“Electricity demand and climate adaptation in Brazil: sectoral demand shocks under alternative extreme temperature measures”

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Abstract

Available empirical estimate of energy consumption’s sensitivity to extreme temperatures has focused mainly on developed countries characterized by temperate climate regimes. In contrast, fewer empirical studies exist for developing or emerging economies in tropical regions. Focusing on Brazil, we adopt a dataset of monthly data from 2004 to 2016 disaggregated by three economic sectors and 27 States. We estimate reduced form responses of electricity demand to heat stress based on a dynamic econometric model. The dynamic setting makes it possible to identify both short-run (intensive margin) and long-run (extensive margin) effects of climatic and socio-economic drivers on electricity consumption. We further contribute to the empirical literature by testing the adequacy of a set of alternative weather variables (namely average temperature, Cooling Degree Days with varying thresholds, and temperature bins) in capturing the intensive and extensive margin effects. We find that (i) the residential electricity demand responds non-linearly to thermal stress, (ii) commercial demand responds approximately linearly and (iii) aggregate industrial consumption is insensitive to heat stress. The estimated long-run elasticities are combined with downscaled shared socioeconomic pathways (SSPs) projections of GDP and population to project electricity demand under no climate change circa 2050 at 0.5° gridded resolution. Our projections indicate a three to four-fold increase of total national electricity demand relative to 2010 due to socio-economic drivers alone, a figure consistent with projections in the Integrated Assessment Modeling literature. We further apply grid-cell level projections of our alternative heat stress variables under future climate change scenarios to construct vectors of shocks to baseline electricity demand. We find that depending on the thermal stress variable adopted, projected additional electricity required due to climate change in 2050 ranges from 4%-18% (3%-11%) of baseline demand for the residential (commercial) sector under RCP 4.5, and to 6%-26% (4%-16%) under RCP 8.5. Results underscore that the choice of the weather indicator measuring thermal stress considerably affects the range of the projected impact of climate change.

Acknowledgments

This project has received funding from the European Research Council (ERC) under the European Union's Horizon 2020 research and innovation programme under grant agreement No 756194 (ENERGYA). The authors would like to thank Enrica De Cian for very helpful comments and suggestions.