 2014. What Do We Learn from the Weather? The New Climate-Economy Literature. Journal of Economic Literature 52, 740–98.

Jorda, 2005. Estimation and Inference of Impulse Responses by Local Projections. American Economic Review 95, 161–182.

Natoli, F. (2023) "The macroeconomic effects of temperature surprise shocks". Available at SSRN: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=4160944.

About the author

Filippo Natoli *is a Senior Economist at the Directorate General for Economics, Statistics and Research of Bank of Italy. His research interests lie at the intersection of macroeconomics and finance, with a focus on monetary and fiscal policy and on the economic implications of climate change. He holds a PhD in Economics from LUISS University of Rome, Italy.*

SUERF Secretariat
c/o OeNB
Otto-Wagner-Platz 3
A-1090 Vienna, Austria
Phone: +43-1-40420-7206
www.suerf.org • suerf@oenb.at