The Macroeconomic Impact of Climate Change: Global vs. Local Temperature

Read-Me File for Replication

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January, 2026

This is the documentation for the replication materials for "The Macroeconomic Impact of Climate Change: Global vs. Local Temperature" (Bilal and Känzig, 2026). It contains information about the data, detailing the sources and accessibility, as well as software requirements and explanations on how to run the codes to replicate all the results in the article.

Overview. The replication package is structured into two subfolders: a `1_empirics` folder and a `2_model` folder. The empirics folder contains a subfolder `data` where the source data is stored. The `_main_analysis.do` file is the main shell that produces all emprical results. Figures and tables are stored in the `3_output/1_figures` and `3_output/2_tables` folders. Output for the estimation of the structural model is saved in the `1_empirics/output folder`.

The model folder contains the Matlab script `AAA_MAIN.m`, which estimates the model and produces the counterfactuals and social cost of carbon estimates shown in the paper., as well as auxiliary functions called by the script `AAA_MAIN.m`. `worldoutput.do` produces the world GDP per capita series.

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1 Data

The data is stored in the `1_empirics/data` folder. The folder contains the following files, which include our global time-series, our panel datasets, as well as country classification crosswalks to other datasets used in the literature. Table 1 presents an overview of the relevant files:

Table 1: Overview of Data Files

File name	Description
`micc_bu_ts.dta`	Time-series dataset for Barro-Ursua sample, 1860-2019.
`micc_bu_panel.dta`	Panel dataset for Barro-Ursua sample, 1860-2019.
`micc_pwt_ts.dta`	Time-series dataset for PWT sample, 1960-2019.
`micc_pwt_panel.dta`	Panel dataset for PWT sample, 1960-2019.
`dell_countries.dta`	Country classification file based on Dell et al. (2012)
`burke_countries.dta`	Country classification file based on Burke et al. (2015)

The variables and their sources are detailed in Tables 2-3 below.

Table 2: Data Series in BU Panel

Variable	Description	Source
`rgdp_bud`	Real GDP	Barro and Ursúa (2008)
`rgdppc_bud`	Real GDP per capita	Barro and Ursúa (2008)
`rgdppc_world_bud`	World real GDP per capita, chain-weighted	Barro and Ursúa (2008)/own calculations
`rgdp_world_bud`	World real GDP, chain-weighted	Barro and Ursúa (2008)/own calculations
`rgdp_world0_bud`	World real GDP, simple weighted	Barro and Ursúa (2008)/own calculations
`rgdppc_world0_bud`	World real GDP per capita, simple weighted	Barro and Ursúa (2008)/own calculations
`rgdppc_gmd`	Real GDP per capita, GMD	Müller et al. (2025)
`rgdppc_world_gmd`	World real GDP per capita, GMD, chain-weighted	Müller et al. (2025)/own calculations
`pcom`	Energy commodity price index	Global financial data/own calculations
`poil_wti`	WTI price	Global financial data
`pop_bud`	Population	Barro and Ursúa (2008)
`pop_world_bud`	World population, chain-weighted	Barro and Ursúa (2008)/own calculations
`treasury10y`	10Y U.S. treasury yield	Global financial data
`gtmp_noaa_aw`	Global mean temperature, NOAA	NOAA

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Variable	Description	Source
gtmpanom_noaa_aw	Global mean temperature anomaly, NOAA	NOAA
gtmp_noaa_aw_dtfe2	Global temperature shock, NOAA, Hamilton filtered h=2, p=6	NOAA/own calculations
gtmp_noaa_aw_dtfe2s	Global temperature shock, NOAA, Hamilton filtered h=2, p=6, standardized	NOAA/own calculations
gtmp_noaa_aw_dtfe1	Global temperature shock, NOAA, Forecast-error h=1, p=6	NOAA/own calculations
gtmp_noaa_aw_dtfe1s	Global temperature shock, NOAA, Forecast-error h=1, p=6, standardized	NOAA/own calculations
gtmp_noaa_aw_dthp1100	Global temperature shock, NOAA, One-sided HP with λ=100	NOAA/own calculations
gtmp_noaa_aw_dthp1100s	Global temperature shock, NOAA, One-sided HP with λ=100, standardized	NOAA/own calculations
gtmp_nasa_aw	Global mean temperature, NASA	NASA
gtmp_bkly_aw	Global mean temperature, Berkeley Earth	Berkeley Earth
oni	Oceanic Nino Index	Webb and Magi (2022)
volcano_count	Number of volcanic eruptions	NOAA

Table 3: Data Series in PWT Panel

Variable	Description	Source
rgdpna_pwt	Real GDP from national accounts, PWT	PWT
rgdppc_pwt	Real GDP per capita, PWT	PWT
rgdppc_wdi	Real GDP per capita, WDI	WDI
rgdpe_pwt	Real GDP (expenditure side), PWT	PWT
rgdpna_world_pwt	World real GDP, PWT, chain-weighted	PWT/own calculations
rgdpna_world0_pwt	World real GDP, PWT, simple weighted	PWT/own calculations
rgdppc_world_pwt	World real GDP per capita, PWT, chain-weighted	PWT/own calculations
rgdppc_world0_pwt	World real GDP per capita, PWT, simple weighted	PWT/own calculations
rgdppc_world_wdi	World real GDP per capita, WDI	WDI
poil_wti	Crude oil price	FRED
pcom_bloomberg	Commodity price index, Bloomberg	Global financial data
treasury1y	1Y U.S. treasury yield	FRED
inv_pwt	Investment (perpetual inventory method), PWT	PWT
invpc_pwt	Investment per capita, PWT	PWT
kpc_pwt	Capital stock per capita, PWT	PWT
rtfpna_pwt	TFP, PWT	PWT
laborprod	Labor productivity (output over employment), PWT	PWT/own calculations
pop_pwt	Population, PWT	PWT
pop_world_pwt	World population, PWT, chain-weighted	PWT/own calculations
gtmp_bkly_aw	Global mean temperature, Berkeley Earth	Berkeley Earth
gtmpanom_bkly_aw	Global mean temperature anomaly, Berkeley Earth	Berkeley Earth

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Variable	Description	Source
gtmp_bkly_aw_dtfe2	Global temperature shock, Berkeley Earth, Hamilton filtered h=2, p=2	Berkeley Earth/own calculations
gtmp_bkly_aw_dtfe2s	Global temperature shock, Berkeley Earth, Hamilton filtered h=2, p=2, standardized	Berkeley Earth/own calculations
gtmp_bkly_aw_dtfe1	Global temperature shock, Berkeley Earth, Forecast-error h=1, p=2	Berkeley Earth/own calculations
gtmp_bkly_aw_dtfe1s	Global temperature shock, Berkeley Earth, Forecast-error h=1, p=2, standardized	Berkeley Earth/own calculations
gtmp_bkly_aw_dthp1100	Global temperature shock, Berkeley Earth, One-sided HP with $\lambda = 100$	Berkeley Earth/own calculations
gtmp_bkly_aw_dthp1100s	Global temperature shock, Berkeley Earth, One-sided HP with $\lambda = 100$, standardized	Berkeley Earth/own calculations
gtmp_noaa_aw	Global mean temperature, NOAA	NOAA
gtmp_noaa_aw_dtfe2s	Global temperature shock, NOAA, Hamilton filtered h=2, p=2, standardized	NOAA/own calculations
gtmp_nasa_aw	Global mean temperature, NASA	NASA
gtmp_nasa_aw_dtfe2s	Global temperature shock, NASA, Hamilton filtered h=2, p=2, standardized	NASA /own calculations
lctmp_bkly_pw	Country-level temperature, population-weighted, Berkeley Earth	Berkeley Earth/own calculations
lctmpanom_bkly_pw	Country-level temperature anomaly, population-weighted, Berkeley Earth	Berkeley Earth/own calculations
lctmp_bkly_pw_dtfe2	Country-level temperature shock, Berkeley Earth, Hamilton filtered h=2, p=2	Berkeley Earth/own calculations
lctmp_bkly_pw_dtfe1	Country-level temperature shock, Berkeley Earth, Forecast-error h=1, p=2	Berkeley Earth/own calculations
high_tas_95_r_aw	Share of days with temperature above threshold 1950–80, area-weighted	ISIMIP/own calculations
high_tas_95_r_awma	Share of days with temperature above threshold 1950–80, area-weighted, 3y MA	ISIMIP/own calculations
high_pr_99_r_aw	Share of days with precipitation above threshold 1950–80, area-weighted	ISIMIP/own calculations
high_pr_99_r_awma	Share of days with precipitation above threshold 1950–80, area-weighted, 3y MA	ISIMIP/own calculations
high_wind_99_r_aw	Share of days with wind speed above threshold 1950–80, area-weighted	ISIMIP/own calculations
high_wind_99_r_awma	Share of days with wind speed above threshold 1950–80, area-weighted, 3y MA	ISIMIP/own calculations
low_pr_25_r_aw	Share of days with precipitation below threshold 1950–80, area-weighted	ISIMIP/own calculations
low_pr_25_r_awma	Share of days with precipitation below threshold 1950–80, area-weighted, 3y MA	ISIMIP/own calculations
gtmp_bkly_awocean	Global mean temperature (ocean surface), Berkeley Earth	Berkeley Earth/own calculations
gtmp_bkly_awocean_dtfe2	Global temperature shock (ocean surface), Berkeley Earth, Hamilton filtered h=2	Berkeley Earth/own calculations
gtmp_bkly_awlandwoa	Global mean temperature (land without Antarctica), Berkeley Earth	Berkeley Earth/own calculations

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Variable	Description	Source
gtmp_bkly_awlandwoa_dtfe2	Global temperature shock (land without Antarctica), Berkeley Earth, Hamilton filtered h=2	Berkeley Earth/own calculations
extmp_bkly_pwdw_dtfe2	External temperature shock, Berkeley Earth, distance-weighted, Hamilton filtered	Berkeley Earth/own calculations
extmp_bkly_pwtw_dtfe2	External temperature shock, Berkeley Earth, trade-weighted, Hamilton filtered	Berkeley Earth/own calculations
oni	Oceanic Nino Index	NOAA
volcano_count	Number of volcanic eruptions	NOAA

2 Replication

Software and computational requirements. We use Stata and Matlab for the analysis in the paper. All codes were written and tested in Stata 16.1 and Matlab 2024b on a personal computer. On a MacBook Pro laptop with 2.4 GHz 8-Core Intel Core i9 processors and 64 GB 2667 MHz DDR4 memory, the whole code takes about 20 minutes to run.

Replication codes. The replication codes are located in the 1_empirics and the 2_model folders. All figures and numbers in the paper can be generated by following the below steps. The results are saved in the 3_output/1_figures and 3_output/2_tables folders.

For the empirical part of the paper, all the codes are located in the 1_empirics folder. All results can be reproduced by running the main shell _main_analysis.do. Table 4 provides more details for each step of the analysis.

Table 4: Replication Steps: Empirical Part

Script	Description	Software
s00a_temperature_plots.do	Produces descriptive plots of global and country-level temperature series used in the analysis.	Stata
s01L_lp_ts_globalshock.do	Estimates time-series local-projection responses to global temperature shocks (BU sample).	Stata
s01S_lp_ts_globalshock.do	Estimates time-series local-projection responses to global temperature shocks (PWT sample).	Stata
s02a_lp_ts_globalshock_bootstrap.m	Computes bootstrap confidence intervals for convoluted time-series local-projection estimates.	MATLAB
s02b_lp_ts_globalshock_bootstrap_shockuncertainty.m	Implements bootstrap inference accounting for shock uncertainty in the time-series analysis.	MATLAB
s02b_var_ts_globalshock.m	Estimates VAR-based time-series responses to global temperature shocks.	MATLAB
s02c_lp_ts_matlabfigs.do	Imports MATLAB output and formats time-series impulse response figures.	Stata
s03L_lp_panel_globalshock.do	Estimates panel local-projection responses to global temperature shocks (BU sample).	Stata
s03S_lp_panel_globalshock.do	Estimates panel local-projection responses to global temperature shocks (PWT sample).	Stata
s04S_lp_panel_localshock.do	Estimates panel local-projection responses to local (country-level) temperature shocks (PWT sample).	Stata
s05S_lp_panel_extremeevents.do	Estimates panel responses to extreme temperature and precipitation events (PWT sample).	Stata
s06S_lp_panel_extremeevents_bottomup.do	Implements bottom-up aggregation of country-level extreme-event responses (PWT sample).	Stata
s07S_lp_panel_externalshock.do	Estimates panel responses to external temperature shocks constructed from foreign exposure (PWT sample).	Stata
s08S_lp_panel_globalshock_regions.do	Estimates heterogeneous panel responses to global temperature shocks across regions (PWT sample).	Stata

For the modeling part of the paper, all the codes are located in the 2_model/ folder. All results can be reproduced by running the main shell AAA_MAIN.m. Table 5 provides more details for each step of the analysis.

Table 5: Replication Steps: Quantitative Part

File / function	Description	Software
AAA_MAIN	Main MATLAB script that sets options, loads data, runs estimation/solution, counterfactuals, and produces figures/tables for the quantitative results.	MATLAB
LoadData	Loads the inputs used in the quantitative analysis (PWT and BU impulse response functions for global and local temperature shocks, and regional variants) and stores them in structured containers (e.g., Data.PWT, Data.BU, Data.PWTR).	MATLAB
SCCparameters	Initializes the carbon-cycle/SCC-related parameters and default carbon pulse sizes used for SCC calculations.	MATLAB
WarmingScenario	Constructs the warming/temperature path used for counterfactual transition experiments.	MATLAB
ExternalEconomicParameters	Sets preference/production parameters and utility function used throughout the model solution.	MATLAB
NumericalParameters	Defines numerical grids and convergence tolerances for the household value function problem.	MATLAB
EstimateAndSolve	Core estimation and solution routine: fits the reduced-form impulse responses for a given dataset and shock specification, estimates the damage process, and solves the model to produce transition paths and impulse responses (output, capital, consumption, productivity), welfare, and the SCC.	MATLAB
SolveCounterfactuals	Convenience wrapper that solves the counterfactual model for welfare and SCC objects given a set of damages and baseline steady state.	MATLAB
Counterfactual	Solves counterfactual equilibria given path of shocks, returning implied transitions paths and SCC.	MATLAB
SolveHouseholdSS	Solves the household steady-state value function using finite-difference methods on the capital grid.	MATLAB
SolveHouseholdTransition	Solves the household value function along the transition path given time-varying shocks.	MATLAB
IRF	Computes model transition paths (output, capital, consumption, welfare) from policy functions.	MATLAB
evalPolicy	Interpolates consumption, savings, and value functions at the current capital level using the capital grid.	MATLAB
FindZeroInterp	Finds the grid point where a function crosses zero using linear interpolation.	MATLAB
ConvolutionMatrix	Builds the convolution matrix used to map transitory shocks into persistent temperature responses.	MATLAB
mycon	Nonlinear constraint used for precaution in estimation to guard against extreme cases.	MATLAB

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File / function	Description	Software
FiguresFitCIsep	Generates model fit figures with confidence bands (data vs. fitted responses) and saves output to disk.	MATLAB
FiguresTransitionCIsep	Generates transition/SCC figures with confidence bands and saves output to disk.	MATLAB
TableResults	Exports baseline quantitative objects (e.g., welfare, SCC, transition outcomes) into a table format for LaTeX import.	MATLAB
FiguresRetroSep	Produces figures for the retrospective exercise since 1960 comparing observed world output to a counterfactual without historical warming.	MATLAB
FiguresWelfareSCCsep	Plots welfare and SCC across sensitivity cases (discounting, warming by 2100, climate sensitivity, and alternative estimation targets) and saves the figures.	MATLAB
FiguresTransitionRegions	Produces region-specific transition and SCC figures based on region-level reduced-form estimates and corresponding model solutions.	MATLAB
AxisFonts	Helper to standardize font sizes for axes, labels, legends, and titles in figures.	MATLAB
plotCI	Helper that draws shaded confidence bands for figures.	MATLAB
printPDF	Utility script that exports the current figure to PDF with the correct size.	MATLAB

References

Barro, Robert J. and José F. Ursúa (2008). "Macroeconomic Crises since 1870". *Brookings Papers on Economic Activity* 1, pp. 255–335.

Bilal, Adrien and Diego Känzig (2026). "The Macroeconomic Impact of Climate Change: Global vs. Local Temperature". *Forthcoming, Quarterly Journal of Economics*.

Burke, Marshall, Solomon M. Hsiang, and Edward Miguel (2015). "Global non-linear effect of temperature on economic production". *Nature* 527.7577, pp. 235–239.

Dell, Melissa, Benjamin F. Jones, and Benjamin A. Olken (2012). "Temperature shocks and economic growth: Evidence from the last half century". *American Economic Journal: Macroeconomics* 4.3, pp. 66–95.

Müller, Karsten, Chenzi Xu, Mohamed Lehbib, and Ziliang Chen (2025). *The global macro database: A new international macroeconomic dataset*. Tech. rep. National Bureau of Economic Research.