Working paper

International Growth Centre

On the Distribution of Climate Damages in the Poor World

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The project aims to construct a global climate-economy (integrated-assessment---IA) model in order to evaluate climate and welfare consequences in the world---with special focus on poor countries---at a high level of resolution. The pilot project followed three lines: (i) construction and numerical solution of a pilot high-resolution IA model; (ii) study of high-resolution data on temperatures and outputs; (iii) studies, using low-resolution (one-region) IA models, of the roles of different production and market structures and technological change for the evolution of world energy use, to be used later in the calibrated high-resolution model.

The construction and numerical solution of the pilot (not yet calibrated) model was completed successfully. The model has several thousand regions and delivers global paths for output and other economic variables and for regional climates. It features climate uncertainty and several realistic market frictions and is significantly more sophisticated and richer than Nordhaus's 8-region RICE, arguably the most advanced current model. Its microeconomic underpinnings also allow welfare evaluation, which is critical in the poor-rich comparison.

Using annual data from the IPCC on temperatures in 5-by-5 degree cells ("regions"), relationships between local and global temperatures were estimated using "statistical downscaling" (a methodology borrowed from meteorology). Regional temperatures respond to global temperature in highly region-specific ways, with some regions responding much more than one-for-one. Weather "shocks", moreover, are large, persistent, and heteroskedastic. Second, using economic data for 1-by-1 degree cells from the G-Econ database, cross-sectional temperature-output relationships were estimated; they will be used to calibrate the high-resolution model. Controlling for the country in which a region resides, a statistically and quantitatively significant effect of decadal average temperature on GDP/capita was established: a 1-degree regional temperature increase decreases regional GDP/capita by 0.9%. Finally, panel data was constructed to relate average five-year growth rates of regional GDP/capita (aggregated to 5-by-5 degree cells) to average temperatures during the previous five years. There are statistically significant but, contrary to existing evidence using annual panel data for countries, quantitatively small effects of weather shocks on either levels or growth rates of GDP/capita. These relationships are not discernibly different across rich and poor regions.

The most notable findings from the one-region IA analyses include (i) novel aggregate measures of energy-saving technical change, indicating a sharp growth increase following the oil-price increases in the 1970s, thus indicating an important role for "directed technical change"; (ii) an argument that monopoly in fossil fuel markets is likely quantitatively important and should be included in any global model; and (iii) an improved (relative to RICE) carbon-cycle model, leading to roughly doubled damage costs.

The project's next stages include (i) further statistical downscaling based not on historical data but on climate projections available from the IPCC, thus allowing the model to appropriately capture "out-of-sample" temperature behaviour; (ii) output-temperature analyses using more data; (iii) calibration of the full high-resolution model, incorporating the key features from the one-region studies; and (iv) quantitative analysis of the distributional (region-by-region) effects of climate change and of policies to mitigate and/or adapt to it.

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